

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

Title: Changes Related to LCO 3.5.1, Accumulators

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-370-A, Rev. 0, Increase accumulator Completion Time from 1 hour to 24 hours (WCAP-15049)

STS NUREGs Affected:

TSTF-370-A, Rev. 0: NUREG-1431

NRC Approval Date:

TSTF-370-A, Rev. 0: 22-Feb-02

TSTF Classification:

TSTF-370-A, Rev. 0: 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 A065: Revise Required Action B.1 Completion Time for TS 3.5.1

VEGP LAR DOC D05: Revise SR 3.5.1.4 Frequency

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

This section discusses changes: (1) that were applicable to previous designs, but are not to the current design; (2) that are already incorporated in the GTS; and (3) that are superseded by another change.

TSTF-370-A, Rev. 0 revises the Completion Time for Condition B in STS 3.5.1 from 1 hour to 24 hours. This change is not applicable to the AP1000 based on the difference in the Completion Times and Core Cooling System design from that of the Westinghouse Owners Group (WOG) PWR. The Completion Time for Condition B in AP1000 Specification 3.5.1 is dependent on Conditions E and C of Specification 3.5.2. The WOG PWR Completion Time for Condition B in STS 3.5.1 is not dependent on Conditions of other Specifications. The Core Cooling System design for the AP1000 differs from that of the PWR design that was evaluated in WOG Topical Report WCAP-15049, "Risk-Informed Evaluation of an Extension to Accumulator Completion Times."

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)

Applicability statement is revised to correct the punctuation after "MODES 1 and 2." from a period to a comma.

V. Applicability

Affected Generic Technical Specifications and Bases:

Section 3.5.1 Accumulators

Changes to the Generic Technical Specifications and Bases:

Applicability statement is revised to correct punctuation.

Required Action B.1 Completion Time statement and the associated bases are revised. The first Completion Time is revised from "8 hours if Condition C or E of LCO 3.5.2 has not been entered" to "8 hours", the logical connector is changed from an "OR" to an "AND", and the second Completion Time is revised from "1 hour if Condition C and E of LCO 3.5.2 has been entered" to "1 hour from discovery of LCO 3.5.1 Condition B entry concurrent with LCO 3.5.2 Condition C or E entry." In addition, the order of the Completion Times is changed. (DOC A065)

SR 3.5.1.4, second Frequency is revised by removing the 3% modifier from the statement. (DOC D05)

SR 3.5.1.4 Bases is revised to include a correlation between the 3% value and 51 cu. ft. value. (DOC D05)

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

None

Rationale for TSTF changes:

None

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

VEGP LAR DOC A065 revises Required Action B.1 Completion Time statement and the associated bases. The first Completion Time is revised to "8 hours", the logical connector is changed to an "AND", and the second Completion Time is revised to "1 hour from discovery of LCO 3.5.1 Condition B entry concurrent with LCO 3.5.2 Condition C or E entry." In addition, the order of the Completion Times is changed to be consistent with the writers guide.

VEGP LAR DOC D05 revises the Frequency for SR 3.5.1.4 and associated bases. The second Frequency is revised by removing the 3% modifier from the statement. The bases is revised to provide a correlation of the 3% volume increase with the 51 cu. ft. associated with the Frequency for SR 3.5.1.4.

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

VEGP LAR DOC A065 changes to Required Action B.1 Completion Time provide clarity to the statement. Specifically changing the logical connector from an "OR" to an "AND" removes any implication that either Completion Time could be followed.

VEGP LAR DOC D05 change to the Frequency for SR 3.5.1.4 removes additional details and change to the associated bases provides a correlation between the 3 % value and 51 cu. ft. value. The 3.0% modifier is removed from the Frequency since the actual volume addition of 51 cu. ft. is provided in the Frequency of SR 3.5.1.4. The bases is revised to explain that 51 cu. ft. is 3% of the nominal borated water volume of 1700 cu. ft.

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

The Applicability statement is revised by changing the period after "MODES 1 and 2." to a comma.

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

The change to the Applicability statement is a correction to the punctuation.

