

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

Title: Changes related to Section 3.1.6, Control Bank Insertion 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 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 A012: Revise Required Action A.2 by replacing “within limits” with “within insertion limits.”
- VEGP LAR DOC A013: Required Action A.1.2 and B.1.2 are revised to make “limit” plural (i.e., “limits”).
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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(1) applicable to operating reactor designs, but not to the AP1000 design; (2) already incorporated in the GTS; or (3) superseded by another change.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)

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)

An editorial change is made in the first sentence of the third paragraph of the “Background” section in the Bases. The sentence is split into two sentences.

A capitalization is made in the ‘Applicable Safety Analyses’ section of the Bases.

V. Applicability

Affected Generic Technical Specifications and Bases:

Section 3.1.6, Control Bank Insertion Limits

Changes to the Generic Technical Specifications and Bases:

APPLICABILITY Note is modified replacing “OPDMS OPERABLE” with “On-Line Power Distribution Monitoring System monitoring parameters.” (DOC A011)

Required Action A.2 is revised to state “insertion limits” replacing “limits.” (DOC A012)

Editorial corrections are made replacing “limit” with “limits” within the ACTIONS Table. (DOC A013)

Bases are revised to replace “OPDMS operable” and “OPDMS inoperable” respectively with “OPDMS monitoring parameters” and “OPDMS not monitoring parameters.” (DOC A011)

In the last sentence of the fourth paragraph of the “Background” section of the Bases, “operability of the Online Power Distribution Monitoring Systems (OPDMS).” is replaced with “status of the Online Power Distribution Monitoring System (OPDMS).” Similarly, in the second sentence of the first paragraph of the “Applicability” section in the Bases, “OPDMS operability” is replaced with “OPDMS status.” (DOC A011)

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

An editorial change is made in the “Background” section of the Bases. The first sentence in the third paragraph was split into two sentences. (APOG Comment)

VI. Traveler Information**Description of TSTF changes:**

None

Rationale for TSTF changes:

NA

Description of changes in RCOL Std. Dep., RCOL COL Item(s), and RCOL PTS Changes:**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.” Also, “operability of OPDMS” is revised to “status of OPDMS” in the fourth paragraph of the “Background” section and “OPDMS operability” is revised to “OPDMS status” in the first paragraph of the “Applicability” section in the Bases.

VEGP LAR DOC A012:

Revise Required Action A.2 by replacing “within limits” with “within insertion limits.”

VEGP LAR DOC A013:

Required Action A.1.2 and B.1.2 are revised to make “limit” plural (i.e., “limits”).

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 limits. 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”).

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 A012

LCO 3.1.6 imposes requirements for “insertion, sequence, and overlap limits.” Condition B is Applicable to sequence and overlap limits, and its Required Action B.2 clearly establishes the requirement to restore sequence and overlap limits. Condition A is applicable only to “insertion” limits, however, its Required Action A.2 is inconsistent in requiring restoration of limits; implying all limits. The restoration action is intended to align with correcting the Condition. As such, the intent of Required Action A.2 is that the restoration be of insertion limits.

There is no change in the intent by adding the clarification of “insertion” to Required Action A.2, but it clarifies the Required Action.

VEGP LAR DOC A013

The alternative Required Actions A.1.1 and B.1.1 immediately preceding Required Actions A.1.2 and B.1.2 reference SDM “limits” (i.e., plural). For consistency the reference is also made plural in the optional Required Actions. There is no change in the implementation of the requirement for SDM to meet limits specified in the COLR.

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

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

The first sentence in the third paragraph of the “Background” section in the Bases was split into two sentences as follows:

The rod cluster control assemblies (RCCAs) are divided among control banks and shutdown banks. ~~g~~Gray rod cluster assemblies (GRCAs) are limited to control banks.

The following capitalization was made in the “Applicable Safety Analyses” section of the Bases:

1. ~~s~~Specified fuel design limits, or

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

The changes are editorial. They provide improved clarity and correction.

VII. GTST Safety Evaluation

Technical Analysis:

Replacing “OPDMS Operable” and “OPDMS inoperable” respectfully 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 phrases “OPDMS is monitoring” and “OPDMS not monitoring.” These changes are acceptable for AP1000 STS because they accurately describe the status of the OPDMS as a condition of applicability of the LCO.

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 3.1.6 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 4/1/2014.

