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

Title: Changes related to Section 3.1.4, Rod Group Alignment Limits

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

STS NUREGs Affected:

NUREG-1430, -1431, -1432, -1433, -1434

NRC Approval Date:

18-Mar-09

TSTF Classification:

Technical 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 A010	The Completion Time for TS 3.1.4, "Rod Group Alignment Limits," Required Action B.1 is revised to swap the order (to list the 1-hour time before the 8-hour time) and replace the "OR" with "AND." The 8 hour Completion Time is revised to delete "with OPDMS OPERABLE."
VEGP LAR DOC A011	Statements referring to "OPDMS OPERABLE" are revised to refer to "OPDMS monitoring parameters." Statements referring to "OPDMS inoperable" are revised to refer to "OPDMS not monitoring parameters."
VEGP LAR DOC A008	TS 3.1.4, SR 3.1.4.3 Frequency is revised to add "Once" as a lead in to state "Once prior to reactor criticality..."

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(1) applicable to operating reactor designs, but not to the AP1000 design; (2) already incorporated in the GTS; or (3) superseded by another change.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-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)

Editorial Corrections

Required Actions A.1.1, B.2.1.2, and D.1.2 are revised to replace “restore SDM to within limit” with “restore SDM to within limits.”

SR 3.1.4.1 is revised to make “limit” plural, i.e., “alignment limit” is replaced with “alignment limits.”

In the “References” section of the Bases, “Accident Analysis” was changed to “Accident Analyses” in Reference 3.

APOG Recommended Changes to Improve the Bases

Throughout the Bases, references to Sections and Chapters of the FSAR do not include the “FSAR” clarifier. Since these Section and Chapter references are to an external document, it is appropriate to include the “FSAR” modifier. (DOC A003)

Last paragraph of the “LCO” section of the Bases was revised to provide clarification consistent with the Specifications.

Editorial correction is recommended in the “Background” section of the Bases for clarity. In the 12th paragraph, the second sentence is revised to replace “These” with “The 16 GRCAs.”

V. Applicability

Affected Generic Technical Specifications and Bases:

Section 3.1.4, Rod Group Alignment Limits

Changes to the Generic Technical Specifications and Bases:

LCO description Note was revised replacing “OPDMS OPERABLE” with “OPDMS monitoring parameters.” (DOC A011)

ACTIONS Table was revised to replace “OPDMS OPERABLE” and “OPDMS inoperable” respectively with “OPDMS monitoring parameters” and “OPDMS not monitoring parameters.” Additional editorial corrections are made. (DOC A011)

For Required Action B.1, Completion Time, the order is swapped (1 hour time is listed before the 8 hour time) and the “OR” is replaced with “AND.” The presentation is simplified by stating the “8 hours” as an upper limit (deleting “with OPDMS monitoring parameters”) always imposed, and the “1 hour with OPDMS not monitoring parameters” as a potentially more limiting requirement. Both these requirements are complied with and are connected using “AND.” (DOC A010)

SR 3.1.4.3 Frequency is revised to add “Once” as a lead in. (DOC A008)

Bases discussion was revised to replace “OPDMS OPERABLE” and “OPDMS inoperable” respectively with “OPDMS monitoring parameters” and “OPDMS not monitoring parameters.” (DOC A011)

The acronym “FSAR” is added to modify “Section” and “Chapter” in references to the FSAR throughout the Bases. (DOC A003)

The last paragraph in the “LCO” section of the Bases was revised to add clarifying information consistent with the Specifications. GRCA bank sequence exchange operations are explained by adding two sentences from LCO 3.1.6 Applicability Bases. Specific changes are described in Section VI under heading “Description of additional changes proposed by NRC staff/preparer of GTST.” (APOG comment)

Editorial corrections are made in Required Actions A.1.1, B.2.1.2, and D.1.2; Condition D; and SR 3.1.4.1. These changes replace “limit” with “limits,” making use of “limits” consistent throughout the Specifications. (NRC staff changes)

Editorial correction is made in the “Background” section in the Bases replacing “These” with “The 16 GRCAs.” (APOG comment)

VI. Traveler Information

Description of TSTF changes:

NA

Rationale for TSTF changes:

NA

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

VEGP LAR DOC A010

The Completion Time for TS 3.1.4, “Rod Group Alignment Limits,” Required Action B.1 is revised to swap the order (to list the 1-hour time before the 8-hours time) and replace the “OR” with “AND.” The 8 hour Completion Time is revised to delete “with OPDMS OPERABLE.” This DOC was revised in response to RAI Letter no. 1, Question 16-2, removing “with OPDMS OPERABLE” from the 8 hours Completion Time.

VEGP LAR DOC A011

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

VEGP LAR DOC A008

TS 3.1.4, SR 3.1.4.3 Frequency is revised to add “Once” as a lead in to state “Once prior to reactor criticality...”

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

VEGP LAR DOC A010

The convention for presentation of Required Actions is to list the shortest Completion Times first. For human-factors considerations, the operator should be presented the more immediate requirements prior to requirements with longer times to complete.

As outlined in TS Section 1.2, Logical Connectors, use of “OR” reflects alternative choices where only one of which must be performed. For TS 3.1.4, Required Action B.1, the Completion Time would not allow an arbitrary choice to be made. While only one Completion Time would be more limiting, based on the status of OPDMS, consideration of both Completion Times is appropriate. As such, the appropriate logical connector is “AND.” The proposed Completion Times continue to result in imposition of only one option (based on the status of OPDMS) which remains consistent with the intent of the current requirements. The 8 hour Completion Time is revised to eliminate “with OPDMS OPERABLE” which remains consistent with the intent of the requirements.

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 apply the 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”).

Replacing “OPDMS” with “On-Line Power Distribution Monitoring System,” is consistent with the guidance on use of acronyms provided in STS Writer’s Guide. “OPDMS” is not defined in TS 3.1.6 prior to its use in Note 2. The proposed wording change continues to provide appropriate TS controls with no change in implementation requirements.

VEGP LAR DOC A008

As described in the STS Writer’s Guide, the frequency of performance is always implied as “once per” unless otherwise stated. The above frequencies are vague in not explicitly stating “once.” TS Section 1.4, Frequency, Example 1.4-2 describes that “The use of ‘Once’ indicates a single performance will satisfy the specified Frequency.”

Since the described SRs do not include the clarifier “once,” a potential misreading of the frequency could lead to performance prior to establishing the stated condition (i.e., each criticality).

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

Condition D is revised to state, “More than one rod not within limit**s**,” replacing “limit” with “limits.”

Required Actions A.1.1, B.2.1.2, and D.1.2 are revised to make “limit” plural (i.e., “limits”). In other words, these changes replace “restore SDM to within limit” with “restore SDM to within limits.”

SR 3.1.4.1 is revised to make “limit” plural, i.e., “alignment limit” is replaced with “alignment limits.”