VII. GTST Safety Evaluation**Technical Analysis:**

VEGP LAR DOC D05: The removal of the 3.0% modifier from the Frequency of SR 3.5.1.4 is made since the actual volume addition, 51 cu. ft., is already provided in the SR Frequency. The percent value is providing a calculation that is not referenced to anything specific, such as total volume or indicated volume. The revised SR 3.5.1.4 continues to include the specific value, 51 cu. ft., at which the SR is required to be performed if the solution volume is increased by this amount. The 3% modifier is stated in the Bases for SR 3.5.1.4. The bases is also revised to explain that 51 cu. ft. value is 3% of the nominal required borated water volume of 1700 cu. ft. Deleting this information from the TS is acceptable because this type of information is not necessary to be included in the TS in order to provide adequate protection of public health and safety.

Other 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.

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 Friday, May 23, 2014.

NRC Final Approval Date:

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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, Units 3 and 4, Technical Specifications Upgrade License Amendment Request, February 24, 2011 (ML12065A057).
3. 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).
4. TSTF-GG-05-01, "Writer's Guide for Plant-Specific Improved Technical Specifications," June 2005 (ML070660229).
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. 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).
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XI. MARKUP of the Applicable GTS Section 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.

3.5 PASSIVE CORE COOLING SYSTEM (PXS)

3.5.1 Accumulators

LCO 3.5.1 Both accumulators shall be OPERABLE.

APPLICABILITY: MODES 1 and 2,
 MODES 3 and 4 with Reactor Coolant System (RCS) pressure > 1000
 psig.

ACTIONS

| CONDITION | REQUIRED ACTION | COMPLETION TIME |
|--|---|---|
| A. One accumulator inoperable due to boron concentration outside limits. | A.1 Restore boron concentration to within limits. | 72 hours |
| B. One accumulator inoperable for reasons other than Condition A. | B.1 Restore accumulator to OPERABLE status. | <p>8 hours if Condition C or E of LCO 3.5.2 has not been entered</p> <p>OR</p> <p>1 hour from discovery of LCO 3.5.1 Condition B entry concurrent with LCO 3.5.2 Condition C or E entryif Condition C or E of LCO 3.5.2 has been entered</p> <p><u>AND</u></p> <p>8 hours</p> |

ACTIONS (continued)

| CONDITION | REQUIRED ACTION | COMPLETION TIME |
|--|--|-----------------|
| C. Required Action and associated Completion Time of Condition A or B not met. | C.1 Be in MODE 3. | 6 hours |
| | <u>AND</u> C.2 Reduce RCS pressure to \leq 1000 psig. | 12 hours |
| D. Two accumulators inoperable. | D.1 Enter LCO 3.0.3. | Immediately |

SURVEILLANCE REQUIREMENTS

| SURVEILLANCE | FREQUENCY |
|--|-----------|
| SR 3.5.1.1 Verify each accumulator isolation valve is fully open. | 12 hours |
| SR 3.5.1.2 Verify the borated water volume in each accumulator is \geq 1667 cu. ft., and \leq 1732 cu. ft. | 12 hours |
| SR 3.5.1.3 Verify the nitrogen cover gas pressure in each accumulator is \geq 637 psig and \leq 769 psig. | 12 hours |

SURVEILLANCE REQUIREMENTS (continued)

| SURVEILLANCE | | FREQUENCY |
|--------------|---|---|
| SR 3.5.1.4 | Verify the boron concentration in each accumulator is ≥ 2600 ppm and ≤ 2900 ppm. | 31 days <u>AND</u> -----NOTE----- Only required for affected accumulators. ----- Once within 6 hours after each solution volume increase of ≥ 51 cu. ft., 3.0% that is not the result of addition from the in-containment refueling water storage tank |
| SR 3.5.1.5 | Verify power is removed from each accumulator isolation valve operator when pressurizer pressure is ≥ 2000 psig. | 31 days |
| SR 3.5.1.6 | Verify system flow performance of each accumulator in accordance with the System Level OPERABILITY Testing Program. | 10 years |

B 3.5 PASSIVE CORE COOLING SYSTEM (PXS)

B 3.5.1 Accumulators

BASES

BACKGROUND Two redundant PXS accumulators provide sufficient water to the reactor vessel during the blowdown phase of a large-break loss-of-coolant accident (LOCA), to provide inventory to help accomplish the refill phase that follows thereafter, to provide Reactor Coolant System (RCS) makeup for a small-break LOCA, and to provide RCS boration for steam line breaks (Ref. 2).

The blowdown phase of a large break LOCA is the initial period of the transient during which the RCS departs from equilibrium conditions, and heat from fission product decay, hot internals, and the vessel continues to be transferred to the reactor coolant. The blowdown phase of the transient ends when the RCS pressure falls to a value approaching that of the containment atmosphere.

