APPENDIX A
IMPROVED RAOC F_Q SURVEILLANCE TS

T

$F_Q(Z)$ (RAOC-~~W~~(Z) Methodology)
3.2.1B

3.2 POWER DISTRIBUTION LIMITS

T

3.2.1B Heat Flux Hot Channel Factor ($F_Q(Z)$ (RAOC-~~W~~(Z) Methodology)

LCO 3.2.1B $F_Q(Z)$, as approximated by $F_Q^C(Z)$ and $F_Q^W(Z)$, shall be within the limits specified in the COLR.

APPLICABILITY: MODE 1.

ACTIONS

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. ------------NOTE------------ Required Action A.4 shall be completed whenever this Condition is entered. --------------------------------	A.1	Reduce THERMAL POWER ≥ 1% RTP for each 1% $F_Q^C(Z)$ exceeds limit.	15 minutes after each $F_Q^C(Z)$ determination
	AND		
$F_Q^C(Z)$ not within limit.	A.2	Reduce Power Range Neutron Flux - High trip setpoints ≥ 1% for each 1% ~~$F_Q^C(Z)$ exceeds limit.~~ that THERMAL POWER is limited below RATED THERMAL POWER by Required Action A.1.	72 hours after each $F_Q^C(Z)$ determination
	AND		
	A.3	Reduce Overpower ΔT trip setpoints ≥ 1% for each 1% ~~$F_Q^C(Z)$ exceeds limit.~~ that THERMAL POWER is limited below RATED THERMAL POWER by Required Action A.1.	72 hours after each $F_Q^C(Z)$ determination
	AND		
	A.4	Perform SR 3.2.1.1 and SR 3.2.1.2.	Prior to increasing THERMAL POWER above the limit of Required Action A.1

T

$F_Q(Z)$ (RAOC-~~W~~(Z) Methodology)
3.2.1B

OR
B.2.1 --------------------NOTE--------------------
Required Action B.2.4 shall be completed whenever Required Action B.2.1 is performed
----
Limit THERMAL POWER to less than RATED THERMAL POWER and reduce AFD limits as specified in the COLR.

Implement a RAOC operating space specified in the COLR that restores $F_Q^W(z)$ to within its limits.

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. ~~--------NOTE-------- Required Action B.4 shall be completed whenever this Condition is entered. ------------------~~ $F_Q^W(Z)$ not within limits.	B.1 ~~Reduce AFD limits ≥ 1% for each 1% $F_Q^W(Z)$ exceeds limit.~~	4 hours 4 hours
	AND	
	B.2 .2 Reduce Power Range Neutron Flux - High trip setpoints ≥ 1% for each 1% that ~~the maximum allowable power of the AFD limits is reduced.~~ THERMAL POWER is limited below RATED THERMAL POWER by Required Action B.2.1.	72 hours
	AND	
	B.~~3~~ 2.3 Reduce Overpower ΔT trip setpoints ≥ 1% for each 1% that ~~the maximum allowable power of the AFD limits is reduced.~~	72 hours
	AND	
	B.~~4~~ 2.4 Perform SR 3.2.1.1 and SR 3.2.1.2.	Prior to increasing THERMAL POWER above the ~~maximum allowable power of the AFD limits~~ limit of Required Action B.2.1
C. Required Action and associated Completion Time not met.	C.1 Be in MODE 2.	6 hours

T

$F_Q(Z)$ (RAOC-~~W~~(Z) Methodology)
3.2.1B

SURVEILLANCE REQUIREMENTS

~~-----NOTE-----~~
~~During power escalation at the beginning of each cycle, THERMAL POWER may be increased until an equilibrium power level has been achieved, at which a power distribution map is obtained.~~

SURVEILLANCE		FREQUENCY
SR 3.2.1.1	Verify $F_Q^C(Z)$ is within limit.	Once after each refueling prior to THERMAL POWER exceeding 75% RTP <u>AND</u> Once within [~~12~~ 24] hours after achieving equilibrium conditions after exceeding, by ≥ 10% RTP, the THERMAL POWER at which $F_Q^C(Z)$ was last verified <u>AND</u> [31 EFPD thereafter <u>OR</u> In accordance with the Surveillance Frequency Control Program]

T

$F_Q(Z)$ (RAOC-~~W~~(Z) Methodology)
3.2.1B

SURVEILLANCE REQUIREMENTS (continued)

	SURVEILLANCE	FREQUENCY
SR 3.2.1.2	~~-----NOTE-----~~ ~~If measurements indicate that the~~ ~~maximum over z [$F_Q^C(Z)$ / K(Z)]~~ ~~has increased since the previous evaluation of $F_Q^C(Z)$:~~ ~~a. Increase $F_Q^W(Z)$ by the greater of a factor of [1.02] or by an appropriate factor specified in the COLR and reverify $F_Q^W(Z)$ is within limits or~~ ~~b. Repeat SR 3.2.1.2 once per 7 EFPD until either a. above is met or two successive flux maps indicate that the~~ ~~maximum over z [$F_Q^C(Z)$ / K(Z)]~~ ~~has not increased.~~ ~~----------~~	within [24] hours after achieving equilibrium conditions after thermal power exceeds 75% RTP
	Verify $F_Q^W(Z)$ is within limit.	Once after each refueling ~~prior to THERMAL POWER exceeding 75% RTP~~ AND 24 Once within [~~12~~] hours after achieving equilibrium conditions after exceeding, by ≥ 10% RTP, the THERMAL POWER at which $F_Q^W(Z)$ was last verified AND

T

$F_Q(Z)$ (RAOC-~~W~~(Z) Methodology)
3.2.1B

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE	FREQUENCY
	[31 EFPD thereafter OR In accordance with the Surveillance Frequency Control Program]

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APPENDIX B
IMPROVED RAOC F_Q SURVEILLANCE TECHNICAL SPECIFICATION BASES

T

$F_Q(Z)$ (RAOC-~~W~~(Z) Methodology)
B 3.2.1B

B 3.2 POWER DISTRIBUTION LIMITS

T

B 3.2.1B Heat Flux Hot Channel Factor ($F_Q(Z)$ (RAOC-~~W~~(Z) Methodology)

BASES

BACKGROUND

The purpose of the limits on the values of $F_Q(Z)$ is to limit the local (i.e., pellet) peak power density. The value of $F_Q(Z)$ varies along the axial height (Z) of the core.

$F_Q(Z)$ is defined as the maximum local fuel rod linear power density divided by the average fuel rod linear power density, assuming nominal fuel pellet and fuel rod dimensions. Therefore, $F_Q(Z)$ is a measure of the peak fuel pellet power within the reactor core.

During power operation, the global power distribution is limited by LCO 3.2.3, "AXIAL FLUX DIFFERENCE (AFD)," and LCO 3.2.4, "QUADRANT POWER TILT RATIO(QPTR)," which are directly and continuously measured process variables. These LCOs, along with LCO 3.1.6, "Control Bank Insertion Limits," maintain the core limits on power distributions on a continuous basis.

$F_Q(Z)$ varies with fuel loading patterns, control bank insertion, fuel burnup, and changes in axial power distribution.

$F_Q(Z)$ is measured periodically using the incore detector system. These measurements are generally taken with the core at or near equilibrium conditions.

Equilibrium conditions are defined as being at a stable reactor power (i.e., within ± 1% RTP) and at stable axial flux conditions (i.e., with an axial flux difference variability of ± 1% over the previous 24 hours). Equilibrium conditions are not required for performance of the $F_Q(z)$ measurements during power ascension following refueling, but plant conditions should be stable during the data collection period (i.e., power within ±1% RTP of the desired power level and axial offset changing by less than 0.5% from the start to the end of the flux map data collection).

Using the measured three dimensional power distributions, it is possible to derive a measured value for $F_Q(Z)$. However, because this value represents an equilibrium condition, it does not include the variations in the value of $F_Q(Z)$ which are present during nonequilibrium situations such as load following or power ascension.

To account for these possible variations, ~~the equilibrium value of $F_Q(Z)$ is adjusted as $F_Q^W(Z)$ by an elevation dependent factor that accounts for the calculated worst case transient conditions.~~

the elevation dependent measured planar radial peaking factors, $F_{XY}(z)$, are increased by an elevation dependent factor, $[T(z)]^{COLR}$, that accounts for the expected maximum values of the transient axial power shapes postulated to occur during RAOC operation. Thus, $[T(z)]^{COLR}$ accounts for the worst case non-equilibrium power shapes that are expected for the assumed RAOC operating space.

The RAOC operating space is defined as the combination of AFD and Control Bank Insertion Limits assumed in the calculation of a particular $[T(z)]^{COLR}$ function. The $[T(z)]^{COLR}$ factors are directly dependent on the AFD and Control Bank Insertion Limit assumptions. The COLR may contain different $[T(z)]^{COLR}$ functions that reflect different operating space assumptions. If the limit on $F_Q(z)$ is exceeded, a more restrictive operating space may be implemented to gain margin for future non-equilibrium operation.

Core monitoring and control under non-equilibrium conditions are accomplished by operating the core within the limits of the appropriate LCOs, including the limits on AFD, QPTR, and control rod insertion.

BASES

APPLICABLE SAFETY ANALYSES

This LCO precludes core power distributions that violate the following fuel design criteria:

a. During a large break loss of coolant accident (LOCA), the peak cladding temperature must not exceed 2200°F (Ref. 1),

b. During a loss of forced reactor coolant flow accident, there must be at least 95% probability at the 95% confidence level (the 95/95 DNB criterion) that the hot fuel rod in the core does not experience a departure from nucleate boiling (DNB) condition,

c. During an ejected rod accident, the energy deposition to the fuel must not exceed 280 cal/gm (Ref. 2), and

d. The control rods must be capable of shutting down the reactor with a minimum required SDM with the highest worth control rod stuck fully withdrawn (Ref. 3).

Limits on $F_Q(Z)$ ensure that the value of the initial total peaking factor assumed in the accident analyses remains valid. Other criteria must also be met (e.g., maximum cladding oxidation, maximum hydrogen generation, coolable geometry, and long term cooling). However, the peak cladding temperature is typically most limiting.

$F_Q(Z)$ limits assumed in the LOCA analysis are typically limiting relative to (i.e., lower than) the $F_Q(Z)$ limit assumed in safety analyses for other postulated accidents. Therefore, this LCO provides conservative limits for other postulated accidents

$F_Q(Z)$ satisfies Criterion 2 of 10 CFR 50.36(c)(2)(ii).

LCO

The Heat Flux Hot Channel Factor, $F_Q(Z)$, shall be limited by the following relationships:

$F_Q(Z) \leq (CFQ / P)\ K(Z)$ for $P > 0.5$

$F_Q(Z) \leq (CFQ / 0.5)\ K(Z)$ for $P \leq 0.5$

where: CFQ is the $F_Q(Z)$ limit at RTP provided in the COLR,

limit

K(Z) is the normalized FQ(Z) as a function of core height provided in the COLR, and

P = THERMAL POWER / RTP

T

$F_Q(Z)$ (RAOC-~~W~~T(Z) Methodology)
B 3.2.1B

BASES

LCO (continued)

2.50

For this facility, the actual values of CFQ and K(Z) are given in the COLR; however, CFQ is normally a number on the order of [~~2.32~~], and K(Z) is a function that looks like the one provided in Figure B 3.2.1B-1.

For Relaxed Axial Offset Control operation, $F_Q(Z)$ is approximated by $F_Q^C(Z)$ and $F_Q^W(Z)$. Thus, both $F_Q^C(Z)$ and $F_Q^W(Z)$ must meet the preceding limits on $F_Q(Z)$.

An $F_Q^C(Z)$ evaluation requires obtaining an incore flux map in MODE 1. From the incore flux map results we obtain the measured value ($F_Q^M(Z)$) of $F_Q(Z)$. Then,

$$F_Q^C(Z) = F_Q^M(Z)\ [1.0815]$$

where [1.0815] is a factor that accounts for fuel manufacturing tolerances and flux map measurement uncertainty.

$F_Q^C(Z)$ is an excellent approximation for $F_Q(Z)$ when the reactor is at the steady state power at which the incore flux map was taken.

The expression for $F_Q^W(Z)$ is:

$$F_{XY}^M(z)\,\frac{[T(z)]^{COLR}}{P}\,A_{XY}(z)\,Rj\,[1.0815]$$

$$F_Q^W(Z) = \cancel{F_Q^C(Z)\,W(Z)}$$

INSERT 1 (next page)

~~where W(Z) is a cycle dependent function that accounts for power distribution transients encountered during normal operation. W(Z) is included in the COLR. The $F_Q^C(Z)$ is calculated at equilibrium conditions.~~

The $F_Q(Z)$ limits define limiting values for core power peaking that precludes peak cladding temperatures above 2200°F during either a large or small break LOCA.

This LCO requires operation within the bounds assumed in the safety analyses. Violating the LCO limits for $F_Q(z)$ could result in unacceptable consequences if a design basis event were to occur while $F_Q(z)$ exceeds its specified limits. Calculations are performed in the core design process to confirm that the core can be controlled in such a manner during operation that it can stay within the LOCA $F_Q(Z)$ limits. If $F_Q^C(Z)$ cannot be maintained within the LCO limits, reduction of the core power is required, and if $F_Q^W(Z)$ cannot be maintained within the LCO limits ~~, reduction of the AFD limits is required. Note that sufficient reduction of the AFD limits will also result in a reduction of the core power.~~ a more restrictive RAOC operating space must be implemented or core power limits and AFD limits must be reduced.