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 #80) 3.1.06, Pg. 08, The first sentence in the "Technical Analyses" of this GTST is deleted. This sentence is not needed since sufficient information is provided in the rest of the paragraph to justify the changes.
3. (Internal #81) 3.1.06, Pg. 13, Two Notes for Applicability of LCO was mistakenly omitted. The Notes are added.
4. (Internal #82) 3.1.06, Pg. 24, An editorial change is made in the "Background" section of the Bases. The first sentence in the third paragraph was split into two sentences.
5. (Internal #83) 3.1.06, Pg. 26, A capitalization was made in the "Applicable Safety Analyses" section in the Bases; "specified" was replaced with "Specified."

NRC Final Approval Date: 6/02/2015

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. 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).
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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.

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. Control bank sequence or overlap limits not met.	B.1.1 Verify SDM is within the limits specified in the COLR.	1 hour
	<u>OR</u>	
	B.1.2 Initiate boration to restore SDM to within limits.	1 hour
C. Required Action and associated Completion Time not met.	<u>AND</u>	
	B.2 Restore control bank sequence and overlap to within limits.	2 hours
	C.1 Be in MODE 2 with $k_{\text{eff}} < 1.0$.	6 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.1.6.1	Verify the estimated critical control bank position is within limits specified in the COLR.	Within 4 hours prior to achieving criticality
SR 3.1.6.2	Verify each control bank insertion is within the limits specified in the COLR.	12 hours
SR 3.1.6.3	Verify sequence and overlap limits, specified in the COLR, are met for control banks not fully withdrawn from the core.	12 hours

B 3.1 REACTIVITY CONTROL SYSTEMS

B 3.1.6 Control Bank Insertion Limits

BASES

BACKGROUND

The insertion limits of the shutdown and control rods are initial assumptions in the safety analyses that assume rod insertion upon reactor trip. The insertion limits directly affect core power and fuel burnup distributions and assumptions of available SDM, and initial reactivity insertion rate.

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," GDC 28, "Reactivity Limits" (Ref. 1) and 10 CFR 50.46, "Acceptance Criteria for Emergency Core Cooling Systems for Light Water Nuclear Power Reactors" (Ref. 2). Limits on control rod insertion 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.

The rod cluster control assemblies (RCCAs) are divided among control banks and shutdown banks. Gray rod cluster assemblies (GRCAs) are limited to control banks. Each bank may be further subdivided into two groups to provide for precise reactivity control. A group consists of two or more RCCAs or GRCAs that are electrically paralleled to step simultaneously. A bank of RCCAs consists of two groups that are moved in a staggered fashion, but always within 1 step of each other. The AP1000 design has seven control banks and four shutdown banks. See LCO 3.1.4, "Rod Group Alignment Limits," for control and shutdown rod OPERABILITY and alignment requirements, and LCO 3.1.7, "Rod Position Indication," for position indication requirements.

The control bank insertion sequence and overlap limits are specified in the COLR. The control banks are required to be at or above the applicable insertion limit lines. There will be two insertion limit lines. Which is applicable will depend on the operability status of the Online Power Distribution Monitoring System (OPDMS).

The control banks are used for precise reactivity control of the reactor. The positions of the control banks are normally controlled automatically by the Plant Control System (PLS), but can also be manually controlled. They are capable of adding reactivity very quickly (compared to borating or diluting).

BASES

BACKGROUND (continued)

The power density at any point in the core must be limited so that the fuel design criteria are maintained. Together, LCO 3.1.4, "Rod Group Alignment Limits," LCO 3.1.5, "Shutdown Bank Insertion Limits," LCO 3.1.6, "Control Bank Insertion Limits," and LCO 3.2.5, "OPDMS - Monitored Parameters," when the OPDMS is ~~OPERABLE~~ **monitoring parameters**, or LCO 3.2.3, "AXIAL FLUX DIFFERENCE (AFD)," and LCO 3.2.4, "QUADRANT POWER TILT RATIO (QPTR)," when the OPDMS is ~~inoperable~~ **not monitoring parameters**, provide limits on control component operation and on monitored process variables which ensure that the core operates within the fuel design criteria.

The shutdown and control bank insertion and alignment limits and power distribution limits are process variables that together characterize and control the three dimensional power distribution of the reactor core. Additionally, the control bank insertion limits control the reactivity that could be added in the event of a rod ejection accident, and the shutdown and control bank insertion limits assure the required SDM is maintained when the OPDMS is ~~inoperable~~ **not monitoring parameters**.

