Industry/TSTF Standard Technical Specification Change Traveler

Revisions to hot channel factor specifications

Priority/Classification: 5) Plant Variation

NUREGs Affected: ☐ 1430 ☑ 1431 ☐ 1432 ☐ 1433 ☐ 1434

Description:

Revise Specification 3.2.1A and 3.2.1B and add new Specification 3.2.1C to correct errors and reflect the majority of core monitoring methodologies used by Westinghouse NSSS plants. Also, the change relocates the penalty factors applied to Fq(z) to the COLR as approved by the NRC in TSTF-98, Rev. 2. The increase Completion Times approved in TSTF-95 and TSTF-99 are applied to similar actions being proposed by this change (Required Action B.1 and B.2). Additionally, a Note is added to Required Actions A.4 and B.4.

Justification:

The majority of the Westinghouse NSSS plants utilize one of three core monitoring methodologies to determine the heat flux hot channel factor; Fq(z)CAOC- Fxy, Fq(z) RAOC- W(z), and Fz(a)CAOC - W(z). This change revises the current Specifications 3.2.1A and 3.2.1B to reflect the approved methodologies and also adds a new Specification 3.2.1C to reflect that methodology.

The Fz(z) penalty of 2% was based on the assumption that Fq(z) would change no more than 2% between monthly flux maps. This assumption was based on calculations for previous core designs that predated low leakage loading patterns, high amounts of burnable poisons, and 18 month cycles of recent cores. Recently, some Westinghouse designed cores have experienced increases in the measured Fq(z) as high as 5% to 6% between monthly flux maps over certain burnup ranges. Therefore, for these cores that are predicted to have larger increases in Fq(z) over certain burnup ranges, a larger penalty factor will be provided on a cycle-specific basis. These penalties will be calculated using NRC approved methodologies and will be specified in the COLR.

In addition, the NRC has accepted this change as documented in NRC acceptance letter for referencing revised version of licensing topical reports WCAP-10216, Rev. 1 "Relaxation of Constant Axial Offset Control - FQ Surveillance Technical Specification," from Thandani (NRC) to Liparulo (W), dated November 26, 1993.

In proposing a new Action B for 3.2.1B and 3.2.1C, the Completion Times for B.1 and B.2 are increased to be consistent with:

1) TSTF-99, which increased the Required Action B.1 Completion Time from 2 hours to 4 hours; and

2) TSTF-95, which increased the Required Action A.2 Completion Time from 8 hours to 72 hours. Required Action A.2 requires a Power Range setpoint reduction. Since the proposed Required Action B.2 is the same requirement to reduce the Power Range setpoint, the proposed Required Action B.2 is also increased to 72 hours. Refer to TSTF095 and TSTF-99 for specific discussion of these extensions.

The addition of a Note to Required Action B.4 ensures the appropriate Surveillances are performed to properly verify that Fq is restored to within limits. Without this Note, Fq could be restored (and, therefore, the Actions exited) prior to performing Required Action B.4.

Revision History

OG Revision 0 Revision Status: Closed

Revision Proposed by WOG

Revision Description:
Original Issue

OG Revision 0 — Revision Status: Closed

Owners Group Review Information

Date Originated by OG: 19-Aug-97

Owners Group Comments
(No Comments)

Owners Group Resolution: Superceeded Date:

OG Revision 1 — Revision Status: Closed

Revision Proposed by WOG

Revision Description:
Revision 1 developed to include the approved relocation of the penality factors applied to Fq(z) to the COLR in TSTF-98.

Owners Group Review Information

Date Originated by OG: 22-Apr-98

Owners Group Comments
(No Comments)

Owners Group Resolution: Superceeded Date: 22-Apr-98

TSTF Review Information

TSTF Received Date: 22-Apr-98 Date Distributed for Review 28-May-98

OG Review Completed: ☑ BWOG ☑ WOG ☑ CEOG ☑ BWROG

TSTF Comments:

Verify changes with D. Buschbaum
Approved by TSTF on 7/10/98 and superceded by revision on 9/1/98.

TSTF Resolution: Superceeded Date: 10-Jul-98

OG Revision 2 — Revision Status: Active — Next Action: TSTF

Revision Proposed by WOG

Revision Description:
Revision 2 developed to include the Completion Time changes approved in TSTF-99 and TSTF-95 and to add a Note to Required Action B.4.

Owners Group Review Information

Date Originated by OG: 08-Jul-98

Owners Group Comments
(No Comments)

Owners Group Resolution: Approved Date: 01-Sep-98

OG Revision 2 **Revision Status: Active** **Next Action: TSTF**

TSTF Review Information

TSTF Received Date: 01-Sep-98 Date Distributed for Review 23-Sep-98

OG Review Completed: ☑ BWOG ☑ WOG ☑ CEOG ☑ BWROG

TSTF Comments:

WOG only change.