In the refill phase of a LOCA, which immediately follows the blowdown phase, reactor coolant inventory has vacated the core through steam flashing and ejection out through the break. The core is essentially in adiabatic heatup. The accumulator inventory is available to help fill voids in the lower plenum and reactor vessel downcomer so as to establish a recovery level at the bottom of the core and ongoing reflood of the core.

The accumulators are pressure vessels, partially filled with borated water and pressurized with nitrogen gas. The accumulators are passive components, since no operator or control actions are required for them to perform their function. Internal accumulator pressure is sufficient to discharge the accumulator contents to the RCS, if RCS pressure decreases below the static accumulator pressure.

Each accumulator is piped into the reactor vessel via an accumulator line and is isolated from the RCS by two check valves in series.

A normally open motor operated valve is arranged in series with the check valves. Upon initiation of a safeguards actuation signal, the normally open valves receive a confirmatory open signal.

Power lockout and position alarms ensure that the valves meet the requirements of the Institute of Electrical and Electronic Engineers (IEEE) Standard 603-1991 (Ref. 1) for "operating bypasses" and that the accumulators will be available for injection without being subject to a single failure.

BASES

BACKGROUND (continued)

The accumulator size, water volume, and nitrogen cover pressure are selected so that both of the accumulators are sufficient to recover the core cooling before significant clad melting or zirconium water reaction can occur following a large break LOCA. One accumulator is adequate during a small break LOCA where the entire contents of one accumulator can possibly be lost via the pipe break. This accumulator performance is based on design basis accident (DBA) assumptions and models (Ref. 3). The Probabilistic Risk Assessment (PRA) (Ref. 4) shows that one of the two accumulators is sufficient for a large break LOCA caused by spurious ADS actuation and that none of the accumulators are required for small break LOCAs, assuming that at least one core makeup tank (CMT) is available. In addition, both accumulators are required for a large break LOCA caused by the break of a cold leg pipe; the probability of this break has been significantly reduced by incorporation of leak-before-break.

**APPLICABLE
SAFETY
ANALYSES**

The accumulators are assumed to be OPERABLE in both the large and small break LOCA analyses at full power (Ref. 3) that establish the acceptance limits for the accumulators. Reference to the analyses for these DBAs is used to assess changes in the accumulators as they relate to the acceptance limits.

For a small break LOCA, a large range of break sizes and locations were analyzed to verify the adequacy of the design. The cases analyzed include the rupture of one 8 inch direct vessel injection line and several smaller break sizes. Acceptable PXS performance was demonstrated.

For a larger LOCA, including a double ended RCS piping rupture, the PXS can provide a sufficiently large flow rate, assuming both accumulators are OPERABLE, to quickly fill the reactor vessel lower plenum and downcomer. Both accumulators, in conjunction with the CMTs, ensure rapid reflooding of the core. For a large LOCA, both lines are available since an 8 inch line break would be a small LOCA.

Following a non-LOCA event such as a steam line break, the RCS experiences a decrease in temperature and pressure due to an increase in energy removal by the secondary system. The cooldown results in a reduction of the core SHUTDOWN MARGIN with a potential for return to power. During such an event the accumulators provide injection of borated water to assist the CMT's boration to mitigate the reactivity transient and ensure the core remains shut down.

BASES

APPLICABLE SAFETY ANALYSES (continued)

The accumulators satisfy Criterion 3 of 10 CFR 50.36(c)(2)(ii).

LCO

This LCO establishes the minimum conditions necessary to ensure that sufficient accumulator flow will be available to meet the necessary acceptance criteria established for core cooling by 10 CFR 50.46 (Ref. 5). These conditions are:

- a. Maximum fuel element cladding temperature is $\leq 2200^{\circ}\text{F}$;
- b. Maximum cladding oxidation is ≤ 0.17 times the total cladding thickness before oxidation;
- c. Maximum hydrogen generation from a zirconium-water reaction is ≤ 0.01 times the hypothetical amount that would be generated if all of the metal in the cladding cylinders surrounding the fuel, excluding the cladding surrounding the plenum volume, were to react; and
- d. The core is maintained in a coolable geometry.

Since the accumulators discharge during the blowdown phase of a LOCA, they do not contribute to the long term cooling requirements of 10 CFR 50.46.