Operation within the subject LCO limits will prevent fuel cladding failures that would breach the primary fission product barrier and release fission products to the reactor coolant in the event of a loss of coolant accident (LOCA), loss of flow, ejected rod, or other accident requiring termination by a Reactor Trip System (RTS) trip function.

**APPLICABLE
SAFETY
ANALYSES**

The shutdown and applicable control bank insertion limits, AFD and QPTR LCOs, are required when the OPDMS is ~~inoperable~~ **not monitoring parameters**, to prevent power distributions that could result in fuel cladding failures in the event of a LOCA, loss of flow, ejected rod, or other accident requiring termination by an RTS trip function.

The acceptance criteria for addressing shutdown and control bank insertion limits and inoperability or misalignment are that:

BASES

APPLICABLE SAFETY ANALYSES (continued)

- a. There be no violations of:
 1. ~~s~~Specified fuel design limits, or
 2. Reactor Coolant System (RCS) pressure boundary integrity; and
- b. The core remains subcritical after accident transients.

As such, the shutdown and control bank insertion limits affect safety analysis involving core reactivity and power distributions (Ref. 3).

The SDM requirement is ensured by the continuous monitoring of the OPDMS and by limiting the control and shutdown bank insertion limits when the OPDMS is ~~inoperable~~not monitoring parameters, so that allowable inserted worth of the RCCAs is such that sufficient reactivity is available in the rods to shut down the reactor to hot zero power with a reactivity margin which assumes the maximum worth RCCA remains fully withdrawn upon trip (Ref. 3).

Operation at the insertion limits or AFD limits may approach the maximum allowable linear heat generation rate or peaking factor, with the allowed QPTR present. Operation at the insertion limit may also indicate the maximum ejected RCCA worth could be equal to the limiting value in fuel cycles that have sufficiently high ejected RCCA worth.

The control and shutdown bank insertion limits ensure that safety analyses assumptions for SDM (with OPDMS ~~inoperable~~not monitoring parameters), ejected rod worth, and power distribution peaking factors are preserved (Ref. 3).

The insertion limits satisfy Criterion 2 of 10 CFR 50.36(c)(2)(ii) in that they are initial conditions assumed in the safety analysis.

LCO

The limits on control banks sequence, overlap, and physical insertion as defined in the COLR, must be maintained because they serve the function of preserving power distribution, ensuring that the SDM is maintained (when OPDMS is ~~inoperable~~not monitoring parameters), ensuring that ejected rod worth is maintained, and ensuring adequate negative reactivity insertion is available on trip. The overlap between control banks provides more uniform rates of reactivity insertion and

BASES

LCO (continued)

withdrawal and is imposed to maintain acceptable power peaking during control bank motion.

APPLICABILITY

The control bank sequence, overlap, and physical insertion limits shall be maintained with the reactor in MODES 1 and 2 with $k_{\text{eff}} \geq 1.0$. There will be two sets of insertion limits applicable to the control banks depending on OPDMS ~~status~~operability. With OPDMS ~~not monitoring parameters~~inoperable, these limits must be maintained since they preserve the assumed power distribution, ejected rod worth, SDM, and reactivity rate insertion assumptions. With OPDMS ~~operable and~~ continuously monitoring power distribution and SDM, the applicable insertion limits must be maintained since they preserve the accident analysis assumptions.

Applicability in MODES 3, 4, and 5 is not required, since neither the power distribution nor ejected rod worth assumptions would be exceeded in these MODES.

The applicability requirements are modified by a Note indicating the LCO requirements are suspended during the performance of SR 3.1.4.2. This SR verifies the freedom of the rods to move, and requires the control bank to move below the LCO limits, which would violate the LCO.

The second Note suspends LCO applicability 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~~monitoring the parameters of LCO 3.2.5, "OPDMS Monitored Parameters."

BASES

ACTIONSA.1.1, A.1.2, A.2, B.1.1, B.1.2, and B.2

When the control banks are outside the acceptable insertion limits, they must be restored to within those limits. This restoration can occur in two ways:

- a. Reducing power to be consistent with rod position; or
- b. Moving rods to be consistent with power.

Also, verification of SDM or initiation of boration to regain SDM is required within 1 hour, since with OPDMS **not monitoring parameters inoperable**, the SDM in MODES 1 and 2, ensured by adhering to the control and shutdown bank insertion limits (see LCO 3.1.1, "SHUTDOWN MARGIN (SDM)"), has been upset. If control banks are not within their insertion limits, then SDM will be verified by the OPDMS or if the OPDMS is **not monitoring parameters inoperable**, by performing a reactivity balance calculation, considering the effects listed in the BASES for SR 3.1.1.1.

