Advanced Passive 1000 (AP1000)
Generic Technical Specification Traveler (GTST)

Title: Changes related to Section 3.2.1, Heat Flux Hot Channel Factor ($F_Q(Z)$) (F_Q Methodology)

I. Technical Specifications Task Force (TSTF) Travelers, Approved Since Revision 2 of STS NUREG-1431, and Used to Develop this GTST

TSTF Number and Title:

TSTF-425, Rev. 3, Relocate Surveillance Frequencies to Licensee Control - RITSTF Initiative 5b
TSTF-519-T, Rev. 0: Increase Standardization in Condition and Required Action Notes

STS NUREGs Affected:

TSTF-425, Rev. 3: NUREG-1430, -1431, -1432, -1433, -1434
TSTF-519, Rev. 0: NUREG-1430, -1431, -1432, -1433, -1434

NRC Approval Date:

TSTF-425, Rev. 3: 18-Mar-2009
TSTF-519, Rev. 0: Not available

TSTF Classification:

TSTF-425, Rev. 3: Technical Change
TSTF-519, Rev. 0: NUREG only change

II. Reference Combined License (RCOL) Standard Departures (Std. Dep.), RCOL COL Items, and RCOL Plant-Specific Technical Specifications (PTS) Changes Used to Develop this GTST

RCOL Std. Dep. Number and Title:

None

RCOL COL Item Number and Title:

None

RCOL PTS Change Number and Title:

VEGP LAR DOC A011	Statements referring to “OPDMS operable” and “OPDMS inoperable” are revised respectively to refer to “OPDMS monitoring parameters” and “OPDMS not monitoring parameters.”
VEGP LAR DOC A018	SR 3.2.1.1 and SR 3.2.1.2 are revised to split each of them into two Surveillances.

III. Comments on Relations Among TSTFs, RCOL Std. Dep., RCOL COL Items, and RCOL PTS Changes

This section discusses the considered changes that are: (1) applicable to operating reactor designs, but not to the AP1000 design; (2) already incorporated in the GTS; or (3) superseded by another change.

TSTF-519-T has already been implemented by AP1000 and the VEGP TS. No change was needed for TSTF-519-T.

TSTF-425 is deferred for future consideration.

IV. Additional Changes Proposed as Part of this GTST (modifications proposed by NRC staff and/or clear editorial changes or deviations identified by preparer of GTST)

Citation of References 4 and 5 in the list of references in the “References” section of the Bases, are added to the ‘Surveillance Requirements” section of the Bases, consistent with Revision 4 of NUREG-1431, Bases for Specification 3.2.1B.

All occurrences of “EFPDs” are replaced with EFPD, which stands for effective full power day(s).

APOG Recommended Changes to Improve the Bases

A correction is recommended in the “Actions” section of the Bases consistent with the TS requirement.

An editorial correction is recommended in the “LCO” section of the Bases for clarity.

V. Applicability

Affected Generic Technical Specifications and Bases:

Section 3.2.1, Heat Flux Hot Channel Factor ($F_Q(Z)$) (F_Q Methodology)

Changes to the Generic Technical Specifications and Bases:

The APPLICABILITY statement is revised replacing "OPDMS inoperable" with "OPDMS not monitoring parameters." (DOC A011)

Surveillance Requirements are redefined. Two current Surveillances are modified and the new Surveillance Requirements consist of four Surveillances. Notes specific to the Surveillances are defined. (DOC A012)

An editorial change is made in the "LCO" section of the Bases. (APOG Comment)

A correction is made in the "Actions A.2" section of the Bases. (APOG Comment)

VI. Traveler Information

Description of TSTF changes:

TSTF-519-T provides consistency in the placement of Notes in Condition and Required Action Column in the ACTIONS Table. Specifically, Notes in the Condition Column should appear to the right of the Condition designator, not above the Condition designator. Notes that apply to all Required Actions of a Condition are placed above the first Required Action and are full width of the Column. Notes that apply to a single Required Action are placed to the right of the designator of the Required Action.

Rationale for TSTF changes:

The changes are editorial corrections and not technical changes.

The change to the Required Action Note placement avoids a potential error-prone situation. If a Condition has a single Required Action and a Note located above the Required Action, that Note will apply to any Required Action added to the Condition in the future. By placing a Note to the right of the Required Action designator, it requires a conscious decision by the licensee to apply the existing Note to the new Required Action.

Description of changes in RCOL Std. Dep., RCOL COL Item(s), and RCOL PTS Changes:

VEGP LAR DOC A011:

Various statements referring to “OPDMS OPERABLE” are revised to refer to “OPDMS monitoring parameters.” Various statements referring to “OPDMS inoperable” are revised to refer to “OPDMS not monitoring parameters.”

VEGP LAR DOC A018:

TS 3.2.1, “Heat Flux Hot Channel Factor ($F_Q(Z)$) (F_Q Methodology),” SR 3.2.1.1 and SR 3.2.1.2 each have three Frequencies, which require verification of $F_Q^W(Z)$ [for SR 3.2.1.1] and $F_Q^C(Z)$ [for SR 3.2.1.2] limits:

“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 [$F_Q^C(Z)$][$F_Q^W(Z)$] was last verified

AND

31 effective full power days (EFPD) thereafter"

SR 3.2.1.1 and SR 3.2.1.2 are revised to split each of them into two Surveillances; one pair of SRs with the "Once after each refueling prior to THERMAL POWER exceeding 75% RTP" Frequency (i.e., new SR 3.2.1.1 and SR 3.2.1.2), and the remaining pair of SRs with the remaining two Frequencies (i.e., new SR 3.2.1.3 and SR 3.2.1.4).