The last paragraph of the “LCO” section of the Bases was revised as follows:

> The LCO is modified by a Note to relax the rod alignment limit on GRCAs during GRCA bank sequence exchange operations. **The two exchanging banks will move out of sequence and overlap limits for several minutes during the sequence exchange.** This operation which occurs frequently throughout the fuel cycle would normally violate

the LCO. **GRCA bank sequence exchange in only allowed with the OPDMS OPERABLE to monitor the parameters of LCO 3.2.5, "On-Line Power Distribution Monitoring System (OPDMS) - Monitored parameters."**

The following editorial change is made in the "Background" section of the Bases (12th paragraph, 2nd sentence):

~~These~~ **The 16 GRCAs** have been subdivided into what has been termed as MA, MB, MC, and MD Banks with 4 GRCAs in each.

The acronym "FSAR" is added to modify "Section" and "Chapter" in references to the FSAR throughout the Bases.

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

The alternative Required Action A.1.1, B.2.1.1, and D.1.1 immediately preceding the Required Actions A.1.2, B.2.1.2, and D.1.2 reference SDM "limits" (i.e., plural). For consistency, the reference is made plural in all the Required Actions. Previously, only Required Action B.1 used "alignment limits." Changing SR 3.1.4.1 to "alignment limits" makes the SR consistent with the Action. These changes are editorial in nature.

The revision to the last paragraph in the "LCO" section in the Bases added clarifying information consistent with the Specifications. These changes provide additional information and clarity.

The change in the "Background" section of the Bases is editorial improving clarity.

Since Bases references to FSAR Sections and Chapters are to an external document, it is appropriate to include the "FSAR" modifier.

VII. GTST Safety Evaluation

Technical Analysis:

Replacing "OPDMS Operable" and "OPDMS inoperable" respectably with "OPDMS monitoring parameters" and "OPDMS not 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" and "OPDMS is not monitoring." These changes are acceptable for AP1000 STS.

Revision of Completion Time to present the shortest Completion Time first and use of "AND" replacing "OR" for two different Completion Times under different Conditions

Two different Completion Times (1 hour, for OPDMS not monitoring parameters and 8 hours, OPDMS monitoring parameters) are provided for Required Action B.1. The convention is to list the shorter Completion Time before the longer Completion Time. This is appropriate since the operator needs to focus on the immediate requirement; otherwise, focus on the first requirement may inadvertently result in neglect of other requirements. Reversing the order in which the Completion Times are presented is appropriate and acceptable.

For TS 3.1.4, the Completion Times for Required Action B.1 are related to two different conditions, OPDMS monitoring parameters and OPDMS not monitoring parameters. While only one Completion Time would apply based on the status of OPDMS, consideration of both Completion Times is appropriate. It is appropriate to use the logical connector "AND." As stated in the VEGP amendment request, the proposed Completion Times continue to result in imposition of only one option (based on the stated conditional exclusions) which remains consistent with the intent of the current requirements. The removal of "with OPDMS OPERABLE" from the 8 hour Completion Time is appropriate since this Completion Time applies when OPDMS is monitoring parameters. The phrase was unnecessary.

Revising Surveillance Frequency to add "Once" as a lead in to state the Frequency

Adding "once" as the lead in to define the surveillance frequency, i.e. revising the Frequency to state: "Once prior to reactor criticality after each removal of the reactor head, and after each earthquake requiring plant shutdown", clarifies the intent of this Surveillance. In this case, a single performance will satisfy the specified frequency. Without the clarifier "once", a misinterpretation is possible where the surveillance is performed for each entry. Accordingly, this change will provide a better understood surveillance frequency for AP1000, will avoid misinterpretation, and is acceptable.

Revising last paragraph of the “LCO” section in the Bases

Additional clarifying information was added in the last paragraph in the LCO section providing clarity during GRCA bank sequence exchange operations. This information is obtained from LCO 3.1.6 Applicability Bases and is consistent with the Specifications. This change is an improvement of the existing discussion in the Bases and is acceptable.

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 3.1.4 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

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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 #3) Throughout the Bases, references to Sections and Chapters of the FSAR do not include the “FSAR” modifier. Since these Section and Chapter references are to an external document, it is appropriate to include the “FSAR” modifier. This is resolved by adding the “FSAR” modifier as appropriate.

2. (Internal #75) 3.1.04, Pg. 08, The sentence stating “The use of the term “OPDMS operable” and “OPDMS inoperable” is not appropriate since only monitoring of the parameters by the system is implied” in the GTST “Technical Analysis” section was deleted. This sentence was considered not necessary since sufficient information is provided in the rest of the paragraph to justify the changes.

3. (Internal #76) 3.1.04, Pg. 35, An editorial change is made in the “Background” section of the Bases replacing “These” with “The 16 GRCAs.”

4. (Internal #77) 3.1.04, Pg. 39, The last paragraph in the “LCO” section of the Bases was improved adding clarifying information. The added information is consistent with LCO 3.1.6 Applicability Bases.

NRC Final Approval Date: 12/4/2015

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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. 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).

4. 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).

5. 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)

6. TSTF-GG-05-01, “Writer's Guide for Plant-Specific Improved Technical Specifications,” June 2005.

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.

3.1 REACTIVITY CONTROL SYSTEMS

3.1.4 Rod Group Alignment Limits

LCO 3.1.4 All shutdown and control rods shall be OPERABLE.

AND

Individual indicated rod positions shall be within 12 steps of their group step counter demand position.

--NOTE--
Not applicable to Gray Rod Cluster Assemblies (GRCAs) during GRCA bank sequence exchange with the On-Line Power Distribution Monitoring System (OPDMS) ~~OPERABLE~~**monitoring parameters**.

APPLICABILITY: MODES 1 and 2.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more rod(s) inoperable.	A.1.1 Verify SDM to be within the limits specified in the COLR.	1 hour
	OR	
	A.1.2 Initiate boration to restore SDM within limit**s**.	1 hour
	AND	
	A.2 Be in MODE 3.	6 hours

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. One rod not within alignment limits.	B.1 Restore rod, to within alignment limits.	81 hours with the OPDMS OPERABLEnot monitoring parameters ORAND 81 hours with the OPDMS inoperablemonitoring parameters
	OR	
	B.2.1.1 Verify SDM to be within the limits specified in the COLR.	1 hour
	OR	
	B.2.1.2 Initiate boration to restore SDM within limits.	1 hour
	AND	
	B.2.2 Reduce THERMAL POWER to ≤ 75% RTP.	2 hours
	AND	
	B.2.3 Verify SDM is within the limits specified in the COLR.	Once per 12 hours
	AND	

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
B. (continued)	B.2.4	---------------NOTE-------------- Only required to be performed when OPDMS is ~~inoperable~~**not monitoring parameters**. -------------------------------------	
		Perform SR 3.2.1.1 and SR 3.2.1.2.	72 hours
	<u>AND</u>		
	B.2.5	--------------NOTE--------------- Only required to be performed when OPDMS is **not monitoring parameters**~~inoperable~~. -------------------------------------	
		Perform SR 3.2.2.1.	72 hours
	<u>AND</u>		
	B.2.6	Re-evaluate safety analyses and confirm results remain valid for duration of operation under these conditions.	5 days
C. Required Action and associated Completion Time of Condition B not met.	C.1	Be in MODE 3.	6 hours