TSTF Resolution: Approved Date: 23-Sep-98

Incorporation Into the NUREGs

File to BBS/LAN Date: TSTF Informed Date: TSTF Approved Date:

NUREG Rev Incorporated:

Affected Technical Specifications

3.2.1B	Fq(z) (Fq Methodology)	
	Change Description:	Renamed to Fq(z) (RAOC-W(z) Methodology)
3.2.1A	Fq(z) (Fxy Methodology)	
	Change Description:	Rename to Fq(z) (CAOC - Fxy Methodology)
3.2.1B Bases	Fq(z) (Fq Methodology)	
	Change Description:	Renamed to Fq(z) (RAOC-W(z) Methodology)
3.2.1A Bases	Fq(z) (Fxy Methodology)	
	Change Description:	Rename to Fq(z) (CAOC - Fxy Methodology)
Bkgnd 3.2.1C Bases	Fq(z) (CAOC- W(z) Methodology)	
	Change Description:	New
Bkgnd 3.2.1B Bases	Fq(z) (Fq Methodology)	
Bkgnd 3.2.1A Bases	Fq(z) (Fxy Methodology)	
S/A 3.2.1C Bases	Fq(z) (CAOC- W(z) Methodology)	
	Change Description:	New
S/A 3.2.1A Bases	Fq(z) (Fxy Methodology)	
LCO 3.2.1C	Fq(z) (CAOC- W(z) Methodology)	
	Change Description:	New
LCO 3.2.1C Bases	Fq(z) (CAOC- W(z) Methodology)	
	Change Description:	New
LCO 3.2.1B Bases	Fq(z) (Fq Methodology)	
LCO 3.2.1A Bases	Fq(z) (Fxy Methodology)	

Appl. 3.2.1C	Fq(z) (CAOC- W(z) Methodology) Change Description: New
Appl. 3.2.1C Bases	Fq(z) (CAOC- W(z) Methodology) Change Description: New
SR 3.2.1B Bases	Fq(z) (Fq Methodology) Change Description: SR Note Bases
Ref. 3.2.1C Bases	Fq(z) (CAOC- W(z) Methodology) Change Description: New
Ref. 3.2.1C Bases	Fq(z) (CAOC- W(z) Methodology) Change Description: New
Action 3.2.1A.A	Fq(z)
Action 3.2.1C.A	Fq(z) (CAOC- W(z) Methodology) Change Description: New
Action 3.2.1B.A	Fq(z) (Fq Methodology)
Action 3.2.1A.A Bases	Fq(z)
Action 3.2.1C.A Bases	Fq(z) (CAOC- W(z) Methodology) Change Description: New
Action 3.2.1B.A Bases	Fq(z) (Fq Methodology)
Action 3.2.1C.B	Fq(z) (CAOC- W(z) Methodology) Change Description: New
Action 3.2.1C.B Bases	Fq(z) (CAOC- W(z) Methodology) Change Description: New
Action 3.2.1C.C	Fq(z) (CAOC- W(z) Methodology) Change Description: New
Action 3.2.1C.C Bases	Fq(z) (CAOC- W(z) Methodology) Change Description: New
Action 3.2.1B.C Bases	Fq(z) (Fq Methodology)
SR 3.2.1C.1	Fq(z) (CAOC- W(z) Methodology) Change Description: New
SR 3.2.1C.1 Bases	Fq(z) (CAOC- W(z) Methodology) Change Description: New
SR 3.2.1A.1 Bases	Fq(z) (Fxy Methodology)
SR 3.2.1C.2	Fq(z) (CAOC- W(z) Methodology) Change Description: New

SR 3.2.1B.2	Fq(z) (Fq Methodology)
SR 3.2.1C.2 Bases	Fq(z) (CAOC- W(z) Methodology) Change Description: New
SR 3.2.1B.2 Bases	Fq(z) (Fq Methodology)
SR 3.2.1A.2 Bases	Fq(z) (Fxy Methodology)

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INSERT NOTE A

-------------NOTE-------------
Required Action A.4 shall be completed whenever this Condition is entered.

INSERT NOTE B

-------------NOTE-------------
Required Action B.4 shall be completed whenever this Condition is entered.

INSERT NOTE A BASES

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 Fq(Z) is properly evaluated prior to increasing THERMAL POWER.

INSERT NOTE B BASES

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 Fq(Z) is properly evaluated prior to increasing THERMAL POWER.

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3.2 POWER DISTRIBUTION LIMITS

3.2.1A Heat Flux Hot Channel Factor ($F_Q(Z)$) (CAOC-F_{xy} Methodology) ~~(F_{xy} Methodology)~~

LCO 3.2.1A $F_Q(Z)$ shall be within the limits specified in the COLR.