Currently, there are two Notes applicable to both SR 3.2.1.1 and SR 3.2.1.2, which state:

> "1. During power escalation at the beginning of each cycle, THERMAL POWER may be increased until a power level for extended operation has been achieved at which a power distribution map is obtained."
>
> "2. If the OPDMS becomes inoperable while in MODE 1 these surveillances must be performed within 31 days of the last verification of OPDMS parameters."

The existing Note 1 is replaced as follows: the new SRs 3.2.1.1 and 3.2.1.2 with the "Once after each refueling prior to THERMAL POWER exceeding 75% RTP" Frequency, will include a new Note stating:

> "Not required to be performed if OPDMS was monitoring parameters upon exceeding 75% RTP."

Existing Note 2 will not be applied to new SRs 3.2.1.1 and 3.2.1.2, and existing Note 1 will not be applied to new SRs 3.2.1.3 and 3.2.1.4. However, for new SRs 3.2.1.3 and 3.2.1.4, existing Note 2 is reworded as SR 3.2.1.3 Note and SR 3.2.1.4 Note 1 stating:

> "Not required to be performed until 31 days after the last verification of OPDMS parameters."

Current SR 3.2.1.2 Note will not be included with new SR 3.2.1.2 and is renumbered as Note 2 in new SR 3.2.1.4.

Rationale for changes in RCOL Std. Dep., RCOL COL Item(s), and RCOL PTS Changes:

VEGP LAR DOC A011:

The On-Line Power Distribution Monitoring System (OPDMS) is not safety related and does not have a safety function. OPDMS is an advanced core monitoring and support package. With OPDMS operating, the power distribution parameters are continuously computed and displayed, and compared against their limit. The TS definition of Operable is applied to assure a system is "capable of performing its specified safety function(s)." As such the use of the defined term is not appropriate for the OPDMS. Additionally, there is no requirement for maintaining its non-safety related capability.

The online monitoring capability of OPDMS is utilized when complying with TS 3.2.5, OPDMS-Monitored Parameters. The parameters required to meet LCO 3.2.5 are only applicable when OPDMS is providing the monitoring for compliance with the applicable limits. When OPDMS is not being utilized, the limits of TS 3.1.6, 3.2.1, 3.2.2, 3.2.3, and 3.2.4 are applicable (note that certain Actions of TS 3.1.4 also impose requirements of TS 3.2.1 and 3.2.2 when OPDMS is not being utilized). The current use of "OPERABLE" (and "inoperable") in referencing whether

OPDMS is being utilized, is misleading and is more appropriately revised to “monitoring” (and “not monitoring”).

VEGP LAR DOC A018:

TS 3.2.1, and therefore its SRs, is currently only applicable when the Online Power Distribution Monitoring System (OPDMS) is “inoperable” (revised to “not monitoring parameters”). (Note that references to OPDMS “OPERABLE” and “inoperable” throughout TS are revised to “monitoring parameters” and “not monitoring parameters,” respectively, as discussed in DOC A011.)

In accordance with SR 3.0.1, SRs are required to be met when the TS is applicable, i.e., immediately on OPDMS not monitoring parameters, and failure to perform a Surveillance within the specified Frequency is a failure to meet the LCO and would constitute a violation of SR 3.0.4. As such, the TS 3.2.1 SRs must be stated such that they are “required to be performed” only after an appropriate allowance when OPDMS was not monitoring and/or is no longer monitoring parameters.

The Surveillance Frequency “Once after each refueling prior to THERMAL POWER exceeding 75% RTP” for proposed SRs 3.2.1.1 and 3.2.1.2 is associated solely with the beginning of cycle startup after a refueling and would have a unique exception related to whether OPDMS was monitoring parameters or not. As described in the current TS 3.2.1 Bases, the existing SRs Note 1 applies to the situation where the OPDMS is inoperable at the beginning of cycle startup after a refueling allowing an equilibrium power level to be achieved at which time a power distribution map can be obtained. The proposed replacement Note will exclude the initial post-refueling flux map and verification of $F_Q(Z)$ when that startup was performed with OPDMS monitoring its associated parameters as power is increased above 75% RTP. If OPDMS ceases to monitor parameters at some point after initial power escalation above 75%, it would be inappropriate to consider this SR not performed and therefore the LCO not met. Appropriate core monitoring was provided for the transition above 75% RTP, and further $F_Q(Z)$ monitoring is adequately addressed by proposed SRs 3.2.1.3 and 3.2.1.4. This is an explicit clarification of the intent of the current stated Frequency and the current SR Note 1 as outlined in the Bases. Therefore, this change is deemed an administrative clarification with no resultant technical change to the current TS.

The Frequencies that are split out into proposed SRs 3.2.1.3 and 3.2.1.4 relate to the periodic verification that is appropriate without the continuous monitoring capability of OPDMS. Additionally, verification is required following a power increase and subsequent equilibrium condition which is more than 10% RTP above the prior verification. This will ensure that $F_Q(Z)$ is verified as soon as RTP (or any other level for extended operation) is achieved. The current SR Note 2 provides an explicit 31-day exception to performing the Surveillance (i.e., for not meeting these Frequencies) when OPDMS is initially not monitoring parameters. The rewording of this allowance in revised SR 3.2.1.3 Note and SR 3.2.1.4 Note 1 provides the same intent, but is worded in accordance with TSTF-GG-05-01, subsection 4.1.7.f and 4.1.7.g. Therefore, this change is deemed an administrative clarification with no resultant technical change to the current TS.