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
D. More than one rod not within alignment limits.	D.1.1 Verify SDM is within the limits specified in the COLR.	1 hour
	<u>OR</u>	
	D.1.2 Initiate boration to restore required SDM to within limits.	1 hour
	<u>AND</u>	
	D.2 Be in MODE 3.	6 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.1.4.1	Verify individual rod positions within alignment limits.	12 hours
SR 3.1.4.2	-------------------------------NOTE------------------------------- Not applicable to GRCAs. --- Verify rod freedom of movement (trippability) by moving each rod not fully inserted in the core ≥ 10 steps in either direction.	92 days

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.1.4.3	--------------------------------NOTE-------------------------------- Not applicable to GRCAs. -- Verify rod drop time of each rod, from the fully withdrawn position, is ≤ 2.47 seconds from the beginning of decay of stationary gripper coil voltage to dashpot entry, with: a. T_{avg} ≥ 500°F, and b. All reactor coolant pumps operating.	**Once prior**~~Prior~~ to reactor criticality after each removal of the reactor head, and after each earthquake requiring plant shutdown

B 3.1 REACTIVITY CONTROL SYSTEMS

B 3.1.4 Rod Group Alignment Limits

BASES

BACKGROUND

The OPERABILITY (e.g., trippability) of the RCCAs is an initial assumption in all safety analyses which assume rod insertion upon reactor trip. Maximum rod misalignment is an initial assumption in the safety analysis that directly affects core power distributions and assumptions of available SDM. Gray Rod Cluster Assemblies (GRCAs) are excluded from this LCO during the planned GRCA bank sequence exchange, with the Online Power Distribution Monitoring System (OPDMS) **monitoring parameters**~~operable~~. The bank sequence exchange of GRCA banks will be periodically necessary to prevent excessive burnup shadowing of fuel rods near the gray rod assemblies. The bank sequence exchange maneuver will purposefully misalign GRCAs from their bank for a short period of time. The exclusion from this LCO is acceptable due to SHUTDOWN MARGIN being calculated exclusive of GRCAs, the relative low worth of individual gray rod assemblies, the short time duration anticipated for the bank sequence exchange maneuver and with OPDMS **monitoring parameters**~~operable~~, power peaking and xenon redistribution effects will be monitored and controlled.

The applicable criteria for these reactivity and power distribution design requirements are 10 CFR 50, Appendix A, GDC 10, "Reactor Design," GDC 26, "Reactivity Control System Redundancy and Protection" (Ref. 1), and 10 CFR 50.46, "Acceptance Criteria for Emergency Core Cooling Systems for Light Water Nuclear Power Plants" (Ref. 2).

Mechanical or electrical failures may cause a control rod to become inoperable or to become misaligned from its group. Control rod inoperability or misalignment may cause increased power peaking due to the asymmetric reactivity distribution and a reduction in the total available rod worth for reactor shutdown. Therefore, control rod alignment and OPERABILITY are related to core operation in design power peaking limits and the core design requirement of a minimum SDM.

Limits on control rod alignment have been established, and all rod positions are monitored and controlled during power operation to ensure that the power distribution and reactivity limits defined by the design power peaking and SDM limits are preserved.

BASES

BACKGROUND (continued)

Rod cluster control assemblies (RCCAs) and GRCAs are moved by their control rod drive mechanisms (CRDMs). Each CRDM moves its RCCA or GRCA one step (approximately 5/8 inch) at a time but at varying rates (steps per minute) depending on the signal output from the Plant Control System (PLS).

The rod control assemblies are divided among control banks and shutdown banks. Each bank may be further subdivided into two groups to provide for precise reactivity control. A group consists of two or more rod control assemblies that are electrically paralleled to step simultaneously. A bank of rod control assemblies consists of two groups that are moved in a staggered fashion, but always within one step of each other. The AP1000 design has seven control banks and four shutdown banks.

The shutdown banks are maintained either in the fully inserted or fully withdrawn position. The control banks are part of the MSHIM (Mechanical Shim) Control System which utilizes two independently OPERABLE groups of control banks for control of reactivity and axial power distribution.

Certain control rods will be pre-selected for inclusion in the Rapid Power Reduction (RPR) system. The purpose of the RPR is to initiate a rapid decrease in the core power during load rejection transients.

Reactivity control is provided primarily by the M banks. The M Banks consist of several control banks operating with a fixed overlap. The bank worth and overlap are defined so as to minimize the impact on axial offset with control bank maneuvering and still retain the reactivity required to meet the desired load changes.

The axial power distribution control is provided by the AO Bank, a relatively high worth bank.

In order to avoid boron adjustment for load follow operation, gray rods are utilized.

There are 16 GRCAs in the AP1000, each composed of 24 rodlets mounted on a common RCCA spider. **The 16 GRCAs**~~These~~ have been subdivided into what has been termed as MA, MB, MC, and MD Banks with 4 GRCAs in each.

BACKGROUND (continued)

Each of the MA, MB, MC, and MD Banks has almost the same worth. The primary gray bank function is to provide additional reactivity during the transition periods. During base load operation, two of the gray banks may be fully inserted into the core. Each of the gray banks consists of a relatively low worth bank.

The MA, MB, MC, MD, M1 and M2 Banks function together with a single variable (i.e., criticality or temperature) driving these groups as if they are in one control group.

The control rods are arranged in a radially symmetric pattern so that control bank motion does not introduce radial asymmetries in the core power distributions.

The axial position of shutdown rods and control rods is indicated by two separate and independent systems, which are the Bank Demand Position Indication System (commonly called group step counters) and the Digital Rod Position Indication (DRPI) System.

The Bank Demand Position Indication System counts the pulses from the rod control system that moves the rods. There is one step counter for each group of rods. Individual rods in a group all receive the same signal to move and should, therefore, all be at the same position indicated by the group step counter for that group. The Bank Demand Position Indication System is considered highly precise (± 1 step or ± 5/8 inch). If a rod does not move one step for each demand pulse, the step counter will still count the pulse and incorrectly reflect the position of the rod.

The DRPI System provides a highly accurate indication of actual control rod position, at a lower precision than the step counters. This system is based on inductive analog signals from a series of coils spaced along a hollow tube. To increase the reliability of the system, the inductive coils are connected alternately to data system A or B. Thus, if one data system fails, the DRPI will go on half-accuracy. The DRPI System is capable of monitoring rod position within at least ± 12 steps with either full accuracy or half accuracy.

BASES

APPLICABLE SAFETY ANALYSES

Control rod misalignment accidents are analyzed in the safety analysis (Ref. 3). The acceptance criteria for addressing control rod inoperability or misalignment is that:

a. There be no violations of:

   1. Specified acceptable fuel design limits, or

   2. Reactor Coolant System (RCS) pressure boundary integrity; and

b. The core remains subcritical after accident transients.

Two types of misalignment are distinguished. During movement of a control rod group, one rod may stop moving, while the other rods in the group continue. This condition may cause excessive power peaking. The second type of misalignment occurs if one rod fails to insert upon a reactor trip and remains stuck fully withdrawn. This condition requires an evaluation to determine that sufficient reactivity worth is held in the control rods to meet the SDM requirement with the maximum worth rod stuck fully withdrawn.