~~Violating the LCO limits for $F_Q(Z)$ produces unacceptable consequences if a design basis event occurs while $F_Q(Z)$ is outside its specified limits.~~

INSERT 1

The various factors in this expression are defined below:

$F_{XY}^{M}(z)$ is the measured radial peaking factor at axial location z and is equal to the value of $F_{Q}^{M}(z)/P^{M}(z)$, where $P^{M}(z)$ is the measured core average axial power shape.

$[T(z)]^{COLR}$ is the cycle and burnup dependent function, specified in the COLR, which accounts for power distribution transients encountered during non-equilibrium normal operation. $[T(z)]^{COLR}$ functions are specified for each analyzed RAOC operating space (i.e., each unique combination of AFD limits and Control Bank Insertion Limits). The $[T(z)]^{COLR}$ functions account for the limiting non-equilibrium axial power shapes postulated to occur during normal operation for each RAOC operating space. Limiting power shapes at both full and reduced power operation are considered in determining the maximum values of $[T(z)]^{COLR}$. The $[T(z)]^{COLR}$ functions also account for the following effects: (1) the presence of spacer grids in the fuel assembly, (2) the increase in radial peaking in rodded core planes due to the presence of control rods during non-equilibrium normal operation, (3) the increase in radial peaking that occurs during part-power operation due to reduced fuel and moderator temperatures, and (4) the increase in radial peaking due to non-equilibrium xenon effects. The $[T(z)]^{COLR}$ functions are normally calculated assuming that the Surveillance is performed at nominal RTP conditions with all shutdown and control rods fully withdrawn, i.e., all rods out (ARO). Surveillance specific $[T(z)]^{COLR}$ values may be generated for a given surveillance core condition.

P is the THERMAL POWER / RTP.

$A_{XY}(z)$ is a cycle, burnup, and power dependent function specified in the COLR or determined at the time of the surveillance using an approved 3D core model and the methodology of Reference 6. It adjusts the measured $F_{XY}^{M}(z)$ to the reference core conditions assumed in generating the $[T(z)]^{COLR}$ factors. Normally, this reference core condition is HFP, ARO, EQXE. For simplicity, $A_{XY}(z)$ may be assumed to be 1.0. If, however, margin is needed for a Surveillance performed at conditions different from the reference core conditions, then the appropriate values for $A_{XY}(z)$ may be used. Sub-factors of $A_{XY}(z)$ may also be determined and included in the COLR. These sub-factors are $F_{PC}(z)$ and $F_{RC}(z)$. $F_{PC}(z)$ is a factor that adjusts the measured $F_{XY}^{M}(z)$ to the reference core power (typically RTP) if the Surveillance is performed at part power conditions. $F_{RC}(z)$ is a factor that adjusts the measured $F_{XY}^{M}(z)$ values to the reference rodded condition (typically ARO) if the surveillance condition includes insertion of the lead control bank. When these sub-factors are used, $A_{XY}(z)$ is the product of $F_{PC}(z)$ and $F_{RC}(z)$.

[1.0815] is a factor that accounts for fuel manufacturing tolerances and measurement uncertainty.

Rj is a cycle and burnup dependent analytical factor specified in the COLR that accounts for potential increases in $F_{Q}^{W}(z)$ between Surveillances. Rj values are provided for each RAOC operating space.

--REVIEWER'S NOTE--

WCAP-17661-P-A, "Improved RAOC and CAOC F_Q Surveillance Technical Specifications," or other appropriate plant specific methodology, is to be listed in the COLR description in the Administrative Controls Section 5.0 to address the methodology used to derive this factor.

T

$F_Q(Z)$ (RAOC-~~W~~(Z) Methodology)
B 3.2.1B

BASES

APPLICABILITY

The $F_Q(Z)$ limits must be maintained in MODE 1 to prevent core power distributions from exceeding the limits assumed in the safety analyses. Applicability in other MODES is not required because there is either insufficient stored energy in the fuel or insufficient energy being transferred to the reactor coolant to require a limit on the distribution of core power.

ACTIONS

A.1

Reducing THERMAL POWER by ≥ 1% RTP for each 1% by which $F_Q^C(Z)$ exceeds its limit, maintains an acceptable absolute power density. $F_Q^C(Z)$ is $F_Q^M(Z)$ multiplied by a factor accounting for manufacturing tolerances and measurement uncertainties. $F_Q^M(Z)$ is the measured value of $F_Q(Z)$. The Completion Time of 15 minutes provides an acceptable time to reduce power in an orderly manner and without allowing the plant to remain in an unacceptable condition for an extended period of time. The maximum allowable power level initially determined by Required Action A.1 may be affected by subsequent determinations of $F_Q^C(Z)$ and would require power reductions within 15 minutes of the $F_Q^C(Z)$ determination, if necessary to comply with the decreased maximum allowable power level. Decreases in $F_Q^C(Z)$ would allow increasing the maximum allowable power level and increasing power up to this revised limit.

A.2

that THERMAL POWER is limited below RATED THERMAL POWER by Required Action A.1

A reduction of the Power Range Neutron Flux - High trip setpoints by ≥ 1% for each 1% ~~by which $F_Q^C(Z)$ exceeds its limit,~~ is a conservative action for protection against the consequences of severe transients with unanalyzed power distributions. The Completion Time of 72 hours is sufficient considering the small likelihood of a severe transient in this time period and the preceding prompt reduction in THERMAL POWER in accordance with Required Action A.1. The maximum allowable Power Range Neutron Flux - High trip setpoints initially determined by Required Action A.2 may be affected by subsequent determinations of $F_Q^C(Z)$ and would require Power Range Neutron Flux - High trip setpoint reductions within 72 hours of the $F_Q^C(Z)$ determination, if necessary to comply with the decreased maximum allowable Power Range Neutron Flux - High trip setpoints. Decreases in $F_Q^C(Z)$ would allow increasing the maximum allowable Power Range Neutron Flux - High trip setpoints.

T

$F_Q(Z)$ (RAOC-~~W~~(Z) Methodology)
B 3.2.1B

BASES

ACTIONS (continued)

that THERMAL POWER is limited below RATED THERMAL POWER by Required Action A.1

A.3

Reduction in the Overpower ΔT trip setpoints (value of K_4) by ≥ 1% for each 1% ~~by which $F_Q^C(Z)$ exceeds its limit,~~ is a conservative action for protection against the consequences of severe transients with unanalyzed power distributions. The Completion Time of 72 hours is sufficient considering the small likelihood of a severe transient in this time period, and the preceding prompt reduction in THERMAL POWER in accordance with Required Action A.1. The maximum allowable Overpower ΔT trip setpoints initially determined by Required Action A.3 may be affected by subsequent determinations of $F_Q^C(Z)$ and would require Overpower ΔT trip setpoint reductions within 72 hours of the $F_Q^C(Z)$ determination, if necessary to comply with the decreased maximum allowable Overpower ΔT trip setpoints. Decreases in $F_Q^C(Z)$ would allow increasing the maximum allowable Overpower ΔT trip setpoints.

A.4

Verification that $F_Q^C(Z)$ has been restored to within its limit, by performing SR 3.2.1.1 and SR 3.2.1.2 prior to increasing THERMAL POWER above the limit imposed by Required Action A.1~~,~~ ensures that core conditions during operation at higher power levels and future operation are consistent with safety analyses assumptions.

Condition A is modified by a Note that requires Required Action A.4 to be performed whenever the Condition is entered. This ensures that SR 3.2.1.1 and SR 3.2.1.2 will be performed prior to increasing THERMAL POWER above the limit of Required Action A.1, even when Condition A is exited prior to performing Required Action A.4. Performance of SR 3.2.1.1 and SR 3.2.1.2 are necessary to assure $F_Q(Z)$ is properly evaluated prior to increasing THERMAL POWER.

B.1

If it is found that the maximum calculated value of $F_Q(Z)$ that can occur during normal maneuvers, $F_Q^W(Z)$, exceeds its specified limits, there exists a potential for $F_Q^C(Z)$ to become excessively high if a normal operational transient occurs~~. Reducing the AFD by ≥ 1% for each 1% by which $F_Q^W(Z)$ exceeds its limit within the allowed Completion Time of 4 hours, restricts the axial flux distribution such that even if a transient occurred, core peaking factors are not exceeded.~~

Implementing a more restrictive RAOC operating space, as specified in the COLR, within the allowed Completion Time of 4 hours will restrict the AFD such that peaking factor limits will not be exceeded during non-equilibrium normal operation. Several RAOC operating spaces, representing successively smaller AFD envelopes and, optionally, shallower Control Bank Insertion Limits, may be specified in the COLR. The corresponding T(z) functions for these operating spaces can be used to determine which RAOC operating space will result in acceptable non-equilibrium operation within the $F_Q^W(z)$ limit.

T

$F_Q(Z)$ (RAOC-~~W~~(Z) Methodology)
B 3.2.1B

BASES

ACTIONS (continued)

~~The implicit assumption is that if W(Z) values were recalculated (consistent with the reduced AFD limits), then $F_Q^C(Z)$ times the recalculated W(Z) values would meet the $F_Q(Z)$ limit. Note that complying with this action (of reducing AFD limits) may also result in a power reduction. Hence the need for Required Actions B.2, B.3 and B.4.~~

INSERT 2 (Next Page)

B.~~2~~ .2

A reduction of the Power Range Neutron Flux-High trip setpoints by ≥ 1% for each 1% by which the maximum allowable power is reduced~~,~~ is a conservative action for protection against the consequences of severe transients with unanalyzed power distributions. The Completion Time of 72 hours is sufficient considering the small likelihood of ~~a~~ the severe transient in this time period and the preceding prompt reduction in THERMAL POWER ~~as a result of reducing~~ limit and AFD limits in accordance with Required Action B.~~1~~ 2.1.

B.~~3~~ 2.3

Reduction in the Overpower ΔT trip setpoints value of K_4 by ≥ 1% for each 1% by which the maximum allowable power is reduced~~,~~ is a conservative action for protection against the consequences of severe transients with unanalyzed power distributions. The Completion Time of 72 hours is sufficient considering the small likelihood of ~~a~~ the severe transient in this time period, and the preceding prompt reduction in THERMAL POWER ~~as a result of reducing~~ limit and AFD limits in accordance with Required Action B.~~1~~ 2.1.

B.~~4~~ 2.4

Verification that $F_Q^W(Z)$ has been restored to within its limit, by performing SR 3.2.1.1 and SR 3.2.1.2 prior to increasing THERMAL POWER above the maximum allowable power limit imposed by Required Action B.~~1~~ 2.1 ensures that core conditions during operation at higher power levels and future operation are consistent with safety analyses assumptions.

~~Condition B is modified by a Note that requires Required Action B.4 to be performed whenever the Condition is entered. This ensures that SR 3.2.1.1 and SR 3.2.1.2 will be performed prior to increasing THERMAL POWER above the limit of Required Action B.1, even when Condition A is exited prior to performing Required Action B.4. Performance of SR 3.2.1.1 and SR 3.2.1.2 are necessary to assure $F_Q(Z)$ is properly evaluated prior to increasing THERMAL POWER.~~

INSERT 2

B.2.1

When $F_Q^W(z)$ exceeds its limit, Required Action B.2.1 may be implemented instead of Required Action B.1. Required Action B.2.1 limits THERMAL POWER to less than RATED THERMAL POWER by the amount specified in the COLR. It also requires reductions in the AFD limits by the amount specified in the COLR. If the RAOC operating spaces specified in the COLR are insufficient to ensure margin to the $F_Q^W(z)$ limit, then Required Action B.2.1 must be entered and THERMAL POWER must be limited to less than the RATED THERMAL POWER and AFD limits must be reduced by the amounts specified in the COLR. This maintains an acceptable absolute power density relative to the maximum power density value assumed in the safety analyses.

The Completion Time of 4 hours provides an acceptable time to reduce the THERMAL POWER and AFD limits in an orderly manner to preclude entering an unacceptable condition during future non-equilibrium operation. The limit on THERMAL POWER initially determined by Required Action B.2.1 may be affected by subsequent determinations of $F_Q^W(z)$ and would require power reductions within 4 hours of the $F_Q^W(z)$ determination, if necessary to comply with the decreased THERMAL POWER limit. Decreases in $F_Q^W(z)$ would allow increasing the THERMAL POWER limit and increasing THERMAL POWER up to this revised limit.

Required Action B.2.1 is modified by a Note that states Required Action B.2.4 shall be completed whenever Required Action B.2.1 is performed. Required Action B.2.4 requires the performance of SR 3.2.1.1 and SR 3.2.1.2 prior to increasing THERMAL POWER above the limit established by Required Action B.2.1. The Note ensures that the SRs will be performed even if Condition B may be exited prior to performing Required Action B.2.4. The performance of SR 3.2.1.1 and SR 3.2.1.2 is necessary to assure $F_Q(Z)$ is properly evaluated prior to increasing THERMAL POWER.

T

$F_Q(Z)$ (RAOC-~~W~~(Z) Methodology)
B 3.2.1B

BASES

ACTIONS (continued)

2.4

C.1

If Required Actions A.1 through A.4 or B.1 through B.~~4~~ are not met within their associated Completion Times, the plant must be placed in a mode or condition in which the LCO requirements are not applicable. This is done by placing the plant in at least MODE 2 within 6 hours.

This allowed Completion Time is reasonable based on operating experience regarding the amount of time it takes to reach MODE 2 from full power operation in an orderly manner and without challenging plant systems.