Current SR 3.2.1.2 Note details requirements when one measurement has increased over a previous measurement. Since the Frequency of “Once after each refueling prior to THERMAL POWER exceeding 75% RTP” is a first performance requirement, there would be no previous measurement to compare to. As such, not including the current SR 3.2.1.2 Note in the split out revised SRs 3.2.1.1 and 3.2.1.2, which contain the first performance Frequency, will not be included with new SR 3.2.1.2.

Note that certain Required Actions specify performance of current SR 3.2.1.1 and SR 3.2.1.2 (i.e., TS 3.1.4 Required Action B.2.4; TS 3.2.1 Required Action A.4; TS 3.2.1 Required Action B.4; TS 3.2.4 Required Action A.3; and TS 3.2.4 Required Action A.6). Current SR 3.2.1.1 and SR 3.2.2 require verification of $F_Q^C(Z)$ and $F_Q^W(Z)$, respectively. These verifications are consistent with the new TS 3.2.1 SRs. The new SR 3.2.1.3 and SR 3.2.1.4 similarly require the same verifications. The differences being associated with performance timing Frequencies and Notes; however, when directed by other Required Actions, those Frequencies are not applicable. Continuing to specify only new SR 3.2.1.1 and SR 3.2.1.2 in these Required Actions retains the current intent and requirements.

These changes are designated as administrative changes and are acceptable because they do not result in technical changes to the TS.

Description of additional changes proposed by NRC staff/preparer of GTST:

The following editorial change is made in the “LCO” section of the Bases:

> The actual values of CFQ are given in the COLR; however, CFQ is normally a number on the order of 2.60. ~~For the AP1000, t~~**T**he normalized...

The following correction is made in the “Actions” section of the Bases, under heading “A.2”:

> ... Power Range Neutron Flux - High trip setpoint reduction within ~~8~~ **72** hours of the $F_Q^C(Z)$ determination, if necessary to comply with the decreased maximum allowable...

Rationale for additional changes proposed by NRC staff/preparer of GTST:

The change in the “Actions” section of the Bases, under heading “A.2,” is a correction. This corrects an obvious misstatement and makes the Bases discussion consistent with the requirements reducing the potential for misunderstanding and misapplication.

The editorial correction in the “LCO” section of the Bases provides clarity.

VII. GTST Safety Evaluation

Technical Analysis:

Replacing “OPDMS inoperable” with “OPDMS not monitoring parameters”

The Applicability in the Specifications and the Bases for this Section are revised to state “OPDMS is not monitoring parameters” replacing “OPDMS is inoperable” consistent with the changes made in TS 3.2.5, OPDMS -Monitoring Parameters.”

In TS, the term “Operable” is applied to assure that a system is “capable of performing its specified safety function(s).” OPDMS is not safety related and does not have a safety function. It is a core monitoring and support package. As described, when OPDMS is operating, the power distribution parameters are continuously computed and displayed, and compared against their limit. It is, therefore, appropriate to use the terms “OPDMS is monitoring parameters” and “OPDMS is not monitoring parameters.”

Changes to the Surveillance Requirements

SR 3.2.1.1 and SR 3.2.1.2 are restructured into four SRs - SR 3.2.1.1, SR 3.2.1.2, SR 3.2.1.3, and SR 3.2.1.4.

The Surveillance Frequency “Once after each refueling prior to THERMAL POWER exceeding 75% RTP” for proposed SRs 3.2.1.1 and 3.2.1.2 is associated solely with the beginning of cycle startup after a refueling and would have a unique exception related to whether OPDMS was monitoring parameters or not.

The Frequencies that are split out into proposed SRs 3.2.1.3 and 3.2.1.4 relate to the periodic verification that is appropriate without the continuous monitoring capability of OPDMS. Additionally, verification is required following a power increase and subsequent equilibrium condition which is more than 10% RTP above the prior verification. This will ensure that $F_Q(Z)$ is verified as soon as RTP (or any other level for extended operation) is achieved. The current SR Note 2 provides an explicit 31-day exception to performing the Surveillance (i.e., for not meeting these Frequencies) when OPDMS is initially not monitoring parameters. The rewording of this allowance in revised SR 3.2.1.3 Note and SR 3.2.1.4 Note 1 provides the same intent, but is worded in accordance with TSTF-GG-05-01, subsection 4.1.7.f and 4.1.7.g.

Thus, the restructuring of the SRs into four SRs provides a better way to present the requirements. It accomplishes the following objectives:

(1) SRs are defined considering when the Surveillance is to be conducted, providing clear guidance and focus for the operators,
(2) Frequencies are specifically stated instead of being surmised from the Notes, and
(3) SRs when OPDMS is monitoring parameters and when it is not are clearly stated.

These changes are not technical and can be considered administrative. These changes are acceptable as they will be easier to understand and implement by the operators.

Remaining Changes

The remaining changes are editorial, clarifying, grammatical, or otherwise considered administrative. These changes do not affect the technical content, but improve the readability, implementation, and understanding of the requirements, and are therefore acceptable.

Having found that this GTST’s proposed changes to the GTS and Bases are acceptable, the NRC staff concludes that AP1000 STS Subsection 3.2.1 is an acceptable model Specification for the AP1000 standard reactor design.