For an accumulator to be OPERABLE, the isolation valve must be fully open with power removed, and the limits established in the Surveillance Requirements for contained water, boron concentration, and nitrogen cover pressure must be met.

APPLICABILITY

In MODES 1 and 2, and in MODES 3 and 4 with RCS pressure > 1000 psig, the accumulator OPERABILITY requirements are based on full power operation. Although cooling requirements decrease as power decreases, the accumulators are still required to provide core cooling as long as elevated RCS pressures and temperatures exist.

This LCO is only applicable at pressures > 1000 psig. At pressures ≤ 1000 psig, the rate of RCS blowdown is such that adequate injection flow from other sources exists to retain peak clad temperatures below the 10 CFR 50.46 limit of 2200°F .

BASES

APPLICABILITY (continued)

In MODES 3 and 4 with RCS pressure \leq 1000 psig, and in MODES 5 and 6, the accumulator motor operated isolation valves are closed to isolate the accumulators from the RCS. This allows the RCS cooldown and depressurization without discharging the accumulators into the RCS or requiring depressurization of the accumulators.

ACTIONSA.1

If the boron concentration of one accumulator is not within limits, action must be taken to restore the parameter.

Deviations in boron concentration are expected to be slight, considering that the pressure and volume are verified once per 12 hours. For one accumulator, boron concentration not within limits will have an insignificant effect on the ability of the accumulators to perform their safety function. Therefore, a Completion Time of 72 hours is considered to be acceptable.

B.1

If one accumulator is inoperable for a reason other than boron concentration, the accumulator must be returned to OPERABLE status within 8 hours. With one accumulator inoperable, the remaining accumulator is capable of providing the required safety function, except for one low probability event (large cold leg LOCA) discussed in the background section. The effectiveness of one accumulator is demonstrated in analysis performed to justify PRA success criteria (Ref. 4). The analysis contained in this reference shows that for a range of other events including small LOCAs and large hot leg LOCAs that with one accumulator unavailable the core is adequately cooled. The incremental conditional core damage probability with this AOT is more than an order of magnitude less than the value indicated to have a small impact on plant risk (Ref. 7).

The 8 hour Completion Time to open the valve, remove power to the valve, or restore the proper water volume or nitrogen cover pressure ensures that prompt action will be taken to return the inoperable accumulator to OPERABLE status. The Completion Time is reasonable since the CMTs are required to be available to provide small break LOCA

BASES

ACTIONS (continued)

mitigation (i.e., **concurrent** entry into Condition C or E of LCO 3.5.2 has not occurred). The effectiveness of backup CMT injection is demonstrated in analysis performed to justify PRA success criteria (Ref. 3). The analysis contained in this reference shows that for a small LOCA, the injection from one CMT without any accumulator injection supports adequate core cooling. This analysis provides a high confidence that with the unavailability of one accumulator, the core can be cooled following design bases accidents.

~~The 1 hour Completion Time, in the case with simultaneous entry into Condition C or E of LCO 3.5.2;~~ **If LCO 3.5.2 Condition C or E is also entered concurrent with this Condition, then a 1 hour Completion Time from discovery of LCO 3.5.1 Condition B entry concurrent with LCO 3.5.2 Condition C or E entry also applies. This 1 hour Completion Time** requires very prompt actions to restore either the accumulator or the CMT (**per LCO 3.5.2 Condition C or E**) to OPERABLE status. This Completion Time is considered reasonable because of the low probability of simultaneously entering these multiple PXS Conditions and the very small likelihood of a LOCA occurring at the same time.

C.1 and C.2

If the Required Action and associated Completion Time of Conditions A or B are not met, the plant must be placed in a MODE or condition in which the LCO does not apply. This is done by placing the plant in MODE 3 within 6 hours and with pressurizer pressure to ≤ 1000 psig within 12 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required plant conditions from full power conditions in an orderly manner and without challenging plant systems.

D.1

If more than one accumulator is inoperable, the plant is in a condition outside the accident analyses; therefore, LCO 3.0.3 must be entered immediately.

BASES

**SURVEILLANCE
REQUIREMENTS**SR 3.5.1.1

Each accumulator valve should be verified to be fully open every 12 hours. This verification ensures each accumulator isolation valve is fully open, as indicated in the control room, and timely discovery if a valve should be less than fully open. If an isolation valve is not fully open, the rate of injection to the RCS would be reduced. Although a motor operated valve position should not change with power removed, a partially closed valve could result in not meeting DBA analyses assumptions (Ref. 3). A 12 hour Frequency is considered reasonable in view of the other administrative controls which ensure that a mispositioned isolation valve is unlikely.