APPLICABILITY: MODE 1.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. ~~1~~ $F_Q(Z)$ not within limit. INSERT NOTE A	A.1 Reduce THERMAL POWER ≥ 1% RTP for each 1% $F_Q(Z)$ exceeds limit.	15 minutes
	~~AND~~	
	~~A.2 Reduce AFD acceptable operation limits by the percentage $F_Q(Z)$ exceeds limit.~~	~~4 hours~~
	AND	
	A.~~3~~ 2 Reduce Power Range Neutron Flux—High trip setpoints ≥ 1% for each 1% $F_Q(Z)$ exceeds limit.	8 hours
	AND	
	A.~~4~~ 3 Reduce Overpower ΔT trip setpoints ≥ 1% for each 1% $F_Q(Z)$ exceeds limit.	72 hours
	AND	
		(continued)

ACTIONS

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. (continued)	A.~~5~~ 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
B. Required Action and associated Completion Time not met.	B.1	Be in MODE 2.	6 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.2.1.1	Verify measured values of $F_Q(Z)$ are within limits.	Once after each refueling prior to THERMAL POWER exceeding 75% RTP <u>AND</u> 31 EFPD thereafter

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.2.1.2	-------------------NOTES------------------- 1. If $F^C_{XY} > F^L_{XY}$, evaluate the effect of F_{XY} on the predicted F_Q^{PR} to determine if $F_Q(Z)$ is within its limits. 2. If $F^{RTP}_{XY} < F^C_{XY} \leq F^L_{XY}$, SR 3.2.1.2 shall be repeated within 24 hours after an increase in THERMAL POWER at which F^C_{XY} was last determined, of at least 20% RTP. -- Verify $F^C_{XY} < F^L_{XY}$.	Once after each refueling prior to THERMAL POWER exceeding 75% RTP AND 31 EFPD thereafter

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B 3.2 POWER DISTRIBUTION LIMITS

B 3.2.1A Heat Flux Hot Channel Factor ($F_Q(Z)$) (CAOC-F_{xy} Methodology) ~~(F_{xy} 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 of the core (Z).

$F_Q(Z)$ 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. ~~adjusted for uncertainty.~~ 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. ~~Therefore,~~ These LCOs, along with LCO 3.1.7, "Control Bank Insertion Limits," maintain ~~preserve~~ 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. ~~and~~ These measurements are generally taken with the core at or near steady state conditions.

Using ~~With~~ the measured three dimensional power distributions, it is possible to determine a measured value for $F_Q(Z)$. However, because this value represents a steady state condition, it does not include variations in the value of $F_Q(Z)$, which are present during a nonequilibrium situation such as load following ~~.~~ or during power ascention.

The steady state value of the fundamental radial peaking factor (F_{xy}) is adjusted by an elevation dependent factor to account for the variations in $F_Q(Z)$ due to transient conditions.

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

(continued)

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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 ~~as an initial condition~~ 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 $F_Q(Z)$ 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 the NRC Policy Statement.

(continued)

BASES (continued)

LCO

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

$$F_Q(Z) \le \frac{CFQ}{P} K(Z) \qquad \text{for } P > 0.5$$

$$F_Q(Z) \le \frac{CFQ}{0.5} K(Z) \qquad \text{for } P \le 0.5$$

where: CFQ is the F_Q 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

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

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 3.2.1A-1.

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 $F_Q(Z)$ cannot be maintained within the LCO limits, reduction of the core power is required.

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

APPLICABILITY

The $F_Q(Z)$ limits must be maintained while 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 insufficient stored energy in the fuel or energy being transferred to the

(continued)

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BASES

APPLICABILITY (continued)

reactor coolant to require a limit on the distribution of core power.

ACTIONS

A.1

Reducing THERMAL POWER by ≥ 1% for each 1% by which $F_Q(Z)$ exceeds its limit maintains an acceptable absolute power density. 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.

~~A.2~~

~~When core peaking factors are sufficiently high that LCO 3.2.3 does not permit operation at RTP, the Acceptable Operation Limits for AFD are scaled down. This percentage reduction is equal to the amount, expressed as a percentage, by which $F_Q(Z)$ exceeds its specified limit. This ensures a near constant maximum linear heat rate in units of kilowatts per foot at the acceptable operation limits. The Completion Time of 4 hours for the change in setpoints is sufficient, considering the small likelihood of a severe transient in this relatively short time period, and the preceding prompt reduction in THERMAL POWER in accordance with Required Action A.1.~~

A.~~3~~2

A reduction of the Power Range Neutron—High trip setpoints by ≥ 1% for each 1% by which $F_Q(Z)$ exceeds its specified limit, is a conservative action for protection against the consequences of severe transients with unanalyzed power distributions. The Completion Time of 8 hours is sufficient, considering the small likelihood of a severe transient in this period, and the preceding prompt reduction in THERMAL POWER in accordance with Required Action A.1.

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BASES

ACTIONS (continued)

A.~~4~~3

Reduction in the Overpower ΔT trip setpoints (value of K_4) by ≥ 1% for each 1% by which $F_Q(Z)$ 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 period, and the preceding prompt reduction in THERMAL POWER in accordance with Required Action A.1.

A.~~5~~4

Verification that $F_Q(Z)$ 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.

INSERT NOTE A BASES

B.1

If the Required Actions of A.1 through A.4 cannot be 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

Verification that $F_Q(Z)$ is within its limit involves increasing the measured values of $F_Q(Z)$ to allow for manufacturing tolerance and measurement uncertainties and then making a comparison with the limits. These limits are provided in the COLR. Specifically, the measured value of the Heat Flux Hot Channel Factor (F_Q^M) is increased by 3% to account for fuel manufacturing tolerances and by 5% for flux

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BASES

SURVEILLANCE REQUIREMENTS

SR 3.2.1.1 (continued)

map measurement uncertainty. This procedure is equivalent to ~~increasing~~ multiplying the directly measured values of $F_Q(Z)$ by 1.0815~~%~~ before comparing with LCO limits (Ref. 4).