References to Previous NRC Safety Evaluation Reports (SERs):

None

VIII. Review Information

Evaluator Comments:

None

Pranab K. Samanta
Brookhaven National Laboratory
631-344-4948
samanta@bnl.gov

Review Information:

Availability for public review and comment on Revision 0 of this traveler approved by NRC staff on 5/20/2014.

APOG Comments (Ref. 7) and Resolutions

1. (Internal #95) 3.2.01, Pg. 10, The first sentence in the second paragraph of the “Technical Analysis” in this GTST was deleted since sufficient information is provided in the rest of the paragraph to justify the change.

2. (Internal #96) 3.2.01, Pg. 41, An editorial change was made in the “LCO” section of the Bases for clarity.

3. (Internal #97) 3.2.01, Pg. 43, A correction was made in the “Actions” section, under heading “A.2, “ of the Bases consistent with the requirements.

NRC Final Approval Date: 12/4/2015

NRC Contact:

T. R. Tjader
United States Nuclear Regulatory Commission
301-415-1187
Theodore.Tjader@nrc.gov

IX. Evaluator Comments for Consideration in Finalizing Technical Specifications and Bases

None

X. References Used in GTST

1. AP1000 DCD, Revision 19, Section 16, “Technical Specifications,” June 2011 (ML11171A500).

2. Southern Nuclear Operating Company, Vogtle Electric Generating Plant, Unit 3 and 4, Technical Specifications Upgrade License Amendment Request, February 24, 2011 (ML12065A057).

3. TSTF-GG-05-01, Technical Specification Task Force (TSTF) Writer's Guide for Plant-Specific Improved Technical Specifications, Revision 1.

4. RAI Letter No. 01 Related to License Amendment Request (LAR) 12-002 for the Vogtle Electric Generating Plant, Units 3 and 4 Combined Licenses, September 7, 2012 (ML12251A355).

5. Southern Nuclear Operating Company, Vogtle Electric Generating Plant, Units 3 and 4, Response to Request for Additional Information Letter No. 01 Related to License Amendment Request LAR-12-002, ND-12-2015, October 04, 2012 (ML12286A363 and ML12286A360).

6. NRC Safety Evaluation (SE) for Amendment No. 13 to Combined License (COL) No. NPF-91 for Vogtle Electric Generating Plant (VEGP) Unit 3, and Amendment No. 13 to COL No. NPF-92 for VEGP Unit 4, September 9, 2013 (ADAMS Package Accession No. ML13238A337), which contains:

ML13238A355,	Cover Letter - Issuance of License Amendment No. 13 for Vogtle Units 3 and 4 (LAR 12-002).
ML13238A359,	Enclosure 1 - Amendment No. 13 to COL No. NPF-91
ML13239A256,	Enclosure 2 - Amendment No. 13 to COL No. NPF-92
ML13239A284,	Enclosure 3 - Revised plant-specific TS pages (Attachment to Amendment No. 13)
ML13239A287,	Enclosure 4 - Safety Evaluation (SE), and Attachment 1 - Acronyms
ML13239A288,	SE Attachment 2 - Table A - Administrative Changes
ML13239A319,	SE Attachment 3 - Table M - More Restrictive Changes
ML13239A333,	SE Attachment 4 - Table R - Relocated Specifications
ML13239A331,	SE Attachment 5 - Table D - Detail Removed Changes
ML13239A316,	SE Attachment 6 - Table L - Less Restrictive Changes

The following documents were subsequently issued to correct an administrative error in Enclosure 3:

ML13277A616,	Letter - Correction To The Attachment (Replacement Pages) - Vogtle Electric Generating Plant Units 3 and 4- Issuance of Amendment Re: Technical Specifications Upgrade (LAR 12-002) (TAC No. RP9402)
ML13277A637,	Enclosure 3 - Revised plant-specific TS pages (Attachment to Amendment No. 13) (corrected)

7. APOG-2014-008, APOG (AP1000 Utilities) Comments on AP1000 Standardized Technical Specifications (STS) Generic Technical Specification Travelers (GTSTs), Docket ID NRC-2014-0147, September 22, 2014 (ML14265A493).

XI. MARKUP of the Applicable GTS Subsection for Preparation of the STS NUREG

The entire section of the Specifications and the Bases associated with this GTST is presented next.

Changes to the Specifications and Bases are denoted as follows: Deleted portions are marked in strikethrough red font, and inserted portions in bold blue font.

3.2 POWER DISTRIBUTION LIMITS

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

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

APPLICABILITY: MODE 1 with On-line Power Distribution Monitoring System (OPDMS) **not monitoring parameters**~~inoperable~~.

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
	<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

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
	<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.	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
C. Required Action and associated Completion Time not met.	C.1	Be in MODE 2.	6 hours

SURVEILLANCE REQUIREMENTS

---NOTES---

1. During power escalation at the beginning of each cycle, THERMAL POWER may be increased until a power level for extended operation has been achieved at which a power distribution map is obtained.

2. If the OPDMS becomes inoperable while in MODE 1 these surveillances must be performed within 31 days of the last verification of OPDMS parameters.