Similarly, if the control banks are found to be out of sequence or in the wrong overlap configuration, they must be restored to meet the limits.

Operation beyond the LCO limits is allowed for a short time period in order to take conservative action because the simultaneous occurrence of either a LOCA, loss of flow accident, ejected rod accident, or other accident during this short time period, together with an inadequate power distribution or reactivity capability, has an acceptably low probability.

The allowed Completion Time of 2 hours for restoring the banks to within the insertion, sequence and overlap limits provides an acceptable time for evaluating and repairing minor problems without allowing the plant to remain outside the insertion limits for an extended period of time.

C.1

If Required Actions A.1 and A.2, or B.1 and B.2 cannot be completed within the associated Completion Times, the plant must be brought to MODE 2 with $k_{eff} < 1.0$, where the LCO is not applicable. The allowed Completion Time of 6 hours is reasonable based on operating experience for reaching the required MODE from full power condition in an orderly manner and without challenging plant systems.

BASES

**SURVEILLANCE
REQUIREMENTS**SR 3.1.6.1

This Surveillance is required to ensure that the reactor does not achieve criticality with the control banks below their insertion limits.

The estimated critical position (ECP) depends upon a number of factors, one of which is xenon concentration. If the ECP was calculated long before criticality, xenon concentration could change to make the ECP substantially in error. Conversely, determining the ECP immediately before criticality could be an unnecessary burden. There are a number of unit parameters requiring operator attention at that point. Performing the ECP calculation within 4 hours prior to criticality avoids a large error from changes in xenon concentration, but allows the operator some flexibility to schedule the ECP calculation with other startup activities.

SR 3.1.6.2

Verification of the control banks insertion limits at a Frequency of 12 hours is sufficient to detect control banks that may be approaching the insertion limits since the insertion limits are monitored and alarms will occur on approach to and/or the exceeding of the limit and, normally, very little rod motion occurs in 12 hours.

SR 3.1.6.3

When control banks are maintained within their insertion limits as checked by SR 3.1.6.2 above, it is unlikely that their sequence and overlap will not be in accordance with requirements provided in the COLR. A Frequency of 12 hours is consistent with the insertion limit check above in SR 3.1.6.2.

REFERENCES

1. 10CFR50, Appendix A, GDC 10, GDC 26, and GDC 28.
 2. 10CFR50.46.
 3. **FSAR** Chapter 15, "Accident Analysis."
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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.

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. Control bank sequence or overlap limits not met.	B.1.1 Verify SDM is within the limits specified in the COLR.	1 hour
	<u>OR</u>	
	B.1.2 Initiate boration to restore SDM to within limits.	1 hour
	<u>AND</u>	
	B.2 Restore control bank sequence and overlap to within limits.	2 hours
C. Required Action and associated Completion Time not met.	C.1 Be in MODE 2 with $k_{\text{eff}} < 1.0$.	6 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.1.6.1	Verify the estimated critical control bank position is within limits specified in the COLR.	Within 4 hours prior to achieving criticality
SR 3.1.6.2	Verify each control bank insertion is within the limits specified in the COLR.	12 hours
SR 3.1.6.3	Verify sequence and overlap limits, specified in the COLR, are met for control banks not fully withdrawn from the core.	12 hours

B 3.1 REACTIVITY CONTROL SYSTEMS

B 3.1.6 Control Bank Insertion Limits

BASES

BACKGROUND

The insertion limits of the shutdown and control rods are initial assumptions in the safety analyses that assume rod insertion upon reactor trip. The insertion limits directly affect core power and fuel burnup distributions and assumptions of available SDM, and initial reactivity insertion rate.

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," GDC 28, "Reactivity Limits" (Ref. 1) and 10 CFR 50.46, "Acceptance Criteria for Emergency Core Cooling Systems for Light Water Nuclear Power Reactors" (Ref. 2). Limits on control rod insertion 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.