Performing the Surveillance in MODE 1 prior to THERMAL POWER exceeding 75% RTP after each refueling ensures that $F_Q(Z)$ is within limit when RTP is achieved, because peaking factors generally decrease as power level is increased.

The Frequency of 31 EFPD is adequate for monitoring the change of power distribution with core burnup because the power distribution changes relatively slowly for this amount of fuel burnup. The Surveillance may be done more frequently if required by the results of SR 3.2.1.2.

SR 3.2.1.2

The nuclear design process includes calculations ~~that predict~~ performed to determine that the core can be operated within the $F_Q(Z)$ limits. Because flux maps are taken at steady state conditions, the axial variations in power distribution for normal operation maneuvers such as load following are not present in the flux map data. These axial variations are, however, conservatively calculated by considering, in the nuclear design process, a wide range of unit maneuvers in normal operation. $F_{xy}(Z)$ is the radial peaking factor, which is one component of $F_Q(Z)$ and should be consistent between the nuclear design values and the measured values. ($F_{xy}(Z)$ multiplied by the normalized average axial power at elevation Z gives $F_Q(Z)$.)

The core plane regions applicable to an F_{xy} evaluation exclude the following, measured in percent of core height:

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

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.

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BASES

SURVEILLANCE REQUIREMENTS

SR 3.2.1.2 (continued)

The following terms are used in the F_{xy} evaluation:

F_{xy}^M = The measured value of F_{xy} obtained directly from the flux map results.

F_{xy}^C = The measured value, F_{xy}^M, multiplied by 1.0815 to account for fuel manufacturing tolerances and flux map measurement uncertainty (Ref. 2).

F_{xy}^{RTP} = The limit of F_{xy} at RTP.

F_{xy}^L = $F_{xy}^{RTP}[(1 + PFXY)(1 - P)]$ (the limit of F_{xy} at the current THERMAL POWER level).

PFXY = The power factor multiplier for F_{xy}.

P = [The Fraction of RTP at which F_{xy} was measured.]

F_Q^{PR} = The predicted value of the Heat Flux Hot Channel Factor.

The predicted value is a maximum value which includes load follow impacts.

F_{xy}^{RTP} and PFXY are provided in the COLR. F_{xy}^M and F_{xy}^C are measured and calculated at discrete core elevations. Note that F_{xy} can be rewritten as $F_{xy}(Z)$ to indicate that F_{xy} varies along the axial height of the core. Flux map data are typically taken for 30 to 75 core elevations.

The top and bottom regions of the core are excluded from the F_{xy} evaluation because of the difficulty of making precise and meaningful measurements in these regions and also because of the low probability that these regions would be more limiting than the central 70% of the core in the accident analyses.

Grid plane regions and rod tip regions are also excluded because the flux data may give spurious values because of the difficulty in lining up flux traces accurately in regions of rapidly varying flux. In addition, these small portions of the core are reduced in local power density because of neutron absorption in the grids and control rods and, therefore, cannot be regions of peak linear power.

An evaluation of $F_{xy}(Z)$ is used to confirm that $F_Q(Z)$ is within its limits. If F_{xy}^C is < F_{xy}^{RTP}, it is concluded that

(continued)

SURVEILLANCE REQUIREMENTS

SR 3.2.1.2 (continued)

the LCO limit on $F_Q(Z)$ is met. This result is true for flux maps taken at reduced power because the $F_{xy}(Z)$ value is inherently decreased as THERMAL POWER is increased. The feedback from the Doppler coefficient and moderator effects flattens the power distribution with increased THERMAL POWER.

The first Note of this Surveillance provides the action to be taken if F^C_{xy} is > F^L_{xy}. In this case, the $F_Q(Z)$ limit may be exceeded. Proportionally increasing the predicted $F^{PR}_Q(Z)$ by the amount that F^L_{xy} is exceeded gives an adjusted $F_Q(Z)$, which is compared with the $F_Q(Z)$ limit. If the adjusted $F_Q(Z)$ exceeds the LCO limit, the operator must perform Required Actions A.1 through A.5.

The second Note in this Surveillance states that if F^C_{xy} is > F^{RTP}_{xy} but < F^L_{xy}, then this Surveillance shall be repeated within 24 hours after exceeding by ≥ 20% RTP the THERMAL POWER at which F^C_{xy} was last determined, so as to demonstrate that $F_{xy}(Z)$ is being sufficiently reduced as power increases. This reduction, because of feedback from the Doppler coefficient and moderator effects, ensures that when RTP is attained, the ~~measured~~ computed $F^{\cancel{M}C}_{xy}(Z)$ is < F^{RTP}_{xy}.

Performing the Surveillance in MODE 1 prior to exceeding 75% RTP after each refueling ensures that the $F_Q(Z)$ limit is met when RTP is achieved.

The Surveillance Frequency of 31 EFPD is adequate to monitor the change of power distribution with core burnup because the power distribution changes relatively slowly for this amount of fuel burnup. The Surveillance may be done more frequently if required by the results of F_{xy} evaluations. Specifically, the F_{xy} evaluation is required by this Surveillance if the evaluation shows that F^{RTP}_{xy} < F^C_{xy} and to demonstrate that the LCO is met after its limit has been exceeded.