SURVEILLANCE		FREQUENCY
SR 3.2.1.1	--------------------------------**NOTE**-------------------------------- **Not required to be performed if OPDMS was monitoring parameters upon exceeding 75% RTP.** --- Verify FQC (Z) 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 FQC (Z) was last verified AND 31 effective full power days (EFPD) thereafter
	Verify $F^C_Q(Z)$ within limit.	**Once after each refueling prior to THERMAL POWER exceeding 75% RTP**

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.2.1.2	**-------------------------------NOTE-------------------------------** **Not required to be performed if OPDMS was monitoring parameters upon exceeding 75% RTP.** **---** **Verify $F^W_Q(Z)$ within limits.**	**Once after each refueling prior to THERMAL POWER exceeding 75% RTP**
SR 3.2.1.3	**-------------------------------NOTE-------------------------------** **Not required to be performed until 31 days after the last verification of OPDMS parameters.** **---** **Verify $F^C_Q(Z)$ within limit.**	**Once within 12 hours after achieving equilibrium conditions after exceeding, by ≥ 10% RTP, the THERMAL POWER at which $F^C_Q(Z)$ was last verified** **<u>AND</u>** **31 effective full power days (EFPD) thereafter**

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.2.1.4	-------------------------------NOTES------------------------------ **1. Not required to be performed until 31 days after the last verification of OPDMS parameters.** **2.** If $F_Q^W(Z)$ measurements indicate maximum over z $F_Q^C(Z)$ 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 3.2.1.4~~2~~ once per 7 EFPD until two successive flux maps indicate maximum over z $F_Q^C(Z)$ has not increased. ---	

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.2.1.4 (continued)	Verify $F_Q^W(Z)$ within limits.	~~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 $F_Q^W(Z)$ was last verified AND 31 EFPD thereafter

B 3.2 POWER DISTRIBUTION LIMITS

B 3.2.1 Heat Flux Hot Channel Factor ($F_Q(Z)$) (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 with the On-line Power Distribution Monitoring System (OPDMS) **not monitoring parameters**~~inoperable~~, 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.

With the OPDMS **monitoring parameters**~~OPERABLE~~, peak **linear power density** ~~kw/ft (Z)~~ (which is proportional to $F_Q(Z)$) is measured continuously. With the OPDMS **not monitoring parameters**~~inoperable~~, $F_Q(Z)$ is measured periodically using the incore detector system. These measurements are generally taken with the core at or near steady state conditions.

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

To account for these possible variations, the steady state value of $F_Q(Z)$ is adjusted by an elevation dependent factor to account for the calculated worst case transient conditions.

BASES

BACKGROUND (continued)

Core monitoring and control under non-equilibrium conditions and the OPDMS **not monitoring parameters**~~inoperable~~ are accomplished by operating the core within the limits of 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 a limit of 2200°F (Ref. 1);

b. During a loss of forced reactor coolant flow accident, there must be at least a 95% probability at a 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 (i.e., lower than) relative to 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 10 CFR 50.36(c)(2)(ii).

BASES

LCO

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

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

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

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

P = THERMAL POWER / RTP

The actual values of CFQ are given in the COLR; however, CFQ is normally a number on the order of 2.60. ~~For the AP1000, t~~**T**he normalized $F_Q(Z)$ as a function of core height is 1.0.

For **Relaxed Axial Offset Control (**RAOC**)** 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 the measured value of $F_Q(Z)$, called $F_Q^M(Z)$ is obtained. Then,

$$F_Q^C(Z) = F_Q^M(Z) * F_Q^{MU}(Z)$$

where $F_Q^{MU}(Z)$ is a factor that accounts for fuel manufacturing tolerances and flux map measurement uncertainty. $F_Q^{MU}(Z)$ is provided in the COLR.

$F_Q^C(Z)$ 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:

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

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.

BASES

LCO (continued)

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 and if $F_Q^W(Z)$ cannot be maintained within LCO limits, reduction of the AFD limits will also result in a reduction of the core power.

Violating the LCO limits for $F_Q(Z)$ may result in an unanalyzed condition while $F_Q(Z)$ is outside its specified limits.

APPLICABILITY

When the OPDMS is **not monitoring parameters**~~inoperable~~ and core power distribution parameters cannot be continuously monitored, it is necessary to determine $F_Q(Z)$ on a periodic basis. Furthermore, 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% of 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 fuel manufacturing tolerances and flux map 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 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.

BASES

ACTIONS (continued)

A.2

A reduction of the Power Range Neutron Flux - High Trip setpoints by ≥ 1% for each 1% by which $F^C_Q(Z)$ 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 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 $F^C_Q(Z)$ and would require Power Range Neutron Flux - High trip setpoint reductions within ~~8~~**72** hours of the $F^C_Q(Z)$ determination, if necessary to comply with the decreased maximum allowable Power Range Neutron Flux - High trip setpoints. Decreases in $F^C_Q(Z)$ would allow increasing the maximum allowable Power Range Neutron Flux - High trip setpoints.

A.3

Reduction in the Overpower ΔT Trip setpoints (value of K_4) by ≥ 1% for each 1% by which $F^C_Q(Z)$ 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 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 $F^C_Q(Z)$ and would require Overpower ΔT trip setpoint reductions within 72 hours of the $F^C_Q(Z)$ determination, if necessary to comply with the decreased maximum allowable Overpower ΔT trip setpoints. Decreases in $F^C_Q(Z)$ would allow increasing the maximum allowable Overpower ΔT trip setpoints.

BASES

ACTIONS (continued)

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, assures 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 $F_Q(Z)$ which 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 would not be exceeded.

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

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 severe transient in this time period and the preceding prompt reduction in

BASES

ACTIONS (continued)

THERMAL POWER as a result of reducing AFD limits in accordance with Required Action B.1.

B.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 severe transient in this time period, and the preceding prompt reduction in THERMAL POWER as a result of reducing AFD limits 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 maximum allowable power 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.

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 without challenging plant systems.