SURVEILLANCE REQUIREMENTS

SR 3.2.1.1 and SR 3.2.1.2 are modified by a Note. The Note applies during the first power ascension after a refueling. It states that THERMAL POWER may be increased until an equilibrium power level has been achieved at which a power distribution map can be obtained. This allowance is modified, however, by one of the Frequency conditions that requires verification that $F_Q^C(Z)$ and $F_Q^W(Z)$ are within their specified limits after a power rise of more than 10% RTP over the THERMAL POWER at which they were last verified to be within specified limits. Because $F_Q^C(Z)$ and $F_Q^W(Z)$ could not have previously been measured in this reload core, there is a second Frequency condition, applicable only for reload cores, that requires determination of these parameters before exceeding 75% RTP. This ensures that some determination of $F_Q^C(Z)$ and $F_Q^W(Z)$ are made at a lower power level at which adequate margin is available before going to 100% RTP. Also, this Frequency condition, together with the Frequency condition requiring verification of $F_Q^C(Z)$ and $F_Q^W(Z)$ following a power increase of more than 10%, ensures that they are verified as soon as RTP (or any other level for extended operation) is achieved. In the absence of these Frequency conditions, it is possible to increase power to RTP and operate for 31 days without verification of $F_Q^C(Z)$ and $F_Q^W(Z)$. The Frequency condition is not intended to require verification of these parameters after every 10% increase in power level above the last verification. It only requires verification after a power level is achieved for extended operation that is 10% higher than that power at which $F_Q(Z)$ was last measured.

T

$F_Q(Z)$ (RAOC-~~W~~(Z) Methodology)
B 3.2.1B

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.2.1.1

Verification that $F_Q^C(Z)$ is within its specified limits involves increasing $F_Q^M(Z)$ to allow for manufacturing tolerance and measurement uncertainties in order to obtain $F_Q^C(Z)$. Specifically, $F_Q^M(Z)$ is the measured value of $F_Q(Z)$ obtained from incore flux map results and $F_Q^C(Z) = F_Q^M(Z)$ [1.0815] (Ref. 4). $F_Q^C(Z)$ is then compared to its specified limits.

The limit with which $F_Q^C(Z)$ is compared varies inversely with power above 50% RTP and directly with a function called K(Z) provided in the COLR.

some determination of $F_Q^C(z)$ is made prior to achieving a significant power level where the peak linear heat rate could approach the limits assumed in the safety analyses.

following a refueling

Performing this Surveillance in MODE 1 prior to exceeding 75% RTP ensures that ~~the $F_Q^C(Z)$ limit is met when RTP is achieved, because peaking factors generally decrease as power level is increased.~~

initial or most recent

24

If THERMAL POWER has been increased by ≥ 10% RTP since the ~~last~~ determination of $F_Q^C(Z)$, another evaluation of this factor is required [~~12~~] hours after achieving equilibrium conditions at this higher power level (to ensure that $F_Q^C(Z)$ values are being reduced sufficiently with power increase to stay within the LCO limits).

This Frequency condition is not intended to require verification of these parameters after every 10% increase in RTP above the THERMAL POWER at which the last verification was performed. It only requires verification after a THERMAL POWER is achieved for extended operation that is 10% higher than the THERMAL POWER at which $F_Q^C(z)$ was last measured.

[The Frequency of 31 EFPD is adequate to monitor the change of power distribution with core burnup because such changes are slow and well controlled when the plant is operated in accordance with the Technical Specifications (TS).

In the absence of these Frequency conditions (discussed above) it is possible to operate for 31 EFPD without verification of $F_Q^C(z)$.

OR

The Surveillance Frequency is controlled under the Surveillance Frequency Control Program.

-------------------------------REVIEWER'S NOTE-------------------------------
Plants controlling Surveillance Frequencies under a Surveillance Frequency Control Program should utilize the appropriate Frequency description, given above, and the appropriate choice of Frequency in the Surveillance Requirement.
---]

T

$F_Q(Z)$ (RAOC-~~W~~(Z) Methodology)
B 3.2.1B

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.2.1.2

The nuclear design process includes calculations performed to determine that the core can be operated within the $F_Q(Z)$ limits. Because flux maps are taken in steady state conditions, the variations in power distribution resulting from normal operational maneuvers are not present in the flux map data. These variations are, however, conservatively calculated by considering a wide range of unit maneuvers in normal operation. ~~The maximum peaking factor increase over steady state values, calculated as a function of core elevation, Z, is called W(Z). Multiplying the measured total peaking factor, $F_Q^C(Z)$, by W(Z) gives the maximum $F_Q(Z)$ calculated to occur in normal operation, $F_Q^W(Z)$.~~

INSERT 3 (Next Page)

The limit with which $F_Q^W(Z)$ is compared varies inversely with power above 50% RTP and directly with the function K(Z) provided in the COLR.

[T(z)]^{COLR} functions are specified

The ~~W(Z) curve is provided~~ in the COLR for discrete core elevations. Flux map data are typically taken for 30 to 75 core elevations. $F_Q^W(Z)$ evaluations are not applicable for ~~the following~~ axial core regions, measured in percent of core height:

a. Lower core region, from 0 to 15% inclusive ~~and~~ ,

b. Upper core region, from 85 to 100% inclusive~~.~~ ,

c. Grid plane regions, ± 2% inclusive, and
d. Core plane regions, within ± 2% of the bank demand position of the control banks.

These regions

~~The top and bottom 15%~~ of the core are excluded from the evaluation because of the low probability that ~~these regions~~ they would be more limiting in the safety analyses and because of the difficulty of making a precise measurement in these regions.

The excluded regions at the top and bottom of the core are specified in the COLR and are defined to ensure that the minimum margin location is adequately surveilled. A slightly smaller exclusion zone may be specified, if necessary, to include the limiting margin location in the surveilled region of the core.

~~This Surveillance has been modified by a Note that may require that more frequent surveillances be performed. If $F_Q^W(Z)$ is evaluated, an evaluation of the expression below is required to account for any increase to $F_Q^M(Z)$ that may occur and cause the $F_Q(Z)$ limit to be exceeded before the next required $F_Q(Z)$ evaluation.~~

~~If the two most recent $F_Q(Z)$ evaluations show an increase in the expression maximum over z [$F_Q^C(Z)$ / K(Z)], it is required to meet the $F_Q(Z)$ limit with the last $F_Q^W(Z)$ increased by the greater of a factor of [1.02] or by an appropriate factor specified in the COLR (Ref. 5)~~

INSERT 3

The measured $F_Q(z)$ can be determined through a synthesis of the measured planar radial peaking factors, $F_{XY}{}^M(z)$, and the measured core average axial power shape, $P^M(z)$. Thus, $F_Q{}^C(z)$ is given by the following expression:

$F_Q{}^C(z) = F_{XY}{}^M(z)\ P^M(z)\ [1.0815] = F_Q{}^M(z)\ [1.0815]$

For RAOC operation, the analytical $[T(z)]^{COLR}$ functions, specified in the COLR for each RAOC operating space, are used together with the measured $F_{XY}(z)$ values to estimate $F_Q(z)$ for non-equilibrium operation within the RAOC operating space. When the $F_{XY}(z)$ values are measured at HFP ARO conditions ($A_{XY}(z)$ equals 1.0), $F_Q{}^W(z)$ is given by the following expression:

$F_Q{}^W(z) = F_{XY}{}^M(z)\ [T(z)]^{COLR}\ Rj\ [1.0815]$

Non-equilibrium operation can result in significant changes to the axial power shape. To a lesser extent, non-equilibrium operation can increase the radial peaking factors, $F_{XY}(z)$, through control rod insertion and through reduced Doppler and moderator feedback at part-power conditions.

The $[T(z)]^{COLR}$ functions quantify these effects for the range of power shapes, control rod insertion, and power levels characteristic of the operating space. Multiplying $[T(z)]^{COLR}$ by the measured full power, unrodded $F_{XY}{}^M(z)$ value, and the factor that accounts for manufacturing and measurement uncertainties gives $F_Q{}^W(z)$, the maximum total peaking factor postulated for non-equilibrium RAOC operation.

T

$F_Q(Z)$ (RAOC-W(Z) Methodology)
B 3.2.1B

BASES

SURVEILLANCE REQUIREMENTS (continued)

~~---------------------------------REVIEWER'S NOTE---------------------------------~~
~~WCAP-10216-P-A, Rev. 1A, "Relaxation of Constant Axial Offset Control and F_Q Surveillance Technical Specification," February 1994, or other appropriate plant specific methodology, is to be listed in the COLR description in the Administrative Controls Section 5.0 to address the methodology used to derive this factor.~~
~~--~~

~~or to evaluate $F_Q(Z)$ more frequently, each 7 EFPD. These alternative requirements prevent $F_Q(Z)$ from exceeding its limit for any significant period of time without detection.~~

~~Performing the Surveillance in MODE 1 prior to exceeding 75% RTP ensures that the $F_Q(Z)$ limit is met when RTP is achieved, because peaking factors are generally decreased as power level is increased.~~

~~$F_Q(Z)$ is verified at power levels ≥ 10% RTP above the THERMAL POWER of its last verification, [12] hours after achieving equilibrium conditions to ensure that $F_Q(Z)$ is within its limit at higher power levels.~~

INSERT 4
(Next Page)

In the absence of these Frequency conditions (discussed above) it is possible to operate for 31 EFPD without verification of $F_Q^W(z)$.

[The Surveillance Frequency of 31 EFPD is adequate to monitor the change of power distribution with core burnup. The Surveillance may be done more frequently if required by the results of $F_Q(Z)$ evaluations.

The Frequency of 31 EFPD is adequate to monitor the change of power distribution because such a change is sufficiently slow, when the plant is operated in accordance with the TS, to preclude adverse peaking factors between 31 day surveillances.

OR

The Surveillance Frequency is controlled under the Surveillance Frequency Control Program.

---------------------------------REVIEWER'S NOTE---------------------------------
Plants controlling Surveillance Frequencies under a Surveillance Frequency Control Program should utilize the appropriate Frequency description, given above, and the appropriate choice of Frequency in the Surveillance Requirement.
--]

INSERT 4

SR 3.2.1.2 requires a Surveillance of $F_Q^W(z)$ during the initial startup following each refueling within [24] hours after achieving equilibrium conditions after exceeding 75% RTP. THERMAL POWER levels below 75% are typically non-limiting with respect to the limit for $F_Q^W(z)$. Also, initial startups following a refueling are slow and well controlled due to startup ramp rate limitations and fuel conditioning requirements. Furthermore, startup physics testing and flux symmetry measurements, also performed at low power, provide confirmation that the core is operating as expected. Consequently, the initial startup following a refueling will not result in non-equilibrium power shapes that could challenge the $F_Q^W(z)$ limit. This Frequency ensures that verification of $F_Q^W(z)$ is performed prior to extended operation at high power levels where the maximum permitted peak LHR could be challenged by non-equilibrium operation.

If a previous Surveillance of $F_Q^W(z)$ was performed at part power conditions, SR 3.2.1.2 also requires that $F_Q^W(z)$ be verified at power levels ≥ 10% RTP above the THERMAL POWER of its last verification within [24] hours after achieving equilibrium conditions. This ensures that $F_Q^W(z)$ is within its limit using radial peaking factors measured at the higher power level.

T

$F_Q(Z)$ (RAOC-W(Z) Methodology)
B 3.2.1B

BASES

REFERENCES

1. 10 CFR 50.46, 1974.
2. Regulatory Guide 1.77, Rev. 0, May 1974.
3. 10 CFR 50, Appendix A, GDC 26.
4. WCAP-7308-L-P-A, "Evaluation of Nuclear Hot Channel Factor Uncertainties," June 1988.
5. WCAP-10216-P-A, Rev. 1A, "Relaxation of Constant Axial Offset Control (and) F_Q Surveillance Technical Specification," February 1994.
6. WCAP-17661-P-A, "Improved RAOC and CAOC F_Q Surveillance Technical Specifications," (date to be determined).