Two types of analysis are performed in regard to static rod misalignment (Ref. 3). With control banks at or above their insertion limits, one type of analysis considers the case when any one rod is completely inserted into the core. The second type of analysis considers the case of a completely withdrawn single rod from a bank inserted to its insertion limit. Satisfying limits on departure from nucleate boiling ratio in both of these cases bounds the situation when a rod is misaligned from its group by 12 steps.

Another type of misalignment occurs if one RCCA fails to insert upon a reactor trip and remains stuck fully withdrawn. This condition is assumed in the evaluation to determine that the required SDM is met with the maximum worth RCCA also fully withdrawn (Ref. 3).

The Required Actions in this LCO assure that either deviations from the alignment limits will be corrected or that THERMAL POWER will be adjusted so that excessive local linear heat rates (LHRs) will not occur, and that the requirements on SDM and ejected rod worth are preserved.

Continued operation of the reactor with a misaligned control rod is allowed if the OPDMS indicates margin to limits or, if the OPDMS is **not monitoring parameters**~~inoperable~~, the heat flux hot channel factor ($F_Q(Z)$) and the nuclear enthalpy hot channel factor ($F^N_{\Delta H}$) are verified to

BASES

APPLICABLE SAFETY ANALYSES (continued)

be within their limits in the COLR and the safety analysis is verified to remain valid. When a control rod is misaligned, the assumptions that are used to determine the rod insertion limits, AFD limits, and quadrant power tilt limits are not preserved. Therefore, the limits may not preserve the design peaking factors, and $F_Q(Z)$ and $F^N_{\Delta H}$ must be verified directly by incore mapping. Bases Section 3.2 (Power Distribution Limits) contains more complete discussions of the relation of $F_Q(Z)$ and $F^N_{\Delta H}$ to the operating limits.

Shutdown and control rod OPERABILITY and alignment are directly related to power distributions and SDM, which are initial conditions assumed in safety analyses. Therefore they satisfy Criterion 2 of 10 CFR 50.36(c)(2)(ii).

LCO

The limits on shutdown or control rod alignments assure that the assumptions in the safety analysis will remain valid. The requirements on control rod OPERABILITY assure that upon reactor trip, the assumed reactivity will be available and will be inserted. The control rod OPERABILITY requirements (i.e., trippability) are separate from the alignment requirements, which ensure that the RCCAs and banks maintain the correct power distribution and rod alignment. The rod OPERABILITY requirement is satisfied provided the rod will fully insert in the required rod drop time assumed in the safety analysis. Rod control malfunctions that result in the inability to move a rod (e.g., rod lift coil failures), but that do not impact trippability, do not result in rod inoperability.

The requirement to maintain the rod alignment to within plus or minus 12 steps is conservative. The minimum misalignment assumed in safety analysis is 24 steps (15 inches), and in some cases a total misalignment from fully withdrawn to fully inserted is assumed.

Failure to meet the requirements of this LCO may produce unacceptable power peaking factors and linear heating rates (LHR), or unacceptable SDMs, which may constitute initial conditions inconsistent with the safety analysis.

LCO (continued)

The LCO is modified by a Note to relax the rod alignment limit on GRCAs during GRCA bank sequence exchange operations. **The two exchanging banks will move out of sequence and overlap limits for several minutes during the sequence exchange.** This operation which occurs frequently throughout the fuel cycle would normally violate the LCO. **GRCA bank sequence exchange is only allowed with the OPDMS OPERABLE to monitor the parameters of LCO 3.2.5, "On-Line Power Distribution Monitoring System (OPDMS) - Monitored Parameters."**

APPLICABILITY

The requirements on RCCA OPERABILITY and alignment are applicable in MODES 1 and 2 because these are the only MODES in which neutron (or fission) power is generated, and the OPERABILITY (i.e., trippability) and alignment of rods have the potential to affect the safety of the plant. In MODES 3, 4, 5, and 6, the alignment limits do not apply because the control rods are bottomed and the reactor is shut down and not producing fission power. In the shutdown MODES, the OPERABILITY of the shutdown and control rods has the potential to affect the required SDM, but this effect can be compensated for by an increase in the boron concentration of the RCS. See LCO 3.1.1, "SHUTDOWN MARGIN (SDM)," for SDM in MODES 3, 4, and 5 and LCO 3.9.1, "Boron Concentration," for boron concentration requirements during refueling.

ACTIONS

A.1.1 and A.1.2

In this situation, SDM verification must include the worth of the untrippable rod as well as a rod of maximum worth.

When one or more rods are inoperable (i.e., untrippable), there is a possibility that the required SDM may be adversely affected. Under these conditions, it is important to determine the SDM, and if it is less than the required value, initiate boration until the required SDM is recovered. The Completion Time of 1 hour is adequate to determine SDM and, if necessary, to initiate boration to restore SDM.

BASES

ACTIONS (continued)

A.2

If the inoperable rod(s) cannot be restored to OPERABLE status, the plant must be brought to a MODE or condition in which the LCO requirements are not applicable. To achieve this status, the unit must be brought to at least MODE 3 within 6 hours.

The allowed Completion Time is reasonable, based on operating experience, for reaching MODE 3 from full power conditions in an orderly manner without challenging plant systems.

B.1

When a rod becomes misaligned, it can usually be moved and is still trippable. With the OPDMS **monitoring parameters**~~OPERABLE~~ adverse peaking factors resulting from the misalignment can be detected. If the rod can be realigned within the Completion Time of 8 hours adverse burnup shadowing in the location of the misaligned rod can be avoided. With the OPDMS **not monitoring parameters**~~inoperable~~ xenon redistribution can potentially cause adverse peaking factors which may not be detected. However, if the rod can be realigned within the Completion Time of 1 hour, local xenon redistribution during this short interval will not be significant and operation may proceed without further restriction.

An alternative to realigning a single misaligned RCCA to the group average position is to align the remainder of the group to the position of the misaligned RCCA. However, this must be done without violating the bank sequence, overlap, and insertion limits specified in LCO 3.1.5, “Shutdown Bank Insertion Limits,” and LCO 3.1.6, “Control Bank Insertion Limits.” The Completion Time of 1 hour gives the operator sufficient time to adjust the rod positions in an orderly manner.

B.2.1.1 and B.2.1.2

With a misaligned rod, SDM must be verified within limit or boration must be initiated to restore SDM within limit.

In many cases, realigning the remainder of the group to the misaligned rod may not be desirable. For example, realigning control bank M2 to a rod that is misaligned 15 steps from the top of the core could require insertion of the M1 bank to maintain overlap limits.

BASES

ACTIONS (continued)

Power operation may continue with one RCCA trippable but misaligned, provided that SDM is verified within 1 hour. The Completion Time of 1 hour represents the time necessary to determine the actual unit SDM and, if necessary, aligning and starting the necessary systems and components to initiate boration.