BASES

SURVEILLANCE REQUIREMENTS

SR 3.2.1.1 and SR 3.2.1.2 are modified by ~~two~~**a** Note~~s.~~**,** ~~The first note~~ **which** applies to the situation where the OPDMS is ~~inoperable~~**not monitoring parameters** at the beginning of cycle startup**, i.e., the**~~.~~ Note ~~1~~ applies during the first power ascension after a refueling. It states that **performance of these SRs is not required if OPDMS was monitoring parameters upon exceeding 75% RTP.**~~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 FQC (Z) and FQW (Z) are within their specified limits after a power rise of more than 10% of RTP over the THERMAL POWER at which they were last verified to be within specified limits.~~ Because F^C_Q (Z) and $F^W_Q(Z)$ could not have previously been measured in this reload core, ~~there is a second~~ **the SR 3.2.1.1 and SR 3.2.1.2** Frequency **is** ~~condition,~~ applicable only for reload cores, **and**~~that~~ requires determination of these parameters before exceeding 75% RTP. This ensures that some determination of $F^C_Q(Z)$ and $F^W_Q(Z)$ are made at a lower power level at which adequate margin is available before going to 100% RTP. Also, ~~this~~**SR 3.2.1.1 and SR 3.2.1.2** Frequency ~~condition,~~ together with the **SR 3.2.1.3 and SR 3.2.1.4 first** Frequency ~~condition~~ requiring verification of $F^C_Q(Z)$ and $F^W_Q(Z)$ 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 $F^C_Q(Z)$ and $F^W_Q(Z)$. The **SR 3.2.1.3 and SR 3.2.1.4 first** Frequency ~~condition~~ is not intended to require verification of these parameters after every 10% increase in power level above the last verification. **They**~~It~~ only require~~s~~ verification after a**n equilibrium** power level is achieved for extended operation that is 10% higher than that power at which $F_Q(Z)$ was last measured.

The ~~second Note~~ **SR 3.2.1.3 Note and SR 3.2.1.4 Note 1** appl**y**~~ies~~ to the situation where the OPDMS **is no longer monitoring parameters**~~becomes inoperable~~ while the plant is in MODE 1. Without the continuous monitoring capability of the OPDMS, F_Q limits must be monitored on a periodic basis. The first measurement must be made within 31 days of the most recent date where the OPDMS data has verified peak **linear power density**~~kw/ft (Z)~~ (and therefore also F_Q) to be within its limit. This is consistent with the 31 day Surveillance Frequency.

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.2.1.1 **and SR 3.2.1.3**

Verification that $F_Q^C(Z)$ is within its specified limits involves increasing the measured values of $F_Q^C(Z)$ 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 $F_Q^C(Z) = F_Q^M(Z) * F_Q^{MU}(Z)$ **(Ref. 4)**. $F_Q^C(Z)$ is then compared to its specified limits.

The limit to which $F_Q^C(Z)$ is compared varies inversely with power above 50% RTP.

Performing the Surveillance in MODE 1 prior to exceeding 75% RTP assures 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 assure that $F_Q^C(Z)$ values are being reduced sufficiently with power increase to stay within the LCO limits).

The Frequency of 31 effective full power days (EFPD~~s~~) 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 Technical Specifications.

SR 3.2.1.2 **and SR 3.2.1.4**

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, $F_Q^W(Z)$.

BASES

SURVEILLANCE REQUIREMENTS (continued)

The limit to which $F_Q^W(Z)$ is compared varies inversely with power.

The W(Z) curve is provided in the COLR for discrete 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 difficulty of making a precise measurement in these regions and because of the low probability that these regions would be more limiting than the safety analyses.

~~This Surveillance~~ **SR 3.2.1.4** has been modified by ~~a~~ Note **2**, which 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 $F_Q^M(Z)$ which could 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 $F_Q^C(Z)$, 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 as specified in the COLR **(Ref. 5)** or to evaluate $F_Q(Z)$ more frequently, each 7 EFPD~~s~~. These alternative requirements will 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% of RTP ensures that the $F_Q(Z)$ limit will be met when RTP is achieved, because peaking factors are generally decreased as power level is increased.

The Surveillance Frequency of 31 EFPD~~s~~ is adequate to monitor the change of power distribution because such a change is sufficiently slow, when the plant is operated in accordance with Technical Specifications, to preclude the occurrence of adverse peaking factors between 31 EFPD Surveillances. The Surveillance may be done more frequently if required by the results of $F_Q(Z)$ evaluations.

BASES

SURVEILLANCE REQUIREMENTS (continued)

$F_Q(Z)$ is verified at power increases of at least 10% RTP above the THERMAL POWER of its last verification, 12 hours after achieving equilibrium conditions, to assure that $F_Q(Z)$ will be within its limit at higher power levels.

REFERENCES

1. 10 CFR 50.46, “Acceptance Criteria for Emergency Core Cooling Systems for Light Water Nuclear Power Reactors,” 1974.
2. Regulatory Guide 1.77, Rev. 0, “Assumptions Used for Evaluating a Control Rod Ejection Accident for Pressurized Water Reactors,” 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 (Westinghouse Proprietary) and WCAP-7308-L-A (Non-Proprietary).
5. WCAP-10216-P-A, Revision 1A, “Relaxation of Constant Axial Offset Control FQ Surveillance Technical Specification,” February 1994 (Westinghouse Proprietary) and WCAP-10217-A (Non-Proprietary).

XII. Applicable STS Subsection After Incorporation of this GTST's Modifications

The entire subsection of the Specifications and the Bases associated with this GTST, following incorporation of the modifications, is presented next.