T

$F_Q(Z)$ (RAOC-~~W(Z)~~ Methodology)
B 3.2.1B

Insert new Figure
(Next Page)

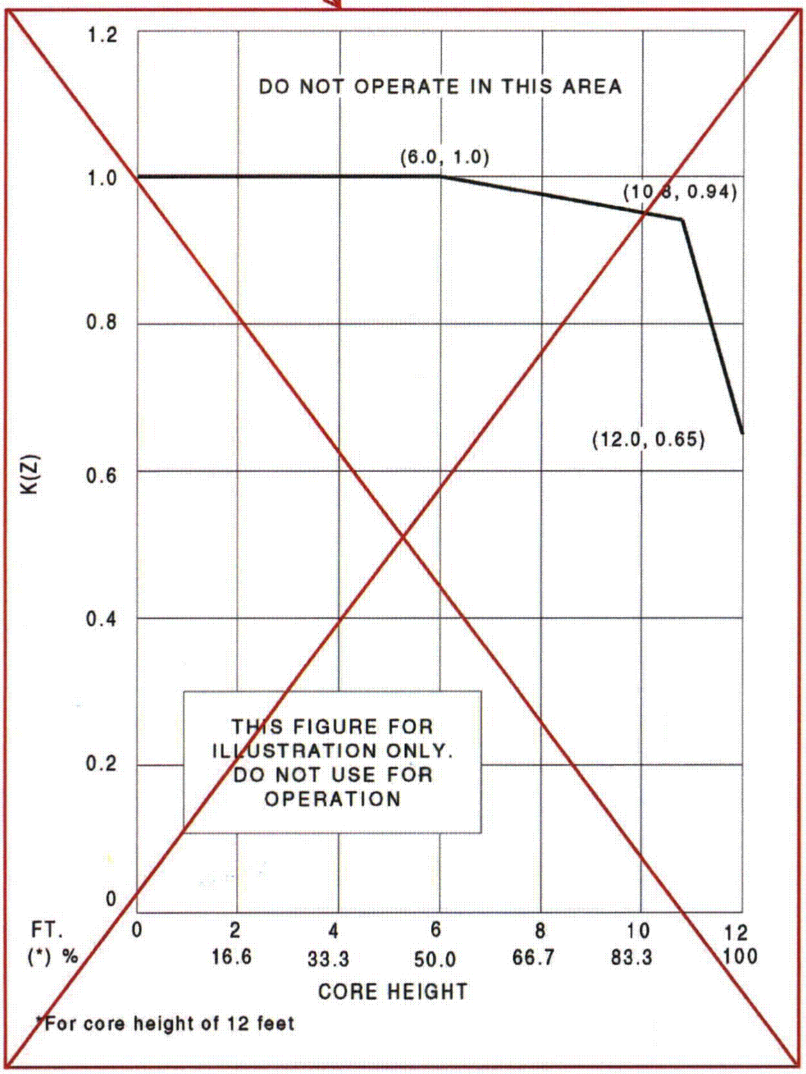
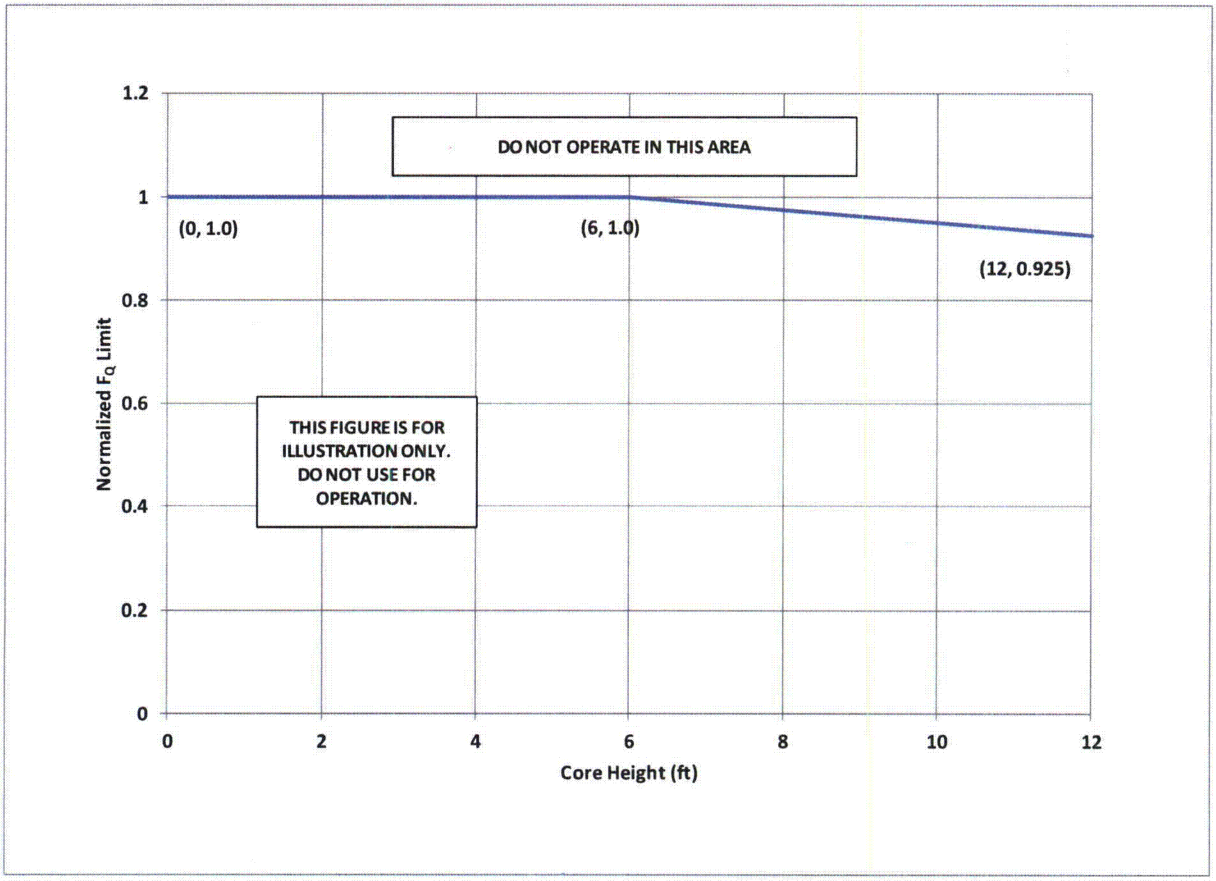


Figure B 3.2.1B-1 (page 1 of 1)
K(Z) - Normalized $F_Q(Z)$ as a Function of Core Height


DO NOT OPERATE IN THIS AREA
(0, 1.0)
(6, 1.0)
(12, 0.925)
THIS FIGURE IS FOR ILLUSTRATION ONLY. DO NOT USE FOR OPERATION.
Normalized F_Q Limit
1.2
1
0.8
0.6
0.4
0.2
0
2
4
6
8
10
12
Core Height (ft)

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APPENDIX C
SAMPLE COLR INPUT FOR A RAOC PLANT

In this appendix, sample F_Q Surveillance COLR data for a RAOC plant are presented. Note that only those aspects of the COLR pertinent to F_Q Surveillance are presented in this appendix. Those aspects include COLR data related to Axial Flux Difference, Control Bank Insertion Limits, and the Heat Flux Hot Channel Factor. The approved version of this report must be added to the list of COLR references in Technical Specification 5.6.5, "Core Operating Limits Report (COLR)," since methodology described in this report will be used to determine core operating limits.

C.1 COLR

This COLR for Plant A Cycle XY has been prepared in accordance with the requirements of Technical Specification 5.6.5.

The TSs affected by this report are:

3.1.6 Control Bank Insertion Limits

3.2.1 Heat Flux Hot Channel Factor – $F_Q(z)$

3.2.3 Axial Flux Difference

C.2 OPERATING LIMITS

The cycle-specific parameter limits and associated data for the specifications listed in Section C.1 are presented in the following subsections. These limits and data have been developed using NRC-approved methodologies including those specified in TS 5.6.5.

C.2.1 Control Bank Insertion Limits (Specification 3.1.6)

C.2.1.1:

Control Bank Insertion Limits are provided for three ROSs. The Control Bank Insertion Limits for each ROS shall be used in conjunction with the associated Axial Flux Difference Limits for the ROS. The control rod banks shall be limited in physical insertion as shown in Figure C-1 for ROS1 and ROS2. For ROS3, the control rod banks shall be limited in physical insertion as shown in Figure C-2.

C.2.2 Heat Flux Hot Channel Factor – $F_Q(z)$ (Specification 3.2.1)

C.2.2.1:

$$F_Q^C(z) \leq \frac{F_Q^{RTP}}{P} * K(z) \quad for\ P > 0.5$$

$$F_Q^C(z) \leq \frac{F_Q^{RTP}}{0.5} * K(z) \quad for\ P \leq 0.5$$

where:

$$F_Q^C(z) = F_Q^M(z) * 1.0815$$

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

C.2.2.2:

$$F_Q^{RTP} = 2.50$$

C.2.2.3:

K(z) is provided in Figure C-3.

C.2.2.4:

$$F_Q^W(z) \leq \frac{F_Q^{RTP}}{P} * K(z) \quad for\ P > 0.5$$

$$F_Q^W(z) \leq \frac{F_Q^{RTP}}{0.5} * K(z) \quad for\ P \leq 0.5$$

where:

$$F_Q^W(z) = [F_{XY}(z)]_{Surv}^M * \frac{[T(z)]^{COLR}}{P} * A_{XY}(z) * R_j * 1.0815$$

and, $[F_{XY}(z)]_{Surv}^M$ is the measured planar radial peaking factor.

C.2.2.5:

$[T(z)]^{COLR}$ values are provided in Tables C-1, C-2, and C-3 for ROS1, ROS2, and ROS3, respectively.

C.2.2.6:

The $A_{XY}(z)$ factors adjust the surveillance to the reference conditions assumed in generating the $[T(z)]^{COLR}$ factors. $A_{XY}(z)$ may be assumed to equal 1.0 or may be determined for specific surveillance conditions using the approved methods listed in TS 5.6.5.

C.2.2.7:

The R_j penalty factors account for the potential decrease in transient F_Q margin between surveillances. The R_j factors for ROS1, ROS2, and ROS3 are provided in Tables C-4, C-5, and C-6, respectively.

C.2.2.8:

Table C-7 provides the required limits on THERMAL POWER and the required AFD reductions for each ROS in the event that additional margin is required.

C.2.3 Axial Flux Difference (Specification 3.2.3)

C.2.3.1:

The Axial Flux Difference limits for ROS1, ROS2, and ROS3 are provided in Figure C-4.

Table C-1 $[T(z)]^{COLR}$ Factors for ROS1

a,c

Note:
1. Axial points 1-5 and 57-61 are excluded. Also, axial points within ±2% of the active core height of a grid location or a bank demand position are excluded.

Table C-2 [T(z)]^{COLR} Factors for ROS2

a,c

Note:
1. Axial points 1-5 and 57-61 are excluded. Also, axial points within ±2% of the active core height of a grid location or a bank demand position are excluded.

Table C-3 $[T(z)]^{COLR}$ Factors for ROS3

a,c

Note:
1. Axial points 1-5 and 57-61 are excluded. Also, axial points within ±2% of the active core height of a grid location or a bank demand position are excluded.

Table C-4 R_j Margin Decrease Factors for ROS1

a,c

Values may be interpolated to the surveillance cycle burnup.

TableC-5 R_j Margin Decrease Factors for ROS2

a,c

Values may be interpolated to the surveillance cycle burnup.

Table C-6 R_j Margin Decrease Factors for ROS3

a,c

Values may be interpolated to the surveillance cycle burnup.

Table C-7 Required THERMAL POWER Limits and AFD Reductions

a,c

Note:
1. AFD reductions should be applied to both the positive and negative sides of the AFD operating space.

a,c

Figure C-1 Control Bank Insertion Limits for RAOC Operating Spaces 1 and 2

*Fully withdrawn shall be the condition where control rods are at a position within the interval ≥ 225 and ≤ 231 steps withdrawn.

NOTE: The Rod Bank Insertion Limits are based on the control bank withdrawal sequence A, B, C, and D and a control bank tip-to-tip distance of 115 steps.

a,c

Figure C-2 Control Bank Insertion Limits for RAOC Operating Space 3

*Fully withdrawn shall be the condition where control rods are at a position within the interval $\geq$ 225 and $\leq$ 231 steps withdrawn.

NOTE: The Rod Bank Insertion Limits are based on the control bank withdrawal sequence A, B, C, and D and a control bank tip-to-tip distance of 115 steps.

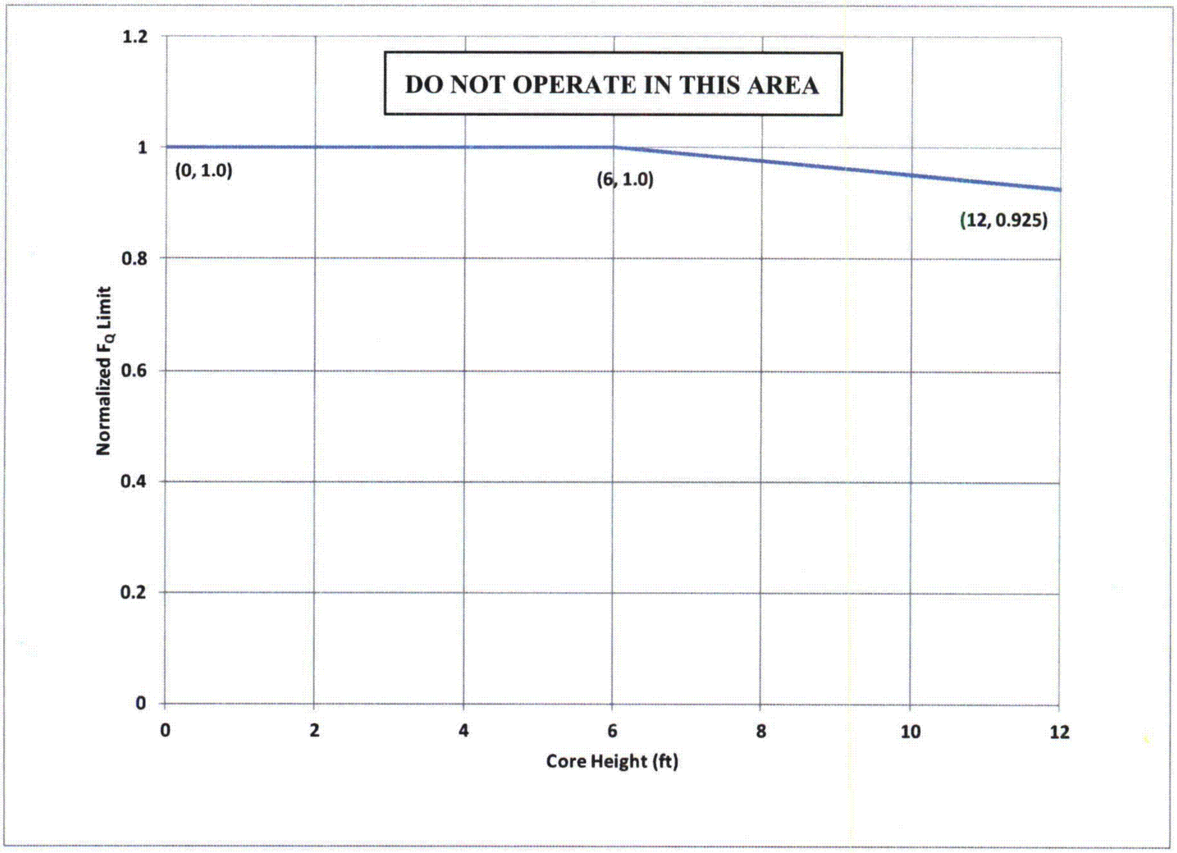

Figure C-3 K(z) – Normalized F_Q Limit as Function of Core Height

a,c

Figure C-4 Axial Flux Difference Limits for ROS1, ROS2, and ROS3

APPENDIX D
IMPROVED CAOC F_Q SURVEILLANCE TS

$F_Q(Z)$ (CAOC-W(Z) Methodology)
3.2.1C

3.2 POWER DISTRIBUTION LIMITS

3.2.1C Heat Flux Hot Channel Factor ($F_Q(Z)$ (CAOC-W(Z) Methodology)

LCO 3.2.1C $F_Q(Z)$, as approximated by $F_Q^C(Z)$ and $F_Q^W(Z)$, shall be within the limits specified in the COLR.