B.2.2, B.2.3, B.2.4, B.2.5, and B.2.6

For continued operation with a misaligned rod, RTP must be reduced, SDM must periodically be verified within limits, hot channel factors ($F_Q(Z)$ and $F^N_{\Delta H}$) must be verified within limits, and the safety analyses must be re-evaluated to confirm continued operation is permissible. A note has been added indicating that Required Actions B.2.4 and B.2.5, F_Q and $F_{\Delta H}$ verification, are only required when the OPDMS is **not monitoring parameters**~~inoperable~~ and therefore unavailable to continuously monitor the core power distribution.

Reduction of power to 75% of RTP ensures that local LHR increases due to a misaligned RCCA will not cause the core design criteria to be exceeded (Ref. 3). The Completion Time of 2 hours gives the operator sufficient time to accomplish an orderly power reduction without challenging the Protection and Safety Monitoring System.

When a rod is known to be misaligned, there is a potential to impact the SDM. Since the core conditions can change with time, periodic verification of SDM is required. A Frequency of 12 hours is sufficient to ensure this requirement continues to be met.

Online monitoring of core power distribution by the OPDMS, or verifying that $F_Q(Z)$ and $F^N_{\Delta H}$ are within the required limits when the OPDMS is **not monitoring parameters**~~inoperable~~, ensures that current operation at 75% of RTP with a rod misaligned is not resulting in power distributions which may invalidate safety analysis assumptions at full power. The Completion Time of 72 hours allows sufficient time to restore OPDMS **monitoring parameters**~~operable~~ or to obtain and analyze offline flux maps of the core power distribution using the incore detector system and to calculate $F_Q(Z)$ and $F^N_{\Delta H}$.

ACTIONS (continued)

Once current conditions have been verified acceptable, time is available to perform evaluations of accident analysis to determine that core limits will not be exceeded during a Design Basis Accident (DBA) for the duration of operation under these conditions. The accident analyses presented in Chapter 15 (Ref. 3) that may be adversely affected will be evaluated to ensure that the analysis results remain valid for the duration under these conditions. A Completion Time of 5 days is sufficient time to obtain the required input data and to perform the analysis.

C.1

When Required Actions cannot be completed within their Completion Times, the unit must be brought to a MODE or Condition in which the LCO requirements are not applicable. To achieve this status, the unit must be brought to at least MODE 3 within 6 hours, which obviates concerns about the development of undesirable xenon or power distributions. The allowed Completion Time of 6 hours is reasonable, based on operating experience, for reaching MODE 3 from full power condition in an orderly manner and without challenging the plant systems.

D.1.1 and D.1.2

More than one control rod becoming misaligned from its group average position is not expected, and has the potential to reduce SDM. Therefore, SDM must be evaluated. One hour allows the operator adequate time to determine SDM.

Restoration of the required SDM, if necessary, requires increasing the RCS boron concentration to provide negative reactivity, as described in the bases of LCO 3.1.1. The required Completion Time of 1 hour for initiating boration is reasonable based on the time required for potential xenon redistribution, the low probability of an accident occurring, and the steps required to complete the action. This allows the operator sufficient time to align the required valves and start the CVS makeup pumps. Boration will continue until the required SDM is restored.

BASES

ACTIONS (continued)

D.2

If more than one rod is found to be misaligned or becomes misaligned because of bank movement, the unit conditions fall outside of the accident analysis assumptions. Since automatic bank sequencing would continue to cause misalignment, the rods must be brought to within the alignment limits within 6 hours or the unit must be brought to a MODE or Condition in which the LCO requirements are not applicable. To achieve this status, the unit must be brought to at least MODE 3 within 6 hours.

The allowed Completion Time is reasonable, based on operating experience, for reaching MODE 3 from full power in an orderly manner and without challenging plant systems.

SURVEILLANCE REQUIREMENTS

SR 3.1.4.1

Verification that individual rod positions are within alignment limits at a Frequency of 12 hours provides a history that allows the operator to detect that a rod is beginning to deviate from its expected position. The specified Frequency takes into account other rod position information that is continuously available to the operator in the main control room so that during actual rod motion, deviations can immediately be detected.

SR 3.1.4.2

Verifying each control rod is OPERABLE would require that each rod be tripped. However, in MODES 1 and 2, tripping each control rod would result in radial or axial power tilts, or oscillations. Exercising each individual control rod every 92 days provides increased confidence that all rods continue to be OPERABLE without exceeding the alignment limit, even if they are not regularly tripped. Moving each control rod by 10 steps will not cause radial or axial power tilts, or oscillations, to occur. The 92 day Frequency takes into consideration other information available to the operator in the control room and SR 3.1.4.1, which is performed more frequently and adds to the determination of OPERABILITY of the rods. Between required performances of SR 3.1.4.2 (determination of control rod OPERABILITY by movement), if a control rod(s) is discovered to be immovable, but remains trippable and aligned, the control rod(s) is considered to be OPERABLE. At any time, if a control rod(s) is immovable, a determination of the trippability (OPERABILITY) of the control rod(s) must be made, and appropriate

BASES

SURVEILLANCE REQUIREMENTS (continued)

action taken. GRCA are excluded from this Surveillance because they are not considered in the calculation of SDM in MODES 1 and 2.

SR 3.1.4.3

Verification of rod drop times allows the operator to determine that the maximum rod drop time permitted is consistent with the assumed rod drop time used in the safety analysis. Measuring rod drop times prior to reactor criticality, after each reactor vessel head removal and each earthquake requiring plant shutdown, ensures that the reactor internals and rod drive mechanism will not interfere with rod motion or rod drop time, and that no degradation in these systems has occurred that would adversely affect control rod motion or drop time. This testing is performed with all RCPs operating and the average moderator temperature ≥ 500°F to simulate a reactor trip under conservative conditions. GRCA are excluded from this Surveillance because they are not considered in the calculation of SDM in MODES 1 and 2.

This Surveillance is performed during a plant outage due to the plant conditions needed to perform the SR and the potential for an unplanned plant transient if the Surveillance were performed with the reactor at power.

REFERENCES

1. 10 CFR 50, Appendix A, GDC 10 and GDC 26.
2. 10 CFR 50.46.
3. **FSAR** Chapter 15, "Accident Analyse~~i~~s."

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.

3.1 REACTIVITY CONTROL SYSTEMS

3.1.4 Rod Group Alignment Limits

LCO 3.1.4 All shutdown and control rods shall be OPERABLE.

AND

Individual indicated rod positions shall be within 12 steps of their group step counter demand position.

---NOTE---
Not applicable to Gray Rod Cluster Assemblies (GRCAs) during GRCA bank sequence exchange with the On-Line Power Distribution Monitoring System (OPDMS) monitoring parameters.