SR 3.5.1.2 and 3.5.1.3

Verification every 12 hours of the borated water volume and nitrogen cover pressure in each accumulator is sufficient to ensure adequate injection during a LOCA. Because of the static design of the accumulator, a 12 hour Frequency usually allows the operator to identify changes before limits are reached. Considering that control room alarms are provided for both parameters these limits are effectively subject to continuous monitoring. The 12 hour Frequency is considered reasonable considering the availability of the control room alarms and the likelihood that, with any deviation which may occur, the accumulators will perform their safety function with slight deviations in these parameters.

SR 3.5.1.4

The boron concentration should be verified to be within required limits for each accumulator every 31 days, since the static design of the accumulators limits the ways in which the concentration can be changed. The 31 day Frequency is adequate to identify changes that could occur from mechanisms such as in-leakage. Sampling the affected accumulator within 6 hours after a **51 cu. ft. (i.e., 3% of nominal required borated water volume of 1700 cu. ft.)** volume increase will promptly identify whether the volume change has caused a reduction of boron concentration to below the required limit. It is not necessary to verify boron concentration if the added water inventory is from the in-containment refueling water storage tank (IRWST), because the water contained in the IRWST is within the accumulator boron concentration requirements. This is consistent with the recommendation of NUREG-1366 (Ref. 6).

BASES

SURVEILLANCE REQUIREMENTS (continued)SR 3.5.1.5

Verification every 31 days that power is removed from each accumulator isolation valve operator when the pressurizer pressure is ≥ 2000 psig ensures that an active failure could not result in the undetected closure of an accumulator motor operated isolation valve. If this were to occur, reduced accumulator capacity might be available for injection following a DBA that required operation of the accumulators. Since power is removed under administrative control, the 31 day Frequency will provide adequate assurance that power is removed.

This SR allows power to be supplied to the motor operated isolation valves when pressurizer pressure is < 2000 psig, thus allowing operational flexibility by avoiding unnecessary delays to manipulate the breakers during unit startup or shutdowns.

Should closure of a valve occur, the safeguard actuation signal provided to the valve would open a closed valve, if required.

SR 3.5.1.6

This SR requires performance of a system performance test of each accumulator to verify flow capabilities. The system performance test demonstrates that the accumulator injection line resistance assumed in accident analyses is maintained. Although the likelihood that system performance would degrade with time is low, it is considered prudent to periodically verify system performance. The System Level Operability Testing Program provides specific test requirements and acceptance criteria.

REFERENCES

1. IEEE Standard 603-1991, "Criteria for Safety Systems for Nuclear Power Generating Stations."
2. Section 6.3 "Passive Core Cooling System."
3. Section 15.6 "Decrease in Reactor Coolant Inventory."
4. AP1000 PRA.

BASES

REFERENCES (continued)

5. 10 CFR 50.46.
 6. NUREG-1366, February 1990.
 7. Regulatory Guide 1.177, 8/98, "An Approach for Plant-Specific, Risk-Informed Decisionmaking: Technical Specifications."
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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.

3.5 PASSIVE CORE COOLING SYSTEM (PXS)

3.5.1 Accumulators

LCO 3.5.1 Both accumulators shall be OPERABLE.

APPLICABILITY: MODES 1 and 2,
MODES 3 and 4 with Reactor Coolant System (RCS) pressure > 1000
psig.

ACTIONS

| CONDITION | REQUIRED ACTION | COMPLETION TIME |
|--|---|--|
| A. One accumulator inoperable due to boron concentration outside limits. | A.1 Restore boron concentration to within limits. | 72 hours |
| B. One accumulator inoperable for reasons other than Condition A. | B.1 Restore accumulator to OPERABLE status. | 1 hour from discovery of LCO 3.5.1 Condition B entry concurrent with LCO 3.5.2 Condition C or E entry <u>AND</u> 8 hours |
| C. Required Action and associated Completion Time of Condition A or B not met. | C.1 Be in MODE 3. <u>AND</u> C.2 Reduce RCS pressure to \leq 1000 psig. | 6 hours 12 hours |
| D. Two accumulators inoperable. | D.1 Enter LCO 3.0.3. | Immediately |