3.2 POWER DISTRIBUTION LIMITS

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

LCO 3.2.1 — $F_Q(Z)$, as approximated by $F^C_Q(Z)$ and $F^W_Q(Z)$, shall be within the limits specified in the COLR.

APPLICABILITY: MODE 1 with On-line Power Distribution Monitoring System (OPDMS) not monitoring parameters.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. ------------NOTE------------ Required Action A.4 shall be completed whenever this Condition is entered. -------------------------------- $F^C_Q(Z)$ not within limit.	A.1 Reduce THERMAL POWER ≥ 1% RTP for each 1% $F^C_Q(Z)$ exceeds limit.	15 minutes after each $F^C_Q(Z)$ determination
	<u>AND</u>	
	A.2 Reduce Power Range Neutron Flux - High trip setpoints ≥ 1% for each 1% $F^C_Q(Z)$ exceeds limit.	72 hours after each $F^C_Q(Z)$ determination
	<u>AND</u>	
	A.3 Reduce Overpower ΔT trip setpoints ≥ 1% for each 1% $F^C_Q(Z)$ exceeds limit.	72 hours after each $F^C_Q(Z)$ 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

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
	AND		
	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.	72 hours
	AND		
	B.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	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
C. Required Action and associated Completion Time not met.	C.1	Be in MODE 2.	6 hours

SURVEILLANCE REQUIREMENTS

	SURVEILLANCE	FREQUENCY
SR 3.2.1.1	--------------------------------NOTE-------------------------------- Not required to be performed if OPDMS was monitoring parameters upon exceeding 75% RTP. --- Verify $F_Q^C(Z)$ within limit.	Once after each refueling prior to THERMAL POWER exceeding 75% RTP
SR 3.2.1.2	--------------------------------NOTE-------------------------------- Not required to be performed if OPDMS was monitoring parameters upon exceeding 75% RTP. --- Verify $F_Q^W(Z)$ within limits.	Once after each refueling prior to THERMAL POWER exceeding 75% RTP

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.2.1.3	------------------------------NOTE------------------------------ Not required to be performed until 31 days after the last verification of OPDMS parameters. -- Verify $F^C_Q(Z)$ within limit.	Once within 12 hours after achieving equilibrium conditions after exceeding, by ≥ 10% RTP, the THERMAL POWER at which $F^C_Q(Z)$ was last verified <u>AND</u> 31 effective full power days (EFPD) thereafter

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.2.1.4	-------------------------------NOTES------------------------------ 1. Not required to be performed until 31 days after the last verification of OPDMS parameters. 2. If $F_Q^W(Z)$ measurements indicate maximum over z$F_Q^C(Z)$ 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 3.2.1.4 once per 7 EFPD until two successive flux maps indicate maximum over z$F_Q^C(Z)$ has not increased. ---	
	Verify $F_Q^W(Z)$ within limits.	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 <u>AND</u> 31 EFPD thereafter

B 3.2 POWER DISTRIBUTION LIMITS

B 3.2.1 Heat Flux Hot Channel Factor ($F_Q(Z)$) (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 with the On-line Power Distribution Monitoring System (OPDMS) not monitoring parameters, 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.

With the OPDMS monitoring parameters, peak linear power density (which is proportional to $F_Q(Z)$) is measured continuously. With the OPDMS not monitoring parameters, $F_Q(Z)$ is measured periodically using the incore detector system. These measurements are generally taken with the core at or near steady state conditions.

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

To account for these possible variations, the steady state value of $F_Q(Z)$ is adjusted by an elevation dependent factor to account for the calculated worst case transient conditions.

BASES

BACKGROUND (continued)

Core monitoring and control under non-equilibrium conditions and the OPDMS not monitoring parameters are accomplished by operating the core within the limits of 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 a limit of 2200°F (Ref. 1);

b. During a loss of forced reactor coolant flow accident, there must be at least a 95% probability at a 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 (i.e., lower than) relative to 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 10 CFR 50.36(c)(2)(ii).

BASES

LCO

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

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

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

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

P = THERMAL POWER / RTP

The actual values of CFQ are given in the COLR; however, CFQ is normally a number on the order of 2.60. The normalized $F_Q(Z)$ as a function of core height is 1.0.

For Relaxed Axial Offset Control (RAOC) 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 the measured value of $F_Q(Z)$, called $F_Q^M(Z)$ is obtained. Then,

$$F_Q^C(Z) = F_Q^M(Z) * F_Q^{MU}(Z)$$

where $F_Q^{MU}(Z)$ is a factor that accounts for fuel manufacturing tolerances and flux map measurement uncertainty. $F_Q^{MU}(Z)$ is provided in the COLR.

$F_Q^C(Z)$ 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:

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

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.

BASES

LCO (continued)

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 and if $F_Q^W(Z)$ cannot be maintained within LCO limits, reduction of the AFD limits will also result in a reduction of the core power.

Violating the LCO limits for $F_Q(Z)$ may result in an unanalyzed condition while $F_Q(Z)$ is outside its specified limits.

APPLICABILITY

When the OPDMS is not monitoring parameters and core power distribution parameters cannot be continuously monitored, it is necessary to determine $F_Q(Z)$ on a periodic basis. Furthermore, 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% of 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 fuel manufacturing tolerances and flux map 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 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.

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 72 hours is sufficient considering the small likelihood of a severe transient in this time period and the 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.

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 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.

BASES

ACTIONS (continued)

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, assures 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 $F_Q(Z)$ which 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 would not be exceeded.