The rod cluster control assemblies (RCCAs) are divided among control banks and shutdown banks. Gray rod cluster assemblies (GRCAs) are limited to control banks. Each bank may be further subdivided into two groups to provide for precise reactivity control. A group consists of two or more RCCAs or GRCAs that are electrically paralleled to step simultaneously. A bank of RCCAs consists of two groups that are moved in a staggered fashion, but always within 1 step of each other. The AP1000 design has seven control banks and four shutdown banks. See LCO 3.1.4, "Rod Group Alignment Limits," for control and shutdown rod OPERABILITY and alignment requirements, and LCO 3.1.7, "Rod Position Indication," for position indication requirements.

The control bank insertion sequence and overlap limits are specified in the COLR. The control banks are required to be at or above the applicable insertion limit lines. There will be two insertion limit lines. Which is applicable will depend on the status of the Online Power Distribution Monitoring System (OPDMS).

The control banks are used for precise reactivity control of the reactor. The positions of the control banks are normally controlled automatically by the Plant Control System (PLS), but can also be manually controlled. They are capable of adding reactivity very quickly (compared to borating or diluting).

BASES

BACKGROUND (continued)

The power density at any point in the core must be limited so that the fuel design criteria are maintained. Together, LCO 3.1.4, "Rod Group Alignment Limits," LCO 3.1.5, "Shutdown Bank Insertion Limits," LCO 3.1.6, "Control Bank Insertion Limits," and LCO 3.2.5, "OPDMS - Monitored Parameters," when the OPDMS is monitoring parameters, or LCO 3.2.3, "AXIAL FLUX DIFFERENCE (AFD)," and LCO 3.2.4, "QUADRANT POWER TILT RATIO (QPTR)," when the OPDMS is not monitoring parameters, provide limits on control component operation and on monitored process variables which ensure that the core operates within the fuel design criteria.

The shutdown and control bank insertion and alignment limits and power distribution limits are process variables that together characterize and control the three dimensional power distribution of the reactor core. Additionally, the control bank insertion limits control the reactivity that could be added in the event of a rod ejection accident, and the shutdown and control bank insertion limits assure the required SDM is maintained when the OPDMS is not monitoring parameters.

Operation within the subject LCO limits will prevent fuel cladding failures that would breach the primary fission product barrier and release fission products to the reactor coolant in the event of a loss of coolant accident (LOCA), loss of flow, ejected rod, or other accident requiring termination by a Reactor Trip System (RTS) trip function.

**APPLICABLE
SAFETY
ANALYSES**

The shutdown and applicable control bank insertion limits, AFD and QPTR LCOs, are required when the OPDMS is not monitoring parameters, to prevent power distributions that could result in fuel cladding failures in the event of a LOCA, loss of flow, ejected rod, or other accident requiring termination by an RTS trip function.

The acceptance criteria for addressing shutdown and control bank insertion limits and inoperability or misalignment are that:

BASES

APPLICABLE SAFETY ANALYSES (continued)

- a. There be no violations of:
 - 1. Specified fuel design limits, or
 - 2. Reactor Coolant System (RCS) pressure boundary integrity; and
- b. The core remains subcritical after accident transients.

As such, the shutdown and control bank insertion limits affect safety analysis involving core reactivity and power distributions (Ref. 3).

The SDM requirement is ensured by the continuous monitoring of the OPDMS and by limiting the control and shutdown bank insertion limits when the OPDMS is not monitoring parameters, so that allowable inserted worth of the RCCAs is such that sufficient reactivity is available in the rods to shut down the reactor to hot zero power with a reactivity margin which assumes the maximum worth RCCA remains fully withdrawn upon trip (Ref. 3).

Operation at the insertion limits or AFD limits may approach the maximum allowable linear heat generation rate or peaking factor, with the allowed QPTR present. Operation at the insertion limit may also indicate the maximum ejected RCCA worth could be equal to the limiting value in fuel cycles that have sufficiently high ejected RCCA worth.

The control and shutdown bank insertion limits ensure that safety analyses assumptions for SDM (with OPDMS not monitoring parameters), ejected rod worth, and power distribution peaking factors are preserved (Ref. 3).

The insertion limits satisfy Criterion 2 of 10 CFR 50.36(c)(2)(ii) in that they are initial conditions assumed in the safety analysis.

LCO

The limits on control banks sequence, overlap, and physical insertion as defined in the COLR, must be maintained because they serve the function of preserving power distribution, ensuring that the SDM is maintained (when OPDMS is not monitoring parameters), ensuring that ejected rod worth is maintained, and ensuring adequate negative reactivity insertion is available on trip. The overlap between control banks provides more uniform rates of reactivity insertion and withdrawal

BASES

LCO (continued)

and is imposed to maintain acceptable power peaking during control bank motion.