SURVEILLANCE REQUIREMENTS

| SURVEILLANCE | | FREQUENCY |
|--------------|---|---|
| SR 3.5.1.1 | Verify each accumulator isolation valve is fully open. | 12 hours |
| SR 3.5.1.2 | Verify the borated water volume in each accumulator is ≥ 1667 cu. ft., and ≤ 1732 cu. ft. | 12 hours |
| SR 3.5.1.3 | Verify the nitrogen cover gas pressure in each accumulator is ≥ 637 psig and ≤ 769 psig. | 12 hours |
| SR 3.5.1.4 | Verify the boron concentration in each accumulator is ≥ 2600 ppm and ≤ 2900 ppm. | 31 days <u>AND</u> -----NOTE----- Only required for affected accumulators. ----- Once within 6 hours after each solution volume increase of ≥ 51 cu. ft., that is not the result of addition from the in-containment refueling water storage tank |
| SR 3.5.1.5 | Verify power is removed from each accumulator isolation valve operator when pressurizer pressure is ≥ 2000 psig. | 31 days |
| SR 3.5.1.6 | Verify system flow performance of each accumulator in accordance with the System Level OPERABILITY Testing Program. | 10 years |

B 3.5 PASSIVE CORE COOLING SYSTEM (PXS)

B 3.5.1 Accumulators

BASES

BACKGROUND Two redundant PXS accumulators provide sufficient water to the reactor vessel during the blowdown phase of a large-break loss-of-coolant accident (LOCA), to provide inventory to help accomplish the refill phase that follows thereafter, to provide Reactor Coolant System (RCS) makeup for a small-break LOCA, and to provide RCS boration for steam line breaks (Ref. 2).

The blowdown phase of a large break LOCA is the initial period of the transient during which the RCS departs from equilibrium conditions, and heat from fission product decay, hot internals, and the vessel continues to be transferred to the reactor coolant. The blowdown phase of the transient ends when the RCS pressure falls to a value approaching that of the containment atmosphere.

In the refill phase of a LOCA, which immediately follows the blowdown phase, reactor coolant inventory has vacated the core through steam flashing and ejection out through the break. The core is essentially in adiabatic heatup. The accumulator inventory is available to help fill voids in the lower plenum and reactor vessel downcomer so as to establish a recovery level at the bottom of the core and ongoing reflood of the core.

The accumulators are pressure vessels, partially filled with borated water and pressurized with nitrogen gas. The accumulators are passive components, since no operator or control actions are required for them to perform their function. Internal accumulator pressure is sufficient to discharge the accumulator contents to the RCS, if RCS pressure decreases below the static accumulator pressure.

Each accumulator is piped into the reactor vessel via an accumulator line and is isolated from the RCS by two check valves in series.

A normally open motor operated valve is arranged in series with the check valves. Upon initiation of a safeguards actuation signal, the normally open valves receive a confirmatory open signal.

Power lockout and position alarms ensure that the valves meet the requirements of the Institute of Electrical and Electronic Engineers (IEEE) Standard 603-1991 (Ref. 1) for "operating bypasses" and that the accumulators will be available for injection without being subject to a single failure.

BASES

BACKGROUND (continued)

The accumulator size, water volume, and nitrogen cover pressure are selected so that both of the accumulators are sufficient to recover the core cooling before significant clad melting or zirconium water reaction can occur following a large break LOCA. One accumulator is adequate during a small break LOCA where the entire contents of one accumulator can possibly be lost via the pipe break. This accumulator performance is based on design basis accident (DBA) assumptions and models (Ref. 3). The Probabilistic Risk Assessment (PRA) (Ref. 4) shows that one of the two accumulators is sufficient for a large break LOCA caused by spurious ADS actuation and that none of the accumulators are required for small break LOCAs, assuming that at least one core makeup tank (CMT) is available. In addition, both accumulators are required for a large break LOCA caused by the break of a cold leg pipe; the probability of this break has been significantly reduced by incorporation of leak-before-break.

**APPLICABLE
SAFETY
ANALYSES**

The accumulators are assumed to be OPERABLE in both the large and small break LOCA analyses at full power (Ref. 3) that establish the acceptance limits for the accumulators. Reference to the analyses for these DBAs is used to assess changes in the accumulators as they relate to the acceptance limits.

For a small break LOCA, a large range of break sizes and locations were analyzed to verify the adequacy of the