REFERENCES

1. 10 CFR 50.46.

2. Regulatory Guide 1.77, Rev. [ ].

(continued)

BASES

REFERENCES (continued)

3. 10 CFR 50.46, GDC 26.

4. [WCAP-7308-L-P-A, "Evaluation of Nuclear Hot Channel Factor Uncertainties," June 1988.]

3.2 POWER DISTRIBUTION LIMITS

3.2.1B Heat Flux Hot Channel Factor ~~($F_Q(Z)$) (F_Q Methodology)~~ $F_Q(Z)$ (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. INSERT NOTE A $F_Q^C(Z)$ not within limit.	A.1 Reduce THERMAL POWER $\geq$ 1% RTP for each 1% $F_Q^C(Z)$ exceeds limit.	15 minutes
	<u>AND</u>	
	A.2 Reduce Power Range Neutron Flux—High trip setpoints $\geq$ 1% for each 1% $F_Q^C(Z)$ exceeds limit.	8 hours
	<u>AND</u>	
	A.3 Reduce Overpower ΔT trip setpoints $\geq$ 1% for each 1% $F_Q^C(Z)$ exceeds limit.	72 hours
	<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

(continued)

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ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
B. $F_Q^W(Z)$ not within limits.	B.1	Reduce AFD limits $\geq$ 1% for each 1% $F_Q^W(Z)$ exceeds limit.	2 hours
C. Required Action and associated Completion Time not met.	C.1	Be in MODE 2.	6 hours

See Insert 1

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INSERT 1

(This page is an insert to page 3.2-5.)

B. $F_Q^W(Z)$ not within limits. INSERT NOTE B	B.1 Reduce AFD limits ≥ 1% for each 1% $F_Q^W(Z)$ exceeds limit.	~~2~~ 4 hours
	<u>AND</u>	
	B.2 Reduce Power Range Neutron Flux - High trip setpoints ≥1% for each 1% that the maximum allowable power of the AFD limits is reduced.	~~8~~ 72 hours
	<u>AND</u>	
	B.3 Reduce Overpower ΔT trip setpoints ≥ 1% for each 1% that the maximum allowable power of the AFD limits is reduced.	72 hours
	<u>AND</u>	
	B.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.

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 AND Once within [12] hours after achieving equilibrium conditions after exceeding, by ≥ 10% RTP, the THERMAL POWER at which $F_Q^C(Z)$ was last verified AND 31 EFPD thereafter

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.2.1.2	-------------------NOTE-------------------	

If ~~$F_Q^W(Z)$ is within limits and~~ measurements indicate that the

$$\text{maximum over } z \left[\frac{F_Q^C(Z)}{K(Z)} \right]$$

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

$$\text{maximum over } z \left[\frac{F_Q^C(Z)}{K(Z)} \right]$$

has not increased.

SURVEILLANCE	FREQUENCY
Verify $F_Q^W(Z)$ is within limit.	Once after each refueling prior to THERMAL POWER exceeding 75% RTP AND (continued)

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SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
SR 3.2.1.2 (continued)	Once within [12] hours after achieving equilibrium conditions after exceeding, by ≥ 10% RTP, the THERMAL POWER at which $F_Q^M(Z)$ was last verified AND 31 EFPD thereafter

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B 3.2 POWER DISTRIBUTION LIMITS

B 3.2.1B Heat Flux Hot Channel Factor ($F_Q(Z)$) (~~F_Q~~ 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 TILT POWER RATIO (QPTR)," which are directly and continuously measured process variables. These LCOs, along with LCO 3.1.7, "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 ~~steady state~~ equilibrium conditions.

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 ~~steady state~~ equilibrium condition, it does not include the variations in the value of $F_Q(Z)$ ~~that~~ which are present during nonequilibrium situations, such as load following ~~,~~ or power ascension.

To account for these possible variations, the ~~steady state~~ 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 ~~nonsteady state~~ non-equilibrium conditions are accomplished by operating the core within the limits of

(continued)

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BACKGROUND (continued)

the appropriate LCOs, including the limits on AFD, QPTR, and control rod insertion.

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 the NRC Policy Statement.

(continued)

BASES (continued)

LCO

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

$$F_Q(Z) \le \frac{CFQ}{P} K(Z) \qquad \text{for } P > 0.5$$

$$F_Q(Z) \le \frac{CFQ}{0.5} K(Z) \qquad \text{for } P \le 0.5$$

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

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

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.

(continued)

The $F_Q^C(z)$ is calculated at equilibrium conditions.

BASES

LCO (continued)

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

$$F_Q^W(Z) = F_Q^C(Z)\ W(Z)$$

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 $F_Q(Z)$ 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 ~~$F_Q(Z)$~~ $F_Q^C(z)$ cannot be maintained within the LCO limits, reduction ~~of the~~ core power is required. Insert 2

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.

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.

(continued)

INSERT 2

This page is an insert to page B 3.2-14.

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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.