APPLICABILITY: MODE 1.

ACTIONS

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. ------------NOTE------------ Required Action A.4 shall be completed whenever this Condition is entered. --------------------------------- $F_Q^C(Z)$ not within limit.	A.1	Reduce THERMAL POWER ≥ 1% RTP for each 1% $F_Q^C(Z)$ exceeds limit.	15 minutes after each $F_Q^C(Z)$ determination
	<u>AND</u>		
	A.2	Reduce Power Range Neutron Flux - High trip setpoints ≥ 1% for each 1% ~~$F_Q^C(Z)$ exceeds limit.~~	72 hours after each $F_Q^C(Z)$ determination that THERMAL POWER is limited below RATED THERMAL POWER by Required Action A.1.
	<u>AND</u>		
	A.3	Reduce Overpower ΔT trip setpoints ≥ 1% for each 1% ~~$F_Q^C(Z)$ exceeds limit.~~	72 hours after each $F_Q^C(Z)$ determination
	<u>AND</u>		
	A.4	Perform SR 3.2.1.1 and SR 3.2.1.2.	Prior to increasing THERMAL POWER above the limit of Required Action A.1

OR
B.2.1 ----------NOTE----------
Required Action B.2.4 shall be completed whenever Required Action B.2.1 is performed
----
Limit THERMAL POWER to less than RATED THERMAL POWER as specified in the COLR.

$F_Q(Z)$ (CAOC-W(Z) Methodology)
3.2.1C

Implement a CAOC operating space specified in the COLR that restores $F_Q^W(z)$ to within its limits.

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
B. ~~-----------NOTE----------- Required Action B.4 shall be completed whenever this Condition is entered. -----------------------------~~	B.1	~~Reduce THERMAL POWER ≥ 1% RTP for each 1% $F_Q^W(Z)$ exceeds limit.~~	4 hours 4 hours
	AND		
$F_Q^W(Z)$ not within limits.	B.2 .2	Reduce Power Range Neutron Flux - High trip setpoints ≥ 1% for each 1% ~~$F_Q^W(Z)$ exceeds limit.~~ that THERMAL POWER is limited below RATED THERMAL POWER by Required Action B.2.1.	72 hours
	AND		
	B.~~3~~ 2.3	Reduce Overpower ΔT trip setpoints ≥ 1% for each 1% ~~$F_Q^W(Z)$ exceeds limit.~~	72 hours
	AND		
	B.~~4~~ 2.4	Perform SR 3.2.1.1 and SR 3.2.1.2.	Prior to increasing THERMAL POWER above the limit of Required Action B.~~1~~ 2.1
C. Required Action and associated Completion Time not met.	C.1	Be in MODE 2.	6 hours

SURVEILLANCE REQUIREMENTS

---NOTE---
During power escalation at the beginning of each cycle, THERMAL POWER may be increased until an equilibrium power level has been achieved, at which a power distribution map is obtained.

SURVEILLANCE		FREQUENCY
SR 3.2.1.1	Verify $F_Q^C(Z)$ is within limit.	Once after each refueling prior to THERMAL POWER exceeding 75% RTP <u>AND</u> Once within [~~12~~ 24] hours after achieving equilibrium conditions after exceeding, by ≥ 10% RTP, the THERMAL POWER at which $F_Q^C(Z)$ was last verified <u>AND</u> [31 EFPD thereafter <u>OR</u> In accordance with the Surveillance Frequency Control Program]

SURVEILLANCE REQUIREMENTS (continued)

	SURVEILLANCE	FREQUENCY
SR 3.2.1.2	~~-----NOTE-----~~ ~~If measurements indicate that the maximum over z [$F_Q^C(Z)$ / K(Z)] has increased since the previous evaluation of $F_Q^C(Z)$:~~ ~~a. Increase $F_Q^W(Z)$ by the greater of a factor of [1.02] or by an appropriate factor specified in the COLR and reverify $F_Q^W(Z)$ is within limits or~~ ~~b. Repeat SR 3.2.1.2 once per 7 EFPD until either a. above is met or two successive flux maps indicate that the maximum over z [$F_Q^C(Z)$ / K(Z)] has not increased.~~ ~~-----~~ Verify $F_Q^W(Z)$ is within limit.	Once after each refueling within [24] hours after achieving equilibrium conditions after THERMAL POWER exceeds 75% RTP ~~Once after each refueling prior to THERMAL POWER exceeding 75% RTP~~ AND Once within [~~12~~ 24] hours after achieving equilibrium conditions after exceeding, by ≥ 10% RTP, the THERMAL POWER at which $F_Q^W(Z)$ was last verified AND

$F_Q(Z)$ (CAOC-W(Z) Methodology)
3.2.1C

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE	FREQUENCY
	[31 EFPD thereafter OR In accordance with the Surveillance Frequency Control Program]

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APPENDIX E
IMPROVED CAOC F_Q SURVEILLANCE TS BASES

$F_Q(Z)$ (CAOC-W(Z) Methodology)
B 3.2.1C

B 3.2 POWER DISTRIBUTION LIMITS

B 3.2.1C Heat Flux Hot Channel Factor ($F_Q(Z)$ (CAOC-W(Z) Methodology)

BASES

BACKGROUND

The purpose of the limits on the values of $F_Q(Z)$ is to limit the local (i.e., pellet) peak power density. The value of $F_Q(Z)$ varies along the axial height (Z) of the core.

$F_Q(Z)$ is defined as the maximum local fuel rod linear power density divided by the average fuel rod linear power density, assuming nominal fuel pellet and fuel rod dimensions. Therefore, $F_Q(Z)$ is a measure of the peak fuel pellet power within the reactor core.

During power operation, the global power distribution is limited by LCO 3.2.3, "AXIAL FLUX DIFFERENCE (AFD)," and LCO 3.2.4, "QUADRANT POWER TILT RATIO (QPTR)," which are directly and continuously measured process variables. These LCOs, along with LCO 3.1.6, "Control Bank Insertion Limits," maintain the core limits on power distributions on a continuous basis.

$F_Q(Z)$ varies with fuel loading patterns, control bank insertion, fuel burnup, and changes in axial power distribution.

$F_Q(Z)$ is measured periodically using the incore detector system. These measurements are generally taken with the core at or near equilibrium conditions.

Equilibrium conditions are defined as being at a stable reactor power (i.e., within ± 1% RTP) and at stable axial flux conditions (i.e., with an axial flux difference variability of ± 1% over the previous 24 hours). Equilibrium conditions are not required for performance of the $F_Q(z)$ measurements during power ascension following refueling, but plant conditions should be stable during the data collection period (i.e., power within ±1% RTP of the desired power level and axial offset changing by less than 0.5% from the start to the end of the flux map data collection).

Using the measured three dimensional power distributions, it is possible to derive a measured value for $F_Q(Z)$. However, because this value represents a equilibrium condition, it does not include the variations in the value of $F_Q(Z)$ which are present during nonequilibrium situations such as load following or power ascension.

To account for these possible variations, the equilibrium value of $F_Q(Z)$ is adjusted as $F_Q^W(Z)$ by an elevation dependent factor that accounts for the calculated worst case transient conditions.

Core monitoring and control under non-equilibrium conditions are accomplished by operating the core within the limits of the appropriate LCOs, including the limits on AFD, QPTR, and control rod insertion.

In the unlikely event that measurements indicate that the limit for $F_Q^W(z)$ could be exceeded during future non-equilibrium operation, a more restrictive CAOC operating space specified in the Core Operating Limits Report (COLR) may be implemented to restore margin to the $F_Q^W(z)$ limit. A CAOC operating space is a unique combination of an allowable AFD band and Control Bank Insertion Limits. A more restrictive CAOC operating space would employ a narrower AFD band, shallower Control Bank Insertion Limits, or a combination of the two. W(z) functions for each CAOC operating space are specified in the COLR. If none of the CAOC operating spaces provides adequate margin to the $F_Q^W(z)$ limit, then THERMAL POWER must be limited to less than RATED THERMAL POWER.

BASES

APPLICABLE SAFETY ANALYSES

This LCO precludes core power distributions that violate the following fuel design criteria:

a. During a large break loss of coolant accident (LOCA), the peak cladding temperature must not exceed 2200°F (Ref. 1),

b. During a loss of forced reactor coolant flow accident, there must be at least 95% probability at the 95% confidence level (the 95/95 DNB criterion) that the hot fuel rod in the core does not experience a departure from nucleate boiling (DNB) condition,

c. During an ejected rod accident, the energy deposition to the fuel must not exceed 280 cal/gm (Ref. 2), and

d. The control rods must be capable of shutting down the reactor with a minimum required SDM with the highest worth control rod stuck fully withdrawn (Ref. 3).

Limits on $F_Q(Z)$ ensure that the value of the initial total peaking factor assumed in the accident analyses remains valid. Other criteria must also be met (e.g., maximum cladding oxidation, maximum hydrogen generation, coolable geometry, and long term cooling). However, the peak cladding temperature is typically most limiting.

$F_Q(Z)$ limits assumed in the LOCA analysis are typically limiting relative to (i.e., lower than) the $F_Q(Z)$ limit assumed in safety analyses for other postulated accidents. Therefore, this LCO provides conservative limits for other postulated accidents.

$F_Q(Z)$ satisfies Criterion 2 of 10 CFR 50.36(c)(2)(ii).

LCO

The Heat Flux Hot Channel Factor, $F_Q(Z)$, shall be limited by the following relationships:

$F_Q(Z) \leq$ (CFQ/P) K(Z) for P > 0.5

$F_Q(Z) \leq$ (CFQ/0.5) K(Z) for $P \leq 0.5$

where: CFQ is the $F_Q(Z)$ limit at RTP provided in the COLR,

K(Z) is the normalized $F_Q(Z)$ as a function of core height provided in the COLR, and

limit

P = THERMAL POWER/RTP

BASES

LCO (continued)

50

For this facility, the actual values of CFQ and K(Z) are given in the COLR; however, CFQ is normally a number on the order of [2.32], and K(Z) is a function that looks like the one provided in Figure B 3.2.1C-1.

For Constant Axial Offset Control operation, $F_Q(Z)$ is approximated by $F_Q^C(Z)$ and $F_Q^W(Z)$. Thus, both $F_Q^C(Z)$ and $F_Q^W(Z)$ must meet the preceding limits on $F_Q(Z)$.

An $F_Q^C(Z)$ evaluation requires obtaining an incore flux map in MODE 1. From the incore flux map results we obtain the measured value ($F_Q^M(Z)$) of $F_Q(Z)$. Then,

$$F_Q^C(Z) = F_Q^M(Z)\ [1.0815]$$

where [1.0815] is a factor that accounts for fuel manufacturing tolerances and flux map measurement uncertainty.

$F_Q^C(Z)$ is an excellent approximation for $F_Q(Z)$ when the reactor is at the steady state power at which the incore flux map was taken.

INSERT 1
(Next Page)

The expression for $F_Q^W(Z)$ is:

$$\frac{[W(z)]^{COLR}\ A_O(z)\ Rj}{P}$$

$$F_Q^W(Z) = F_Q^C(Z)\ \cancel{W(Z)}$$

~~where W(Z) is a cycle dependent function that accounts for power distribution transients encountered during normal operation. W(Z) is included in the COLR. The $F_Q^C(Z)$ is calculated at equilibrium conditions.~~

Violating the $F_Q(z)$ LCO limits could result in unacceptable consequences if a design basis event were to occur while $F_Q(z)$ exceeds its specified limits.

The $F_Q(Z)$ limits define limiting values for core power peaking that precludes peak cladding temperatures above 2200°F during either a large or small break LOCA.