APPLICABILITY: MODES 1 and 2.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more rod(s) inoperable.	A.1.1 Verify SDM to be within the limits specified in the COLR. OR A.1.2 Initiate boration to restore SDM within limits. AND A.2 Be in MODE 3.	1 hour 1 hour 6 hours

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. One rod not within alignment limits.	B.1 Restore rod to within alignment limits.	1 hour with the OPDMS not monitoring parameters <u>AND</u> 8 hours
	<u>OR</u>	
	B.2.1.1 Verify SDM to be within the limits specified in the COLR.	1 hour
	<u>OR</u>	
	B.2.1.2 Initiate boration to restore SDM within limits.	1 hour
	<u>AND</u>	
	B.2.2 Reduce THERMAL POWER to ≤ 75% RTP.	2 hours
	<u>AND</u>	
	B.2.3 Verify SDM is within the limits specified in the COLR.	Once per 12 hours
	<u>AND</u>	

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
B. (continued)	B.2.4	---------------NOTE-------------- Only required to be performed when OPDMS is not monitoring parameters. ------------------------------------- Perform SR 3.2.1.1 and SR 3.2.1.2.	72 hours
	<u>AND</u>		
	B.2.5	--------------NOTE--------------- Only required to be performed when OPDMS is not monitoring parameters. ------------------------------------- Perform SR 3.2.2.1.	72 hours
	<u>AND</u>		
	B.2.6	Re-evaluate safety analyses and confirm results remain valid for duration of operation under these conditions.	5 days
C. Required Action and associated Completion Time of Condition B not met.	C.1	Be in MODE 3.	6 hours
D. More than one rod not within alignment limits.	D.1.1	Verify SDM is within the limits specified in the COLR.	1 hour
	<u>OR</u>		

ACTIONS (continued)

CONDITION	REQUIRED ACTION		COMPLETION TIME
D. (continued)	D.1.2	Initiate boration to restore required SDM to within limits.	1 hour
	AND		
	D.2	Be in MODE 3.	6 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.1.4.1	Verify individual rod positions within alignment limits.	12 hours
SR 3.1.4.2	--------------------------------NOTE-------------------------------- Not applicable to GRCAs. --- Verify rod freedom of movement (trippability) by moving each rod not fully inserted in the core ≥ 10 steps in either direction.	92 days

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.1.4.3	--------------------------------NOTE-------------------------------- Not applicable to GRCAs. --- Verify rod drop time of each rod, from the fully withdrawn position, is ≤ 2.47 seconds from the beginning of decay of stationary gripper coil voltage to dashpot entry, with: a. T_{avg} ≥ 500°F, and b. All reactor coolant pumps operating.	Once prior to reactor criticality after each removal of the reactor head, and after each earthquake requiring plant shutdown

B 3.1 REACTIVITY CONTROL SYSTEMS

B 3.1.4 Rod Group Alignment Limits

BASES

BACKGROUND

The OPERABILITY (e.g., trippability) of the RCCAs is an initial assumption in all safety analyses which assume rod insertion upon reactor trip. Maximum rod misalignment is an initial assumption in the safety analysis that directly affects core power distributions and assumptions of available SDM. Gray Rod Cluster Assemblies (GRCAs) are excluded from this LCO during the planned GRCA bank sequence exchange, with the Online Power Distribution Monitoring System (OPDMS) monitoring parameters. The bank sequence exchange of GRCA banks will be periodically necessary to prevent excessive burnup shadowing of fuel rods near the gray rod assemblies. The bank sequence exchange maneuver will purposefully misalign GRCAs from their bank for a short period of time. The exclusion from this LCO is acceptable due to SHUTDOWN MARGIN being calculated exclusive of GRCAs, the relative low worth of individual gray rod assemblies, the short time duration anticipated for the bank sequence exchange maneuver and with OPDMS monitoring parameters, power peaking and xenon redistribution effects will be monitored and controlled.

The applicable criteria for these reactivity and power distribution design requirements are 10 CFR 50, Appendix A, GDC 10, “Reactor Design,” GDC 26, “Reactivity Control System Redundancy and Protection” (Ref. 1), and 10 CFR 50.46, “Acceptance Criteria for Emergency Core Cooling Systems for Light Water Nuclear Power Plants” (Ref. 2).

Mechanical or electrical failures may cause a control rod to become inoperable or to become misaligned from its group. Control rod inoperability or misalignment may cause increased power peaking due to the asymmetric reactivity distribution and a reduction in the total available rod worth for reactor shutdown. Therefore, control rod alignment and OPERABILITY are related to core operation in design power peaking limits and the core design requirement of a minimum SDM.

Limits on control rod alignment have been established, and all rod positions are monitored and controlled during power operation to ensure that the power distribution and reactivity limits defined by the design power peaking and SDM limits are preserved.

BACKGROUND (continued)

Rod cluster control assemblies (RCCAs) and GRCAs are moved by their control rod drive mechanisms (CRDMs). Each CRDM moves its RCCA or GRCA one step (approximately 5/8 inch) at a time but at varying rates (steps per minute) depending on the signal output from the Plant Control System (PLS).

The rod control assemblies are divided among control banks and shutdown banks. Each bank may be further subdivided into two groups to provide for precise reactivity control. A group consists of two or more rod control assemblies that are electrically paralleled to step simultaneously. A bank of rod control assemblies consists of two groups that are moved in a staggered fashion, but always within one step of each other. The AP1000 design has seven control banks and four shutdown banks.

The shutdown banks are maintained either in the fully inserted or fully withdrawn position. The control banks are part of the MSHIM (Mechanical Shim) Control System which utilizes two independently OPERABLE groups of control banks for control of reactivity and axial power distribution.

Certain control rods will be pre-selected for inclusion in the Rapid Power Reduction (RPR) system. The purpose of the RPR is to initiate a rapid decrease in the core power during load rejection transients.

Reactivity control is provided primarily by the M banks. The M Banks consist of several control banks operating with a fixed overlap. The bank worth and overlap are defined so as to minimize the impact on axial offset with control bank maneuvering and still retain the reactivity required to meet the desired load changes.

The axial power distribution control is provided by the AO Bank, a relatively high worth bank.

In order to avoid boron adjustment for load follow operation, gray rods are utilized.

There are 16 GRCAs in the AP1000, each composed of 24 rodlets mounted on a common RCCA spider. The 16 GRCAs have been subdivided into what has been termed as MA, MB, MC, and MD Banks with 4 GRCAs in each.

BASES

BACKGROUND (continued)

Each of the MA, MB, MC, and MD Banks has almost the same worth. The primary gray bank function is to provide additional reactivity during the transition periods. During base load operation, two of the gray banks may be fully inserted into the core. Each of the gray banks consists of a relatively low worth bank.

The MA, MB, MC, MD, M1 and M2 Banks function together with a single variable (i.e., criticality or temperature) driving these groups as if they are in one control group.

The control rods are arranged in a radially symmetric pattern so that control bank motion does not introduce radial asymmetries in the core power distributions.

The axial position of shutdown rods and control rods is indicated by two separate and independent systems, which are the Bank Demand Position Indication System (commonly called group step counters) and the Digital Rod Position Indication (DRPI) System.

The Bank Demand Position Indication System counts the pulses from the rod control system that moves the rods. There is one step counter for each group of rods. Individual rods in a group all receive the same signal to move and should, therefore, all be at the same position indicated by the group step counter for that group. The Bank Demand Position Indication System is considered highly precise (± 1 step or ± 5/8 inch). If a rod does not move one step for each demand pulse, the step counter will still count the pulse and incorrectly reflect the position of the rod.