BASES

ACTIONS (continued)

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, is a conservative action for protection against the consequences of severe transients with unanalyzed power distributions. The Completion Time of 8 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.

A.3

(value of K_4)

Reduction in the Overpower ΔT 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.

A.4

and SR 3.2.1.2

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

and future operation

INSERT NOTE A BASES

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 2 hours, restricts the axial flux distribution such that even if a transient occurred, core peaking factors are not exceeded.

Insert 3

(continued)

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INSERT 3

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 B.2, B.3 and B.4.

B.2

the maximum allowable

A reduction of the Power Range Neutron Flux-High trip setpoints by ≥1% for each 1% by which power is reduced, is a conservative action for protection against the consequences of severe transients with unanalyzed power distributions. The Completion Time of 8 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 B.1.

as a result of reducing AFD limits

B.3

value of Kq

Reduction in the Overpower ΔT trip setpoints by ≥1% for each 1% by which 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 severe transient in this time period, and the preceding prompt reduction in THERMAL POWER in accordance with Required Action B.1.

B.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 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.

maximum allowable power

INSERT NOTE B BASES

BASES

ACTIONS (continued)

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.

(continued)

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.

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.

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).

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).

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

(continued)

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SURVEILLANCE REQUIREMENTS

SR 3.2.1.2 (continued)

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 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.

The top and bottom 15% of the core are excluded from the evaluation because of the low probability that these regions 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 and found to be within its limit, 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

$$\text{maximum over z} \left[\frac{F_Q^C(Z)}{K(Z)} \right],$$

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), 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. INSERT 4

(continued)

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INSERT 4

[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.]

BASES

SURVEILLANCE REQUIREMENTS

SR 3.2.1.2 (continued)

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 $\geq$ 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.

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.

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) FQ Surveillance Technical Specification", February 1994.

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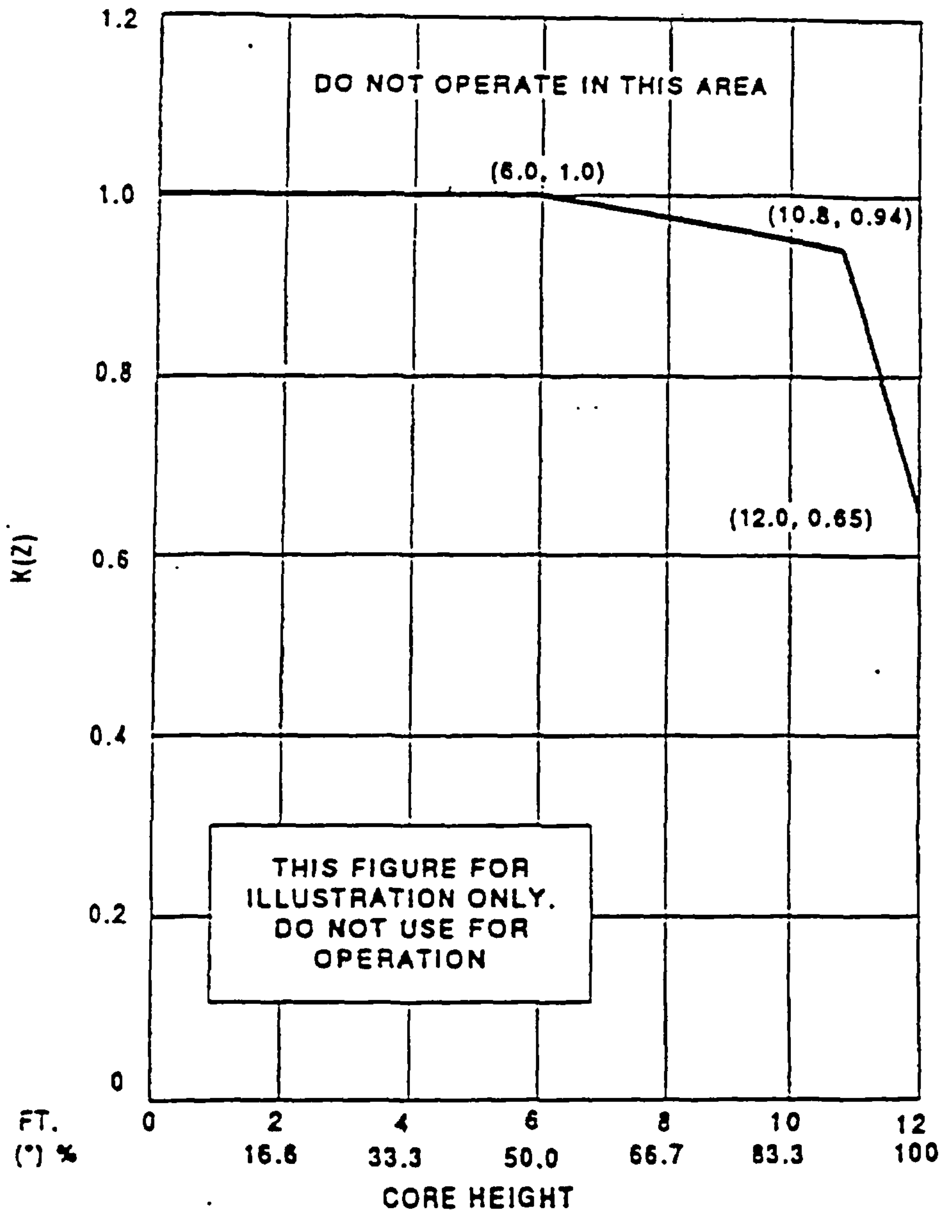