This LCO requires operation within the bounds assumed in the safety analyses. Calculations are performed in the core design process to confirm that the core can be controlled in such a manner during operation that it can stay within the LOCA $F_Q(Z)$ limits. ~~If $F_Q^C(Z)$ cannot be maintained within the LCO limits, reduction of the core power is required.~~

~~Violating the LCO limits for $F_Q(Z)$ produces unacceptable consequences if a design basis event occurs while $F_Q(Z)$ is outside its specified limits.~~

INSERT 1

$[W(z)]^{COLR}$ is the cycle and burnup dependent function, specified in the COLR, which accounts for power distribution transients encountered during non-equilibrium normal operation. $[W(z)]^{COLR}$ functions are specified for each analyzed CAOC operating space (i.e., each unique combination of AFD band and Control Bank Insertion Limits). The $[W(z)]^{COLR}$ functions account for the limiting non-equilibrium axial power shapes postulated to occur during normal operation for each RAOC operating space. Limiting power shapes at both full and reduced power operation are considered in determining the maximum values of $[W(z)]^{COLR}$. The $[W(z)]^{COLR}$ functions also account for the following effects: (1) the increase in radial peaking in rodded core planes due to the presence of control rods during non-equilibrium normal operation, (2) the increase in radial peaking that occurs during part-power operation due to reduced fuel and moderator temperatures, and (3) the increase in radial peaking due to non-equilibrium xenon effects. The $[W(z)]^{COLR}$ functions are normally calculated assuming that the Surveillance is performed at the Target Axial Offset core conditions. Surveillance specific $[W(z)]^{COLR}$ values may be generated for a given surveillance core condition.

P is the THERMAL POWER / RTP.

$A_Q(z)$ is a cycle, burnup, and power dependent function specified in the COLR or determined at the time of the surveillance using an approved 3D core model and the methodology of Reference 6. It adjusts the measured $F_Q^M(z)$ to the Target Axial Offset core conditions. For simplicity, $A_Q(z)$ may be assumed to be 1.0 when the surveillance is performed at the target AO. If, however, margin is needed for a Surveillance performed at conditions different from the Target AO core conditions, then the appropriate values for $A_Q(z)$ may be used.

Rj is a cycle and burnup dependent analytical factor specified in the COLR that accounts for potential increases in $F_Q^W(z)$ between Surveillances. Rj values are provided for each CAOC operating space.

--REVIEWER'S NOTE--

WCAP-17661-P-A, "Improved RAOC and CAOC F_Q Surveillance Technical Specifications," or other appropriate plant specific methodology, is to be listed in the COLR description in the Administrative Controls Section 5.0 to address the methodology used to derive this factor.

BASES

APPLICABILITY

The $F_Q(Z)$ limits must be maintained in MODE 1 to prevent core power distributions from exceeding the limits assumed in the safety analyses. Applicability in other MODES is not required because there is either insufficient stored energy in the fuel or insufficient energy being transferred to the reactor coolant to require a limit on the distribution of core power.

ACTIONS

A.1

Reducing THERMAL POWER by ≥ 1% RTP for each 1% by which $F_Q^C(Z)$ exceeds its limit, maintains an acceptable absolute power density. $F_Q^C(Z)$ is $F_Q^M(Z)$ multiplied by a factor accounting for manufacturing tolerances and measurement uncertainties. $F_Q^M(Z)$ is the measured value of $F_Q(Z)$. The Completion Time of 15 minutes provides an acceptable time to reduce power in an orderly manner and without allowing the plant to remain in an unacceptable condition for an extended period of time. The maximum allowable power level initially determined by Required Action A.1 may be affected by subsequent determinations of $F_Q^C(Z)$ and would require power reductions within 15 minutes of the $F_Q^C(Z)$ determination, if necessary to comply with the decreased maximum allowable power level. Decreases in $F_Q^C(Z)$ would allow increasing the maximum allowable power level and increasing power up to this revised limit.

A.2

A reduction of the Power Range Neutron Flux - High trip setpoints by ≥ 1% for each 1% ~~by which $F_Q^C(Z)$ exceeds its limit,~~ that THERMAL POWER is limited below RATED THERMAL POWER by Required Action A.1 is a conservative action for protection against the consequences of severe transients with unanalyzed power distributions. The Completion Time of 72 hours is sufficient considering the small likelihood of a severe transient in this time period and the preceding prompt reduction in THERMAL POWER in accordance with Required Action A.1. The maximum allowable Power Range Neutron Flux – High trip setpoints initially determined by Required Action A.2 may be affected by subsequent determinations of $F_Q^C(Z)$ and would require Power Range Neutron Flux – High trip setpoint reductions within 72 hours of the $F_Q^C(Z)$ determination, if necessary to comply with the decreased maximum allowable Power Range Neutron Flux – High trip setpoints. Decreases in $F_Q^C(Z)$ would allow increasing the maximum allowable Power Range Neutron Flux – High trip setpoints.

BASES

ACTIONS (continued)

A.3

Reduction in the Overpower ΔT trip setpoints (value of K_4) by ≥ 1% for each 1% ~~by which $F_Q^C(Z)$ exceeds its limit,~~ that THERMAL POWER is limited below RATED THERMAL POWER by Required Action A.1 is a conservative action for protection against the consequences of severe transients with unanalyzed power distributions. The Completion Time of 72 hours is sufficient considering the small likelihood of a severe transient in this time period, and the preceding prompt reduction in THERMAL POWER in accordance with Required Action A.1. The maximum allowable Overpower ΔT trip setpoints initially determined by Required Action A.3 may be affected by subsequent determinations of $F_Q^C(Z)$ and would require Overpower ΔT trip setpoint reductions within 72 hours of the $F_Q^C(Z)$ determination, if necessary to comply with the decreased maximum allowable Overpower ΔT trip setpoints. Decreases in $F_Q^C(Z)$ would allow increasing the maximum Overpower ΔT trip setpoints.

A.4

Verification that $F_Q^C(Z)$ has been restored to within its limit, by performing SR 3.2.1.1 and SR 3.2.1.2 prior to increasing THERMAL POWER above the limit imposed by Required Action A.1, ensures that core conditions during operation at higher power levels and future operation are consistent with safety analyses assumptions.

Condition A is modified by a Note that requires Required Action A.4 to be performed whenever the Condition is entered. This ensures that SR 3.2.1.1 and SR 3.2.1.2 will be performed prior to increasing THERMAL POWER above the limit of Required Action A.1, even when Condition A is exited prior to performing Required Action A.4. Performance of SR 3.2.1.1 and SR 3.2.1.2 are necessary to assure $F_Q(Z)$ is properly evaluated prior to increasing THERMAL POWER.

B.1

If it is found that the maximum calculated value of $F_Q(Z)$ that can occur during normal maneuvers, $F_Q^W(Z)$, exceeds its specified limits, there exists a potential for $F_Q^C(Z)$ to become excessively high if a normal operational

INSERT 2
(Next Page)

BASES

ACTIONS (continued)

transient occurs. ~~Reducing the THERMAL POWER by ≥ 1% RTP for each 1% by which $F_Q^W(Z)$ exceeds its limit within the allowed Completion Time of 4 hours, maintains an acceptable absolute power density such that even if a transient occurred, core peaking factors are not exceeded.~~

INSERT 3
(Next Page)

.2

B.2

that THERMAL POWER is limited below RATED THERMAL POWER by Required Action B.2.1

A reduction of the Power Range Neutron Flux-High trip setpoints by ≥ 1% for each 1% ~~by which $F_Q^W(Z)$ exceeds its limit~~, is a conservative action for protection against the consequences of severe transients with unanalyzed power distributions. The Completion Time of 72 hours is sufficient considering the small likelihood of a severe transient in this time period and the preceding prompt reduction in the THERMAL POWER limit in accordance with Required Action B.~~1~~ 2.1.

the

limit

2.1.

2.3

B.~~3~~

that THERMAL POWER is limited below RATED THERMAL POWER by Required Action B.2.1

Reduction in the Overpower ΔT trip setpoints value of K_4 by ≥ 1% for each 1% ~~by which $F_Q^W(Z)$ exceeds its limit~~, is a conservative action for protection against the consequences of severe transients with unanalyzed power distributions. The Completion Time of 72 hours is sufficient considering the small likelihood of a severe transient in this time period, and the preceding prompt reduction in the THERMAL POWER limit in accordance with Required Action B.~~1~~ 2.1.

the

limit

2.4

B.~~4~~

2.1

Verification that $F_Q^W(Z)$ has been restored to within its limit, by performing SR 3.2.1.1 and SR 3.2.1.2 prior to increasing THERMAL POWER above the limit imposed by Required Action B.~~1~~ ensures that core conditions during operation at higher power levels and future operation are consistent with safety analyses assumptions.

~~Condition B is modified by a Note that requires Required Action B.4 to be performed whenever the Condition is entered. This ensures that SR 3.2.1.1 and SR 3.2.1.2 will be performed prior to increasing THERMAL POWER above the limit of Required Action B.1, even when Condition A is exited prior to performing Required Action B.4. Performance of SR 3.2.1.1 and SR 3.2.1.2 are necessary to assure $F_Q(Z)$ is properly evaluated prior to increasing THERMAL POWER.~~

INSERT 2

Implementing a more restrictive CAOC operating space, specified in the COLR, within the allowed Completion Time of 4 hours will restrict the AFD such that core peaking factor limits will not be exceeded during non-equilibrium normal operation. Several CAOC operating spaces, representing successively smaller AFD bands and, optionally, shallower Control Bank Insertion Limits, may be specified in the COLR. The corresponding $[W(z)]^{COLR}$ functions for these operating spaces can be used to determine which CAOC operating space would result in acceptable non-equilibrium operation within the $FQ^{W}(z)$ limit.

INSERT 3

B.2.1

When $F_Q^W(z)$ exceeds its limit, Required Action B.2.1 may be implemented instead of Required Action B.1. Required Action B.2.1 limits THERMAL POWER to less than RATED THERMAL POWER by the amount specified in the COLR. If the more restrictive CAOC operating spaces specified in the COLR are insufficient to ensure margin to the $F_Q^W(z)$ limit, the THERMAL POWER must be limited to less than RATED THERMAL POWER by the amount specified in the COLR. This maintains an acceptable absolute power density relative to the maximum power density value assumed in the safety analyses.

The Completion Time of 4 hours provides an acceptable time to reduce power in an orderly manner to preclude entering an unacceptable condition during future non-equilibrium operation. The limit on THERMAL POWER initially determined by Required Action B.2.1 may be affected by subsequent determinations of $F_Q^W(z)$ and would require power reductions within 4 hours of the $F_Q^W(z)$ determination, if necessary to comply with the decreased THERMAL POWER limit. Decreases in $F_Q^W(z)$ would allow increasing the THERMAL POWER limit and increasing THERMAL POWER up to this revised limit.

Required Action B.2.1 is modified by a Note that states Required Action B.2.4 shall be completed whenever Required Action B.2.1 is performed. Required Action B.2.4 requires the performance of SR 3.2.1.1 and SR 3.2.1.2 prior to increasing THERMAL POWER above the limit established by Required Action B.2.1. The Note ensures that the SRs will be performed even if Condition B may be exited prior to performing Required Action B.2.4. The performance of SR 3.2.1.1 and SR 3.2.1.2 is necessary to assure $F_Q(Z)$ is properly evaluated prior to increasing THERMAL POWER.

BASES

ACTIONS (continued)

C.1

2.4

If Required Actions A.1 through A.4 or B.1 through B.4 are not met within their associated Completion Times, the plant must be placed in a mode or condition in which the LCO requirements are not applicable. This is done by placing the plant in at least MODE 2 within 6 hours.

This allowed Completion Time is reasonable based on operating experience regarding the amount of time it takes to reach MODE 2 from full power operation in an orderly manner and without challenging plant systems.

SURVEILLANCE REQUIREMENTS

~~SR 3.2.1.1 and SR 3.2.1.2 are modified by a Note. The Note applies during the first power ascension after a refueling. It states that THERMAL POWER may be increased until an equilibrium power level has been achieved at which a power distribution map can be obtained. This allowance is modified, however, by one of the Frequency conditions that requires verification that $F_Q^C(Z)$ and $F_Q^W(Z)$ are within their specified limits after a power rise of more than 10% RTP over the THERMAL POWER at which they were last verified to be within specified limits. Because $F_Q^C(Z)$ and $F_Q^W(Z)$ could not have previously been measured in this reload core, there is a second Frequency condition, applicable only for reload cores, that requires determination of these parameters before exceeding 75% RTP. This ensures that some determination of $F_Q^C(Z)$ and $F_Q^W(Z)$ are made at a lower power level at which adequate margin is available before going to 100% RTP. Also, this Frequency condition, together with the Frequency condition requiring verification of $F_Q^C(Z)$ and $F_Q^W(Z)$ following a power increase of more than 10%, ensures that they are verified as soon as RTP (or any other level for extended operation) is achieved. In the absence of these Frequency conditions, it is possible to increase power to RTP and operate for 31 days without verification of $F_Q^C(Z)$ and $F_Q^W(Z)$. The Frequency condition is not intended to require verification of these parameters after every 10% increase in power level above the last verification. It only requires verification after a power level is achieved for extended operation that is 10% higher than that power at which $F_Q(Z)$ was last measured.~~

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.2.1.1

Verification that $F_Q^C(Z)$ is within its specified limits involves increasing $F_Q^M(Z)$ to allow for manufacturing tolerance and measurement uncertainties in order to obtain $F_Q^C(Z)$. Specifically, $F_Q^M(Z)$ is the measured value of $F_Q(Z)$ obtained from incore flux map results and $F_Q^C(Z) = F_Q^M(Z)$ [1.0815] (Ref. 4). $F_Q^C(Z)$ is then compared to its specified limits.