The DRPI System provides a highly accurate indication of actual control rod position, at a lower precision than the step counters. This system is based on inductive analog signals from a series of coils spaced along a hollow tube. To increase the reliability of the system, the inductive coils are connected alternately to data system A or B. Thus, if one data system fails, the DRPI will go on half-accuracy. The DRPI System is capable of monitoring rod position within at least ± 12 steps with either full accuracy or half accuracy.

BASES

APPLICABLE SAFETY ANALYSES

Control rod misalignment accidents are analyzed in the safety analysis (Ref. 3). The acceptance criteria for addressing control rod inoperability or misalignment is that:

a. There be no violations of:

   1. Specified acceptable fuel design limits, or

   2. Reactor Coolant System (RCS) pressure boundary integrity; and

b. The core remains subcritical after accident transients.

Two types of misalignment are distinguished. During movement of a control rod group, one rod may stop moving, while the other rods in the group continue. This condition may cause excessive power peaking. The second type of misalignment occurs if one rod fails to insert upon a reactor trip and remains stuck fully withdrawn. This condition requires an evaluation to determine that sufficient reactivity worth is held in the control rods to meet the SDM requirement with the maximum worth rod stuck fully withdrawn.

Two types of analysis are performed in regard to static rod misalignment (Ref. 3). With control banks at or above their insertion limits, one type of analysis considers the case when any one rod is completely inserted into the core. The second type of analysis considers the case of a completely withdrawn single rod from a bank inserted to its insertion limit. Satisfying limits on departure from nucleate boiling ratio in both of these cases bounds the situation when a rod is misaligned from its group by 12 steps.

Another type of misalignment occurs if one RCCA fails to insert upon a reactor trip and remains stuck fully withdrawn. This condition is assumed in the evaluation to determine that the required SDM is met with the maximum worth RCCA also fully withdrawn (Ref. 3).

The Required Actions in this LCO assure that either deviations from the alignment limits will be corrected or that THERMAL POWER will be adjusted so that excessive local linear heat rates (LHRs) will not occur, and that the requirements on SDM and ejected rod worth are preserved.

Continued operation of the reactor with a misaligned control rod is allowed if the OPDMS indicates margin to limits or, if the OPDMS is not monitoring parameters, the heat flux hot channel factor ($F_Q(Z)$) and the nuclear enthalpy hot channel factor ($F^N_{\Delta H}$) are verified to be within their

BASES

APPLICABLE SAFETY ANALYSES (continued)

limits in the COLR and the safety analysis is verified to remain valid. When a control rod is misaligned, the assumptions that are used to determine the rod insertion limits, AFD limits, and quadrant power tilt limits are not preserved. Therefore, the limits may not preserve the design peaking factors, and $F_Q(Z)$ and $F^N_{\Delta H}$ must be verified directly by incore mapping. Bases Section 3.2 (Power Distribution Limits) contains more complete discussions of the relation of $F_Q(Z)$ and $F^N_{\Delta H}$ to the operating limits.

Shutdown and control rod OPERABILITY and alignment are directly related to power distributions and SDM, which are initial conditions assumed in safety analyses. Therefore they satisfy Criterion 2 of 10 CFR 50.36(c)(2)(ii).

LCO

The limits on shutdown or control rod alignments assure that the assumptions in the safety analysis will remain valid. The requirements on control rod OPERABILITY assure that upon reactor trip, the assumed reactivity will be available and will be inserted. The control rod OPERABILITY requirements (i.e., trippability) are separate from the alignment requirements, which ensure that the RCCAs and banks maintain the correct power distribution and rod alignment. The rod OPERABILITY requirement is satisfied provided the rod will fully insert in the required rod drop time assumed in the safety analysis. Rod control malfunctions that result in the inability to move a rod (e.g., rod lift coil failures), but that do not impact trippability, do not result in rod inoperability.

The requirement to maintain the rod alignment to within plus or minus 12 steps is conservative. The minimum misalignment assumed in safety analysis is 24 steps (15 inches), and in some cases a total misalignment from fully withdrawn to fully inserted is assumed.

Failure to meet the requirements of this LCO may produce unacceptable power peaking factors and linear heating rates (LHR), or unacceptable SDMs, which may constitute initial conditions inconsistent with the safety analysis.

BASES

LCO (continued)

The LCO is modified by a Note to relax the rod alignment limit on GRCAs during GRCA bank sequence exchange operations. The two exchanging banks will move out of sequence and overlap limits for several minutes during the sequence exchange. This operation which occurs frequently throughout the fuel cycle would normally violate the LCO. GRCA bank sequence exchange is only allowed with the OPDMS OPERABLE to monitor the parameters of LCO 3.2.5, “On-Line Power Distribution Monitoring System (OPDMS) - Monitored Parameters.”

APPLICABILITY

The requirements on RCCA OPERABILITY and alignment are applicable in MODES 1 and 2 because these are the only MODES in which neutron (or fission) power is generated, and the OPERABILITY (i.e., trippability) and alignment of rods have the potential to affect the safety of the plant. In MODES 3, 4, 5, and 6, the alignment limits do not apply because the control rods are bottomed and the reactor is shut down and not producing fission power. In the shutdown MODES, the OPERABILITY of the shutdown and control rods has the potential to affect the required SDM, but this effect can be compensated for by an increase in the boron concentration of the RCS. See LCO 3.1.1, “SHUTDOWN MARGIN (SDM),” for SDM in MODES 3, 4, and 5 and LCO 3.9.1, “Boron Concentration,” for boron concentration requirements during refueling.

ACTIONS

A.1.1 and A.1.2

In this situation, SDM verification must include the worth of the untrippable rod as well as a rod of maximum worth.

When one or more rods are inoperable (i.e., untrippable), there is a possibility that the required SDM may be adversely affected. Under these conditions, it is important to determine the SDM, and if it is less than the required value, initiate boration until the required SDM is recovered. The Completion Time of 1 hour is adequate to determine SDM and, if necessary, to initiate boration to restore SDM.

BASES

ACTIONS (continued)

A.2

If the inoperable rod(s) cannot be restored to OPERABLE status, the plant must be brought to a MODE or condition in which the LCO requirements are not applicable. To achieve this status, the unit must be brought to at least MODE 3 within 6 hours.

The allowed Completion Time is reasonable, based on operating experience, for reaching MODE 3 from full power conditions in an orderly manner without challenging plant systems.

B.1

When a rod becomes misaligned, it can usually be moved and is still trippable. With the OPDMS monitoring parameters adverse peaking factors resulting from the misalignment can be detected. If the rod can be realigned within the Completion Time of 8 hours adverse burnup shadowing in the location of the misaligned rod can be avoided. With the OPDMS not monitoring parameters xenon redistribution can potentially cause adverse peaking factors which may not be detected. However, if the rod can be realigned within the Completion Time of 1 hour, local xenon redistribution during this short interval will not be significant and operation may proceed without further restriction.