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

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 severe transient in this time period and the preceding prompt reduction in

BASES

ACTIONS (continued)

THERMAL POWER as a result of reducing AFD limits in accordance with Required Action B.1.

B.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 severe transient in this time period, and the preceding prompt reduction in THERMAL POWER as a result of reducing AFD limits 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 maximum allowable power 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.

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 without challenging plant systems.

BASES

SURVEILLANCE REQUIREMENTS

SR 3.2.1.1 and SR 3.2.1.2 are modified by a Note, which applies to the situation where the OPDMS is not monitoring parameters at the beginning of cycle startup, i.e., the Note applies during the first power ascension after a refueling. It states that performance of these SRs is not required if OPDMS was monitoring parameters upon exceeding 75% RTP. Because $F^C_Q(Z)$ and $F^W_Q(Z)$ could not have previously been measured in this reload core, the SR 3.2.1.1 and SR 3.2.1.2 Frequency is applicable only for reload cores, and requires determination of these parameters before exceeding 75% RTP. This ensures that some determination of $F^C_Q(Z)$ and $F^W_Q(Z)$ are made at a lower power level at which adequate margin is available before going to 100% RTP. Also, SR 3.2.1.1 and SR 3.2.1.2 Frequency together with the SR 3.2.1.3 and SR 3.2.1.4 first Frequency requiring verification of $F^C_Q(Z)$ and $F^W_Q(Z)$ 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 $F^C_Q(Z)$ and $F^W_Q(Z)$. The SR 3.2.1.3 and SR 3.2.1.4 first Frequency is not intended to require verification of these parameters after every 10% increase in power level above the last verification. They only require verification after an equilibrium power level is achieved for extended operation that is 10% higher than that power at which $F_Q(Z)$ was last measured.

The SR 3.2.1.3 Note and SR 3.2.1.4 Note 1 apply to the situation where the OPDMS is no longer monitoring parameters while the plant is in MODE 1. Without the continuous monitoring capability of the OPDMS, F_Q limits must be monitored on a periodic basis. The first measurement must be made within 31 days of the most recent date where the OPDMS data has verified peak linear power density (and therefore also F_Q) to be within its limit. This is consistent with the 31 day Surveillance Frequency.

<u>SR 3.2.1.1 and SR 3.2.1.3</u>

Verification that $F^C_Q(Z)$ is within its specified limits involves increasing the measured values of $F^C_Q(Z)$ to allow for manufacturing tolerance and measurement uncertainties in order to obtain $F^C_Q(Z)$. Specifically, $F^M_Q(Z)$ is the measured value of $F_Q(Z)$ obtained from incore flux map results and $F^C_Q(Z) = F^M_Q(Z) * F^{MU}_Q(Z)$ (Ref. 4). $F^C_Q(Z)$ is then compared to its specified limits.

BASES

SURVEILLANCE REQUIREMENTS (continued)

The limit to which $F_Q^C(Z)$ is compared varies inversely with power above 50% RTP.

Performing the Surveillance in MODE 1 prior to exceeding 75% RTP assures 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 assure that $F_Q^C(Z)$ values are being reduced sufficiently with power increase to stay within the LCO limits).

The Frequency of 31 effective full power days (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 Technical Specifications.

SR 3.2.1.2 and SR 3.2.1.4

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, $F_Q^W(Z)$.

The limit to which $F_Q^W(Z)$ is compared varies inversely with power.

BASES

SURVEILLANCE REQUIREMENTS (continued)

The W(Z) curve is provided in the COLR for discrete core elevations. $F^W_Q(Z)$ 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 difficulty of making a precise measurement in these regions and because of the low probability that these regions would be more limiting than the safety analyses.

SR 3.2.1.4 has been modified by Note 2, which may require that more frequent surveillances be performed. If $F^W_Q(Z)$ is evaluated and found to be within its limit, an evaluation of the expression below is required to account for any increase to $F^M_Q(Z)$ which could 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 $F^C_Q(Z)$, it is required to meet the $F_Q(Z)$ limit with the last $F^W_Q(Z)$ increased by the greater of a factor of 1.02 or by an appropriate factor as specified in the COLR (Ref. 5) or to evaluate $F_Q(Z)$ more frequently, each 7 EFPD. These alternative requirements will 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% of RTP ensures that the $F_Q(Z)$ limit will be met when RTP is achieved, because peaking factors are generally decreased as power level is increased.

The Surveillance 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 Technical Specifications, to preclude the occurrence of adverse peaking factors between 31 EFPD Surveillances. The Surveillance may be done more frequently if required by the results of $F_Q(Z)$ evaluations.

BASES

SURVEILLANCE REQUIREMENTS (continued)

$F_Q(Z)$ is verified at power increases of at least 10% RTP above the THERMAL POWER of its last verification, 12 hours after achieving equilibrium conditions, to assure that $F_Q(Z)$ will be within its limit at higher power levels.

REFERENCES

1. 10 CFR 50.46, “Acceptance Criteria for Emergency Core Cooling Systems for Light Water Nuclear Power Reactors,” 1974.

2. Regulatory Guide 1.77, Rev. 0, “Assumptions Used for Evaluating a Control Rod Ejection Accident for Pressurized Water Reactors,” 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 (Westinghouse Proprietary) and WCAP-7308-L-A (Non-Proprietary).

5. WCAP-10216-P-A, Revision 1A, “Relaxation of Constant Axial Offset Control F_Q Surveillance Technical Specification,” February 1994 (Westinghouse Proprietary) and WCAP-10217-A (Non-Proprietary).