The limit with which $F_Q^C(Z)$ is compared varies inversely with power above 50% RTP and directly with a function called K(Z) provided in the COLR.

following a refueling

Performing this Surveillance in MODE 1 prior to exceeding 75% RTP ensures that ~~the $F_Q^C(Z)$ limit is met when RTP is achieved, because peaking factors generally decrease as power level is increased.~~

some determination of $F_Q^C(z)$ is made prior to achieving a significant power level where the peak linear heat rate could approach the limits assumed in the safety analyses.

initial or most recent

If THERMAL POWER has been increased by ≥ 10% RTP since the ~~last~~ determination of $F_Q^C(Z)$, another evaluation of this factor is required [~~12~~] 24 hours after achieving equilibrium conditions at this higher power level (to ensure that $F_Q^C(Z)$ values are being reduced sufficiently with power increase to stay within the LCO limits).

This Frequency condition is not intended to require verification of these parameters after every 10% increase in RTP above the THERMAL POWER at which the last verification was performed. It only requires verification after a power level is achieved for extended operation that is 10% higher than the THERMAL POWER at which $F_Q^C(z)$ was last measured.

In the absence of these Frequency conditions (discussed above) it is possible to operate for 31 EFPD without verification of $F_Q^C(z)$.

[The Frequency of 31 EFPD is adequate to monitor the change of power distribution with core burnup because such changes are slow and well controlled when the plant is operated in accordance with the Technical Specifications (TS).

OR

The Surveillance Frequency is controlled under the Surveillance Frequency Control Program.

----------------------------------REVIEWER'S NOTE----------------------------------
Plants controlling Surveillance Frequencies under a Surveillance Frequency Control Program should utilize the appropriate Frequency description, given above, and the appropriate choice of Frequency in the Surveillance Requirement.
---]

$F_Q(Z)$ (CAOC-W(Z) Methodology)
B 3.2.1C

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.2.1.2

The nuclear design process includes calculations performed to determine that the core can be operated within the $F_Q(Z)$ limits. Because flux maps are taken in steady state conditions, the variations in power distribution resulting from normal operational maneuvers are not present in the flux map data. These variations are, however, conservatively calculated by considering a wide range of unit maneuvers in normal operation. The maximum peaking factor increase over steady state values, calculated as a function of core elevation, Z, is called ~~W(Z)~~ $[W(z)]^{COLR}$. Multiplying the measured total peaking factor, $F_Q^C(Z)$, by ~~W(Z)~~ $[W(z)]^{COLR}$ gives the maximum $F_Q(Z)$ calculated to occur in normal operation, $F_Q^W(Z)$.

The limit with which $F_Q^W(Z)$ is compared varies inversely with power above 50% RTP and directly with the function K(Z) provided in the COLR.

The ~~W(Z) curve is~~ $[W(z)]^{COLR}$ factors are provided in the COLR for discrete core elevations. Flux map data are typically taken for 30 to 75 core elevations. $F_Q^W(Z)$ evaluations are not applicable for ~~the following axial core regions, measured in percent of core height:~~ axial core regions near the top and bottom of the core. The excluded regions, usually the top and bottom [15]%, are specified in the COLR and are defined to ensure that the minimum margin location is adequately surveilled. A slightly smaller exclusion zone may be specified, if necessary, to include the limiting margin location in the surveilled region of the core.

~~a. Lower core region, from 0 to 15% inclusive and~~

~~b. Upper core region, from 85 to 100% inclusive.~~

~~The top and bottom 15%~~ These regions of the core are excluded from the evaluation because of the low probability that ~~these regions~~ they would be more limiting in the safety analyses and because of the difficulty of making a precise measurement in these regions.

This Surveillance has been modified by a Note that may require that more frequent surveillances be performed. If $F_Q^W(Z)$ is evaluated, an evaluation of the expression below is required to account for any increase to $F_Q^M(Z)$ that may occur and cause the $F_Q(Z)$ limit to be exceeded before the next required $F_Q(Z)$ evaluation.

If the two most recent $F_Q(Z)$ evaluations show an increase in the expression

maximum over z $[F_Q^C(Z) / K(Z)]$,

it is required to meet the $F_Q(Z)$ limit with the last $F_Q^W(Z)$ increased by the greater of a factor of [1.02] or by an appropriate factor specified in the COLR (Ref. 5)

BASES

SURVEILLANCE REQUIREMENTS (continued)

~~-----REVIEWER'S NOTE-----~~
~~WCAP-10216-P-A, Rev. 1A, Relaxation of Constant Axial Offset Control and F_Q Surveillance Technical Specification, February 1994, or other appropriate plant specific methodology, is to be listed in the COLR description in the Administrative Controls Section 5.0 to address the methodology used to derive this factor.~~
~~-----~~

INSERT 4
(Next Page)

~~or to evaluate $F_Q(Z)$ more frequently, each 7 EFPD. These alternative requirements prevent $F_Q(Z)$ from exceeding its limit for any significant period of time without detection.~~

~~Performing the Surveillance in MODE 1 prior to exceeding 75% RTP ensures that the $F_Q(Z)$ limit is met when RTP is achieved, because peaking factors are generally decreased as power level is increased.~~

~~$F_Q(Z)$ is verified at power levels ≥ 10% RTP above the THERMAL POWER of its last verification, [12] hours after achieving equilibrium conditions to ensure that $F_Q(Z)$ is within its limit at higher power levels.~~

In the absence of these Frequency conditions (discussed above) it is possible to operate for 31 EFPD without verification of $F_Q^W(z)$.

~~[~~The Surveillance Frequency of 31 EFPD is adequate to monitor the change of power distribution with core burnup. The Surveillance may be done more frequently if required by the results of $F_Q(Z)$ evaluations.

The Frequency of 31 EFPD is adequate to monitor the change of power distribution because such a change is sufficiently slow, when the plant is operated in accordance with the TS, to preclude adverse peaking factors between 31 day surveillances.

OR

The Surveillance Frequency is controlled under the Surveillance Frequency Control Program.

-----REVIEWER'S NOTE-----
Plants controlling Surveillance Frequencies under a Surveillance Frequency Control Program should utilize the appropriate Frequency description, given above, and the appropriate choice of Frequency in the Surveillance Requirement.
-----]

INSERT 4

SR 3.2.1.2 requires a Surveillance of $F_Q^W(z)$ during the initial startup following each refueling within [24] hours after achieving equilibrium conditions after exceeding 75% RTP. THERMAL POWER levels below 75% are typically non-limiting with respect to the limit for $F_Q^W(z)$. Initial startups following a refueling are slow and well controlled due to startup ramp rate limitations and fuel conditioning requirements. Furthermore, startup physics testing and flux symmetry measurements, also performed at low power, provide confirmation that the core is operating as expected. Consequently, the initial startup following a refueling will not result in non-equilibrium power shapes that could challenge the $F_Q^W(z)$ limit. This Frequency ensures that verification of $F_Q^W(z)$ is performed prior to extended operation at power levels where the maximum permitted peak LHR could be challenged by non-equilibrium operation.

If a previous Surveillance of $F_Q^W(z)$ was performed at part power conditions, SR 3.2.1.2 also requires that $F_Q^W(z)$ be verified at power levels ≥ 10% RTP above the THERMAL POWER of its last verification within [24] hours after achieving equilibrium conditions. This ensures that $F_Q^W(z)$ is within its limit using power distribution data measured at the higher power level.

BASES

REFERENCES

1. 10 CFR 50.46, 1974.
2. Regulatory Guide 1.77, Rev. 0, May 1974.
3. 10 CFR 50, Appendix A, GDC 26.
4. WCAP-7308-L-P-A, "Evaluation of Nuclear Hot Channel Factor Uncertainties," June 1988.
5. WCAP-10216-P-A, Rev. 1A, "Relaxation of Constant Axial Offset Control (and) F_Q Surveillance Technical Specification," February 1994.
6. WCAP-17661-P-A, "Improved RAOC and CAOC F_Q Surveillance Technical Specifications," (date to be determined).

$F_Q(Z)$ (CAOC-W(Z) Methodology)
B 3.2.1C

Insert new Figure (Next Page)

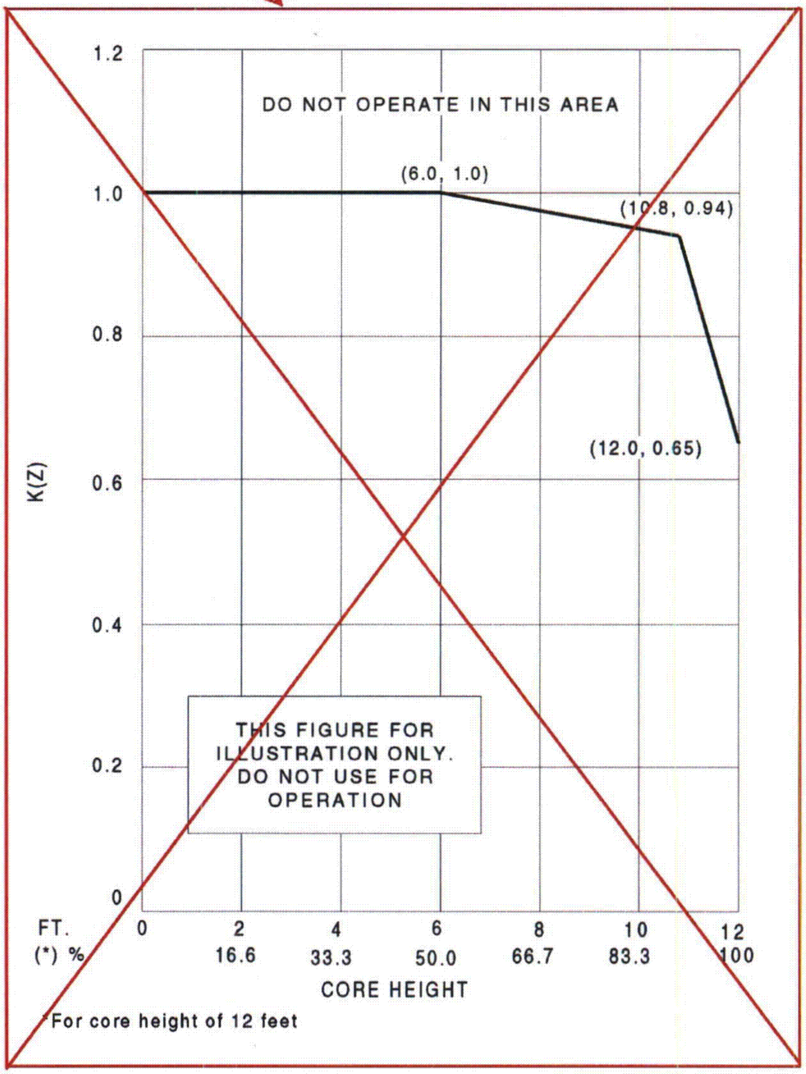
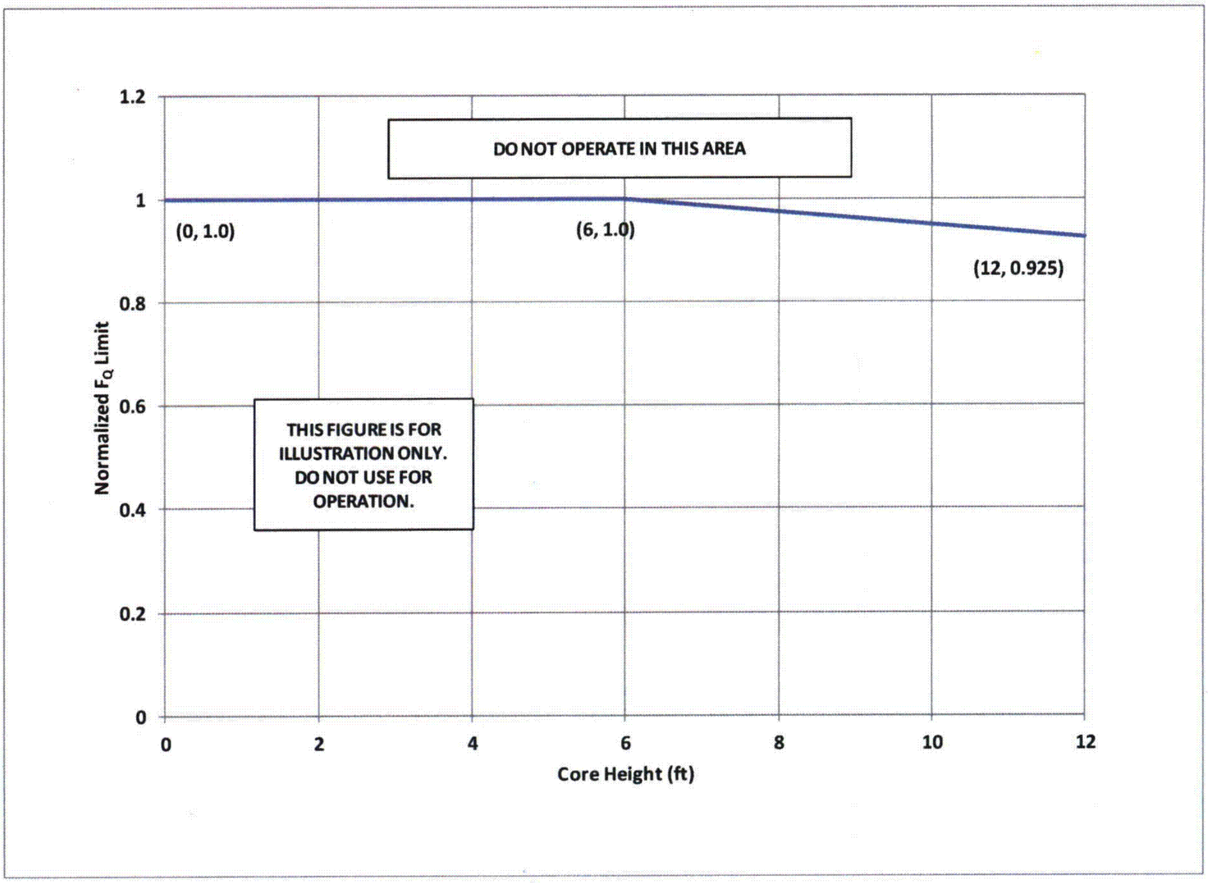


Figure B 3.2.1C-1 (page 1 of 1)
K(Z) - Normalized $F_Q(Z)$ as a Function of Core Height

Westinghouse STS B 3.2.1C-12 Rev. 4.0


DO NOT OPERATE IN THIS AREA
(0, 1.0)
(6, 1.0)
(12, 0.925)
THIS FIGURE IS FOR ILLUSTRATION ONLY. DO NOT USE FOR OPERATION.
Normalized F_Q Limit
1.2
1
0.8
0.6
0.4
0.2
0
0
2
4
6
8
10
12
Core Height (ft)

APPENDIX F
SAMPLE COLR INPUT FOR A CAOC PLANT

In this appendix, sample F_Q Surveillance COLR data for a CAOC plant are presented. Note that only those aspects of the COLR pertinent to F_Q Surveillance are presented in this appendix. Those aspects include COLR data related to Axial Flux Difference, Control Bank Insertion Limits, and the Heat Flux Hot Channel Factor. The approved version of this report must be added to the list of COLR references in TS 5.6.5, "Core Operating Limits Report (COLR)", since methodology described in this report will be used to determine core operating limits.