An alternative to realigning a single misaligned RCCA to the group average position is to align the remainder of the group to the position of the misaligned RCCA. However, this must be done without violating the bank sequence, overlap, and insertion limits specified in LCO 3.1.5, “Shutdown Bank Insertion Limits,” and LCO 3.1.6, “Control Bank Insertion Limits.” The Completion Time of 1 hour gives the operator sufficient time to adjust the rod positions in an orderly manner.

B.2.1.1 and B.2.1.2

With a misaligned rod, SDM must be verified within limit or boration must be initiated to restore SDM within limit.

In many cases, realigning the remainder of the group to the misaligned rod may not be desirable. For example, realigning control bank M2 to a rod that is misaligned 15 steps from the top of the core could require insertion of the M1 bank to maintain overlap limits.

ACTIONS (continued)

Power operation may continue with one RCCA trippable but misaligned, provided that SDM is verified within 1 hour. The Completion Time of 1 hour represents the time necessary to determine the actual unit SDM and, if necessary, aligning and starting the necessary systems and components to initiate boration.

B.2.2, B.2.3, B.2.4, B.2.5, and B.2.6

For continued operation with a misaligned rod, RTP must be reduced, SDM must periodically be verified within limits, hot channel factors ($F_Q(Z)$ and $F^N_{\Delta H}$) must be verified within limits, and the safety analyses must be re-evaluated to confirm continued operation is permissible. A note has been added indicating that Required Actions B.2.4 and B.2.5, F_Q and $F_{\Delta H}$ verification, are only required when the OPDMS is not monitoring parameters and therefore unavailable to continuously monitor the core power distribution.

Reduction of power to 75% of RTP ensures that local LHR increases due to a misaligned RCCA will not cause the core design criteria to be exceeded (Ref. 3). The Completion Time of 2 hours gives the operator sufficient time to accomplish an orderly power reduction without challenging the Protection and Safety Monitoring System.

When a rod is known to be misaligned, there is a potential to impact the SDM. Since the core conditions can change with time, periodic verification of SDM is required. A Frequency of 12 hours is sufficient to ensure this requirement continues to be met.

Online monitoring of core power distribution by the OPDMS, or verifying that $F_Q(Z)$ and $F^N_{\Delta H}$ are within the required limits when the OPDMS is not monitoring parameters, ensures that current operation at 75% of RTP with a rod misaligned is not resulting in power distributions which may invalidate safety analysis assumptions at full power. The Completion Time of 72 hours allows sufficient time to restore OPDMS monitoring parameters or to obtain and analyze offline flux maps of the core power distribution using the incore detector system and to calculate $F_Q(Z)$ and $F^N_{\Delta H}$.

BASES

ACTIONS (continued)

Once current conditions have been verified acceptable, time is available to perform evaluations of accident analysis to determine that core limits will not be exceeded during a Design Basis Accident (DBA) for the duration of operation under these conditions. The accident analyses presented in Chapter 15 (Ref. 3) that may be adversely affected will be evaluated to ensure that the analysis results remain valid for the duration under these conditions. A Completion Time of 5 days is sufficient time to obtain the required input data and to perform the analysis.

C.1

When Required Actions cannot be completed within their Completion Times, the unit must be brought to a MODE or Condition in which the LCO requirements are not applicable. To achieve this status, the unit must be brought to at least MODE 3 within 6 hours, which obviates concerns about the development of undesirable xenon or power distributions. The allowed Completion Time of 6 hours is reasonable, based on operating experience, for reaching MODE 3 from full power condition in an orderly manner and without challenging the plant systems.

D.1.1 and D.1.2

More than one control rod becoming misaligned from its group average position is not expected, and has the potential to reduce SDM. Therefore, SDM must be evaluated. One hour allows the operator adequate time to determine SDM.

Restoration of the required SDM, if necessary, requires increasing the RCS boron concentration to provide negative reactivity, as described in the bases of LCO 3.1.1. The required Completion Time of 1 hour for initiating boration is reasonable based on the time required for potential xenon redistribution, the low probability of an accident occurring, and the steps required to complete the action. This allows the operator sufficient time to align the required valves and start the CVS makeup pumps. Boration will continue until the required SDM is restored.

BASES

ACTIONS (continued)

D.2

If more than one rod is found to be misaligned or becomes misaligned because of bank movement, the unit conditions fall outside of the accident analysis assumptions. Since automatic bank sequencing would continue to cause misalignment, the rods must be brought to within the alignment limits within 6 hours or the unit must be brought to a MODE or Condition in which the LCO requirements are not applicable. To achieve this status, the unit must be brought to at least MODE 3 within 6 hours.

The allowed Completion Time is reasonable, based on operating experience, for reaching MODE 3 from full power in an orderly manner and without challenging plant systems.

SURVEILLANCE REQUIREMENTS

SR 3.1.4.1

Verification that individual rod positions are within alignment limits at a Frequency of 12 hours provides a history that allows the operator to detect that a rod is beginning to deviate from its expected position. The specified Frequency takes into account other rod position information that is continuously available to the operator in the main control room so that during actual rod motion, deviations can immediately be detected.

SR 3.1.4.2

Verifying each control rod is OPERABLE would require that each rod be tripped. However, in MODES 1 and 2, tripping each control rod would result in radial or axial power tilts, or oscillations. Exercising each individual control rod every 92 days provides increased confidence that all rods continue to be OPERABLE without exceeding the alignment limit, even if they are not regularly tripped. Moving each control rod by 10 steps will not cause radial or axial power tilts, or oscillations, to occur. The 92 day Frequency takes into consideration other information available to the operator in the control room and SR 3.1.4.1, which is performed more frequently and adds to the determination of OPERABILITY of the rods. Between required performances of SR 3.1.4.2 (determination of control rod OPERABILITY by movement), if a control rod(s) is discovered to be immovable, but remains trippable and aligned, the control rod(s) is considered to be OPERABLE. At any time, if a control rod(s) is immovable, a determination of the trippability (OPERABILITY) of the control rod(s) must be made, and appropriate

BASES

SURVEILLANCE REQUIREMENTS (continued)

action taken. GRCA are excluded from this Surveillance because they are not considered in the calculation of SDM in MODES 1 and 2.

SR 3.1.4.3

Verification of rod drop times allows the operator to determine that the maximum rod drop time permitted is consistent with the assumed rod drop time used in the safety analysis. Measuring rod drop times prior to reactor criticality, after each reactor vessel head removal and each earthquake requiring plant shutdown, ensures that the reactor internals and rod drive mechanism will not interfere with rod motion or rod drop time, and that no degradation in these systems has occurred that would adversely affect control rod motion or drop time. This testing is performed with all RCPs operating and the average moderator temperature ≥ 500°F to simulate a reactor trip under conservative conditions. GRCA are excluded from this Surveillance because they are not considered in the calculation of SDM in MODES 1 and 2.

This Surveillance is performed during a plant outage due to the plant conditions needed to perform the SR and the potential for an unplanned plant transient if the Surveillance were performed with the reactor at power.

REFERENCES

1. 10 CFR 50, Appendix A, GDC 10 and GDC 26.

2. 10 CFR 50.46.

3. FSAR Chapter 15, “Accident Analyses.”