*For core height of 12 feet

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

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3.2 POWER DISTRIBUTION LIMITS

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

3.2.1~~B~~C Heat Flux Hot Channel Factor ~~($F_Q(Z)$) (F_Q Methodology)~~

LCO 3.2.1~~B~~C $F_Q(Z)$, 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. $F_Q^C(Z)$ not within limit. INSERT NOTE A	A.1	Reduce THERMAL POWER ≥ 1% RTP for each 1% $F_Q^C(Z)$ exceeds limit.	15 minutes
	AND		
	A.2	Reduce Power Range Neutron Flux—High trip setpoints ≥ 1% for each 1% $F_Q^C(Z)$ exceeds limit.	8 hours
	AND		
	A.3	Reduce Overpower ΔT trip setpoints ≥ 1% for each 1% $F_Q^C(Z)$ exceeds limit.	72 hours
	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

(continued)

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
B. $F_Q^W(Z)$ not within limits.	B.1	Reduce AFD limits ≥ 1% for each 1% $F_Q^W(Z)$ exceeds limit.	2 hours
C. Required Action and associated Completion Time not met.	C.1	Be in MODE 2.	6 hours

REPLACE WITH INSERT 5

INSERT 5

(This page is an insert to page 3.2-5.)

B. $F_Q^W(Z)$ not within limits. INSERT NOTE B	B.1 Reduce THERMAL POWER $\geq 1\%$ RTP for each 1% $F_Q^W(Z)$ exceeds limit.	~~2~~ 4 hours
	AND	
	B.2 Reduce Power Range Neutron Flux - High trip setpoints $\geq 1\%$ for each 1% $F_Q^W(Z)$ exceeds limit.	~~8~~ 72 hours
	AND	
	B.3 Reduce Overpower ΔT trip setpoints $\geq 1\%$ for each 1% $F_Q^W(Z)$ exceeds limit.	72 hours
	AND	
	B.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

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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] 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

(continued)

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SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.2.1.2	-------------------NOTE------------------- If ~~$F_Q^C(Z)$ is within limits, and~~ measurements indicate that the $$\text{maximum over } z \left[\frac{F_Q^C(Z)}{K(Z)} \right]$$ 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 $$\text{maximum over } z \left[\frac{F_Q^C(Z)}{K(Z)} \right]$$ has not increased. -- Verify $F_Q^W(Z)$ is within limit.	Once after each refueling prior to THERMAL POWER exceeding 75% RTP AND (continued)

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SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
SR 3.2.1.2 (continued)	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 31 EFPD thereafter

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B 3.2 POWER DISTRIBUTION LIMITS

B 3.2.1~~B~~ C Heat Flux Hot Channel Factor ~~($F_Q(Z)$)~~ $F_Q(Z)$ (CAOC-W(Z) Methodology) ~~(F_Q 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 TILT POWER RATIO (QPTR)," which are directly and continuously measured process variables. These LCOs, along with LCO 3.1.7, "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 ~~steady state~~ equilibrium conditions.

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 ~~steady state~~ equilibrium condition, it does not include the variations in the value of $F_Q(Z)$ ~~that~~ which are present during nonequilibrium situations, such as load following ~~,~~ or power ascension.

To account for these possible variations, the ~~steady state~~ 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 ~~nonsteady state~~ non-equilibrium conditions are accomplished by operating the core within the limits of

(continued)

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BACKGROUND (continued)

the appropriate LCOs, including the limits on AFD, QPTR, and control rod insertion.

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 the NRC Policy Statement.

(continued)

BASES (continued)

LCO

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

$$F_Q(Z) \le \frac{CFQ}{P} K(Z) \qquad \text{for } P > 0.5$$

$$F_Q(Z) \le \frac{CFQ}{0.5} K(Z) \qquad \text{for } P \le 0.5$$

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

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

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 ~~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.

(continued)

BASES

The $F_Q^C(z)$ is calculated at equilibrium conditions.

LCO (continued)

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

$$F_Q^W(Z) = F_Q^C(Z)\ W(Z)$$

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 $F_Q(Z)$ 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 ~~$F_Q(Z)$~~ $F_Q^C(Z)$ 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.

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.

(continued)

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BASES

ACTIONS (continued)

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, is a conservative action for protection against the consequences of severe transients with unanalyzed power distributions. The Completion Time of 8 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.

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.

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.

INSERT NOTE A BASES

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~~ THERMAL POWER by ≥ 1% RTP for each 1% by which $F_Q^W(Z)$ exceeds its limit within the allowed Completion Time of 2 hours, ~~restricts the axial flux distribution~~ maintains an acceptable absolute power density such that even if a transient occurred, core peaking factors are not exceeded.