F.1 COLR

This COLR for Plant A Cycle XY has been prepared in accordance with the requirements of TS 5.6.5.

The TSs affected by this report are:

3.1.6 Control Bank Insertion Limits

3.2.1 Heat Flux Hot Channel Factor - $F_Q(z)$

3.2.3 Axial Flux Difference

F.2 OPERATING LIMITS

The cycle-specific parameter limits and associated data for the specifications listed in Section F.1 are presented in the following subsections. These limits and data have been developed using NRC-approved methodologies including those specified in TS 5.6.5.

F.2.1 Control Bank Insertion Limits (Specification 3.1.6)

F.2.1.1:

Control Bank Insertion Limits are provided for three COSs. The Control Bank Insertion Limits for each COS shall be used in conjunction with the associated Axial Flux Difference Limits for the COS. The control rod banks shall be limited in physical insertion as shown in Figure F-1 for COS1, COS2, and COS3.

F.2.2 Heat Flux Hot Channel Factor – $F_Q(z)$ (Specification 3.2.1)

F.2.2.1:

$$F_Q^C(z) \leq \frac{F_Q^{RTP}}{P} * K(z) \quad for\ P > 0.5$$

$$F_Q^C(z) \leq \frac{F_Q^{RTP}}{0.5} * K(z) \quad for\ P \leq 0.5$$

where:

$$F_Q^C(z) = F_Q^M(z) * 1.0815$$

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

F.2.2.2:

$$F_Q^{RTP} = 2.50$$

F.2.2.3:

K(z) is provided in Figure F-2.

F.2.2.4:

$$F_Q^W(z) \leq \frac{F_Q^{RTP}}{P} * K(z) \quad for\ P > 0.5$$

$$F_Q^W(z) \leq \frac{F_Q^{RTP}}{0.5} * K(z) \quad for\ P \leq 0.5$$

where:

$$F_Q^W(z) = F_Q^C(z) * \frac{[W(z)]^{COLR}}{P} * A_Q(z) * R_j$$

F.2.2.5:

$[W(z)]^{COLR}$ values are provided in Tables F-1, F-2, and F-3 for COS1, COS2, and COS3, respectively.

F.2.2.6:

The $A_Q(z)$ factor adjusts the surveillance to the Target AO conditions. $A_Q(z)$ may be assumed to be equal to 1.0 or may be determined for specific surveillance conditions using the approved methods listed in TS 5.6.5. If $A_Q(z)$ is assumed to be equal 1.0, the surveillance should be performed as close as possible to the Target AO.

F.2.2.7:

The R_j penalty factors account for the potential decrease in transient F_Q margin between surveillances. The R_j factors for COS1, COS2, and COS3 are provided in Tables F-4, F-5, and F-6, respectively.

F.2.2.8:

Table F-7 provides the required limits on thermal power for each COS in the event that additional margin is required.

F.2.3 Axial Flux Difference (Specification 3.2.3)

F.2.3.1:

The AFD target bands for COS1, COS2, and COS3 are provided in Table F-8.

F.2.3.2:

The AFD Acceptable Operation Limits are provided in Figure F-3.

Table F-1 $[W(z)]^{COLR}$ Factors for COS1

a,c

Note:
1. Axial points 1-5 and 57-61 are in the exclusion zone and are not included in the table.

Table F-2 $[W(z)]^{COLR}$ Factors for COS2

a,c

Note:

1. Axial points 1-5 and 57-61 are in the exclusion zone and are not included in the table.

Table F-3 $[W(z)]^{COLR}$ Factors for COS3

a,c

Note:
1. Axial points 1-5 and 57-61 are in the exclusion zone and are not included in the table.

Table F-4 R_j Margin Decrease Factors for COS1

a,c

Values may be interpolated to the surveillance cycle burnup.

Table F-5 R_j Margin Decrease Factors for COS2

a.c

Values may be interpolated to the surveillance cycle burnup.

Table F-6 R_j Margin Decrease Factors for COS3

a,c

Values may be interpolated to the surveillance cycle burnup.

Table F-7 Required THERMAL POWER Limits

a,c

Table F-8 CAOC Axial Flux Difference Operating Bands

a,c

a.c

Figure F-1 Control Bank Insertion Limits for CAOC Operating Spaces 1, 2, and 3

*Fully withdrawn shall be the condition where control rods are at a position within the interval ≥ 225 and ≤ 231 steps withdrawn.

NOTE: The Rod Bank Insertion Limits are based on the control bank withdrawal sequence A, B, C, and D and a control bank tip-to-tip distance of 115 steps.

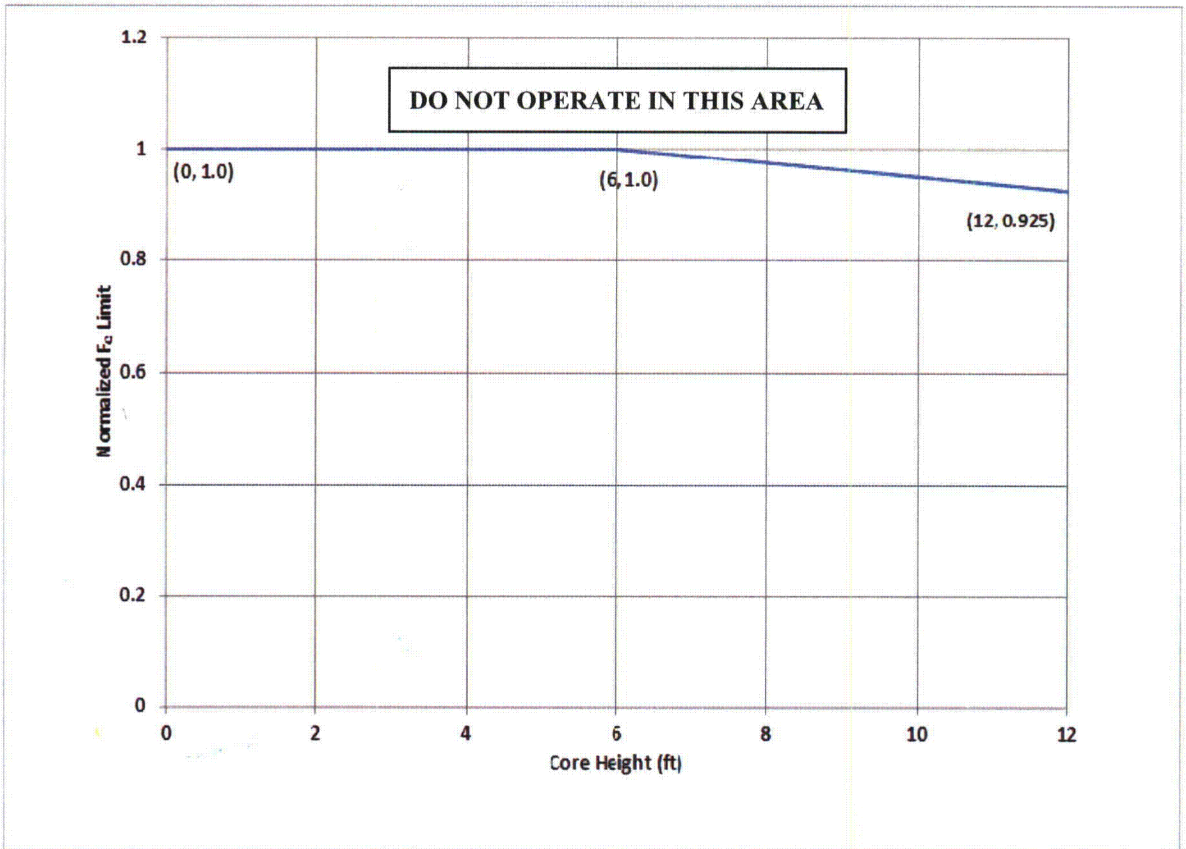


Figure F-2 K(z) – Normalized F_Q Limit as Function of Core Height

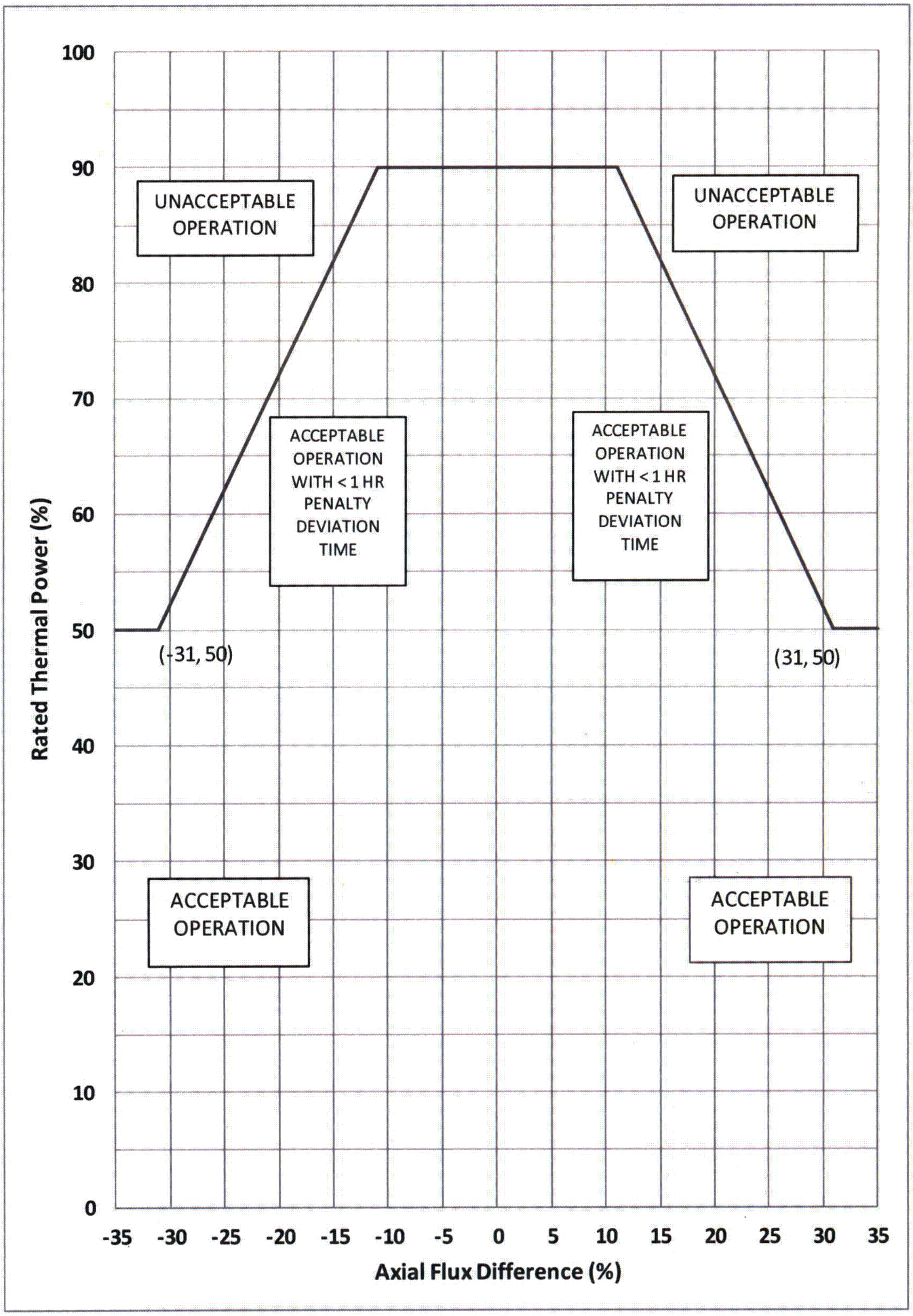


Figure F-3 Axial Flux Difference Acceptable Operation Limits