APPLICABILITY

The control bank sequence, overlap, and physical insertion limits shall be maintained with the reactor in MODES 1 and 2 with $k_{\text{eff}} \geq 1.0$. There will be two sets of insertion limits applicable to the control banks depending on OPDMS status. With OPDMS not monitoring parameters, these limits must be maintained since they preserve the assumed power distribution, ejected rod worth, SDM, and reactivity rate insertion assumptions. With OPDMS continuously monitoring power distribution and SDM, the applicable insertion limits must be maintained since they preserve the accident analysis assumptions.

Applicability in MODES 3, 4, and 5 is not required, since neither the power distribution nor ejected rod worth assumptions would be exceeded in these MODES.

The applicability requirements are modified by a Note indicating the LCO requirements are suspended during the performance of SR 3.1.4.2. This SR verifies the freedom of the rods to move, and requires the control bank to move below the LCO limits, which would violate the LCO.

The second Note suspends LCO applicability 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 monitoring the parameters of LCO 3.2.5, "OPDMS Monitored Parameters."

ACTIONS

A.1.1, A.1.2, A.2, B.1.1, B.1.2, and B.2

When the control banks are outside the acceptable insertion limits, they must be restored to within those limits. This restoration can occur in two ways:

- a. Reducing power to be consistent with rod position; or

BASES

ACTIONS (continued)

- b. Moving rods to be consistent with power.

Also, verification of SDM or initiation of boration to regain SDM is required within 1 hour, since with OPDMS not monitoring parameters, the SDM in MODES 1 and 2, ensured by adhering to the control and shutdown bank insertion limits (see LCO 3.1.1, "SHUTDOWN MARGIN (SDM)"), has been upset. If control banks are not within their insertion limits, then SDM will be verified by the OPDMS or if the OPDMS is not monitoring parameters, by performing a reactivity balance calculation, considering the effects listed in the BASES for SR 3.1.1.1.

Similarly, if the control banks are found to be out of sequence or in the wrong overlap configuration, they must be restored to meet the limits.

Operation beyond the LCO limits is allowed for a short time period in order to take conservative action because the simultaneous occurrence of either a LOCA, loss of flow accident, ejected rod accident, or other accident during this short time period, together with an inadequate power distribution or reactivity capability, has an acceptably low probability.

The allowed Completion Time of 2 hours for restoring the banks to within the insertion, sequence and overlap limits provides an acceptable time for evaluating and repairing minor problems without allowing the plant to remain outside the insertion limits for an extended period of time.

C.1

If Required Actions A.1 and A.2, or B.1 and B.2 cannot be completed within the associated Completion Times, the plant must be brought to MODE 2 with $k_{\text{eff}} < 1.0$, where the LCO is not applicable. The allowed Completion Time of 6 hours is reasonable based on operating experience for reaching the required MODE from full power condition in an orderly manner and without challenging plant systems.

BASES

**SURVEILLANCE
REQUIREMENTS**SR 3.1.6.1

This Surveillance is required to ensure that the reactor does not achieve criticality with the control banks below their insertion limits.

The estimated critical position (ECP) depends upon a number of factors, one of which is xenon concentration. If the ECP was calculated long before criticality, xenon concentration could change to make the ECP substantially in error. Conversely, determining the ECP immediately before criticality could be an unnecessary burden. There are a number of unit parameters requiring operator attention at that point. Performing the ECP calculation within 4 hours prior to criticality avoids a large error from changes in xenon concentration, but allows the operator some flexibility to schedule the ECP calculation with other startup activities.

SR 3.1.6.2

Verification of the control banks insertion limits at a Frequency of 12 hours is sufficient to detect control banks that may be approaching the insertion limits since the insertion limits are monitored and alarms will occur on approach to and/or the exceeding of the limit and, normally, very little rod motion occurs in 12 hours.

SR 3.1.6.3

When control banks are maintained within their insertion limits as checked by SR 3.1.6.2 above, it is unlikely that their sequence and overlap will not be in accordance with requirements provided in the COLR. A Frequency of 12 hours is consistent with the insertion limit check above in SR 3.1.6.2.

REFERENCES

1. 10CFR50, Appendix A, GDC 10, GDC 26, and GDC 28.
 2. 10CFR50.46.
 3. FSAR Chapter 15, "Accident Analysis."
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