INSERT 6

(continued)

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INSERT 6

B.2

A reduction of the Power Range Neutron Flux-High trip setpoints by ≥1% for each 1% by which $F^W_Q(Z)$ exceeds its limit, is a conservative action for protection against the consequences of severe transients with unanalyzed power distributions. The Completion Time of 8 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 B.1.

B.3

value of K_4

Reduction in the Overpower ΔT trip setpoints by ≥1% for each 1% by which $F^W_Q(Z)$ 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 B.1.

B.4

Verification that $F^W_Q(Z)$ 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.

INSERT NOTE B BASES

ACTIONS (continued)

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.

(continued)

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.

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.

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).

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).

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

(continued)

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BASES

SURVEILLANCE REQUIREMENTS

SR 3.2.1.2 (continued)

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 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.

The top and bottom 15% of the core are excluded from the evaluation because of the low probability that these regions 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 and found to be within its limit, 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

$$\text{maximum over z} \left[\frac{F_Q^C(Z)}{K(Z)} \right],$$

the greater of

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

INSERT 7

(continued)

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INSERT 7

[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.]

BASES

SURVEILLANCE REQUIREMENTS

SR 3.2.1.2 (continued)

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.

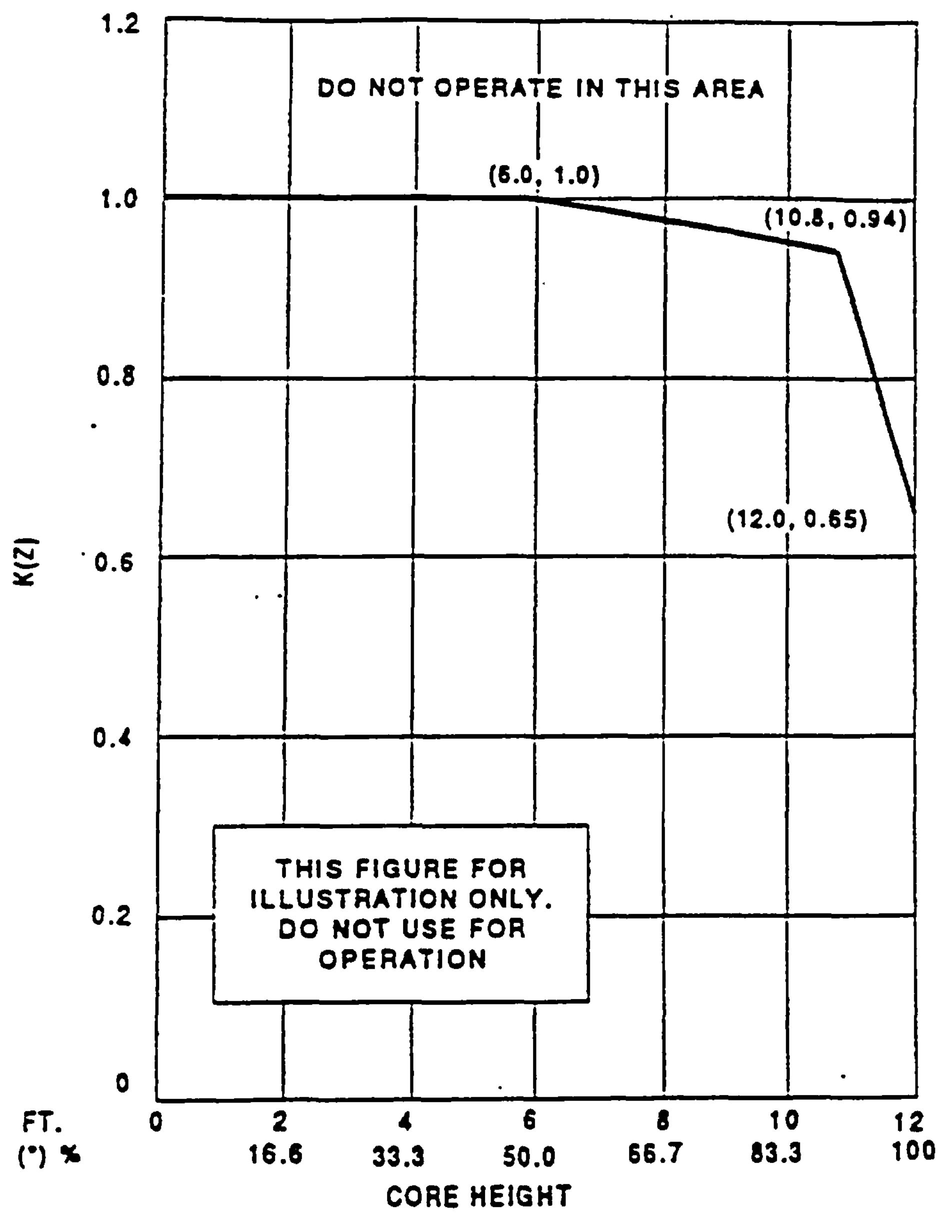
$F_Q(Z)$ is verified at power levels ≥ 10% RTP above the THERMAL POWER of its last verification, [12] hours after achieving equilibrium conditions to ensure that $F_Q(Z)$ is within its limit at higher power levels.

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.

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) FQ Surveillance Technical Specification," February 1994.



*For core height of 12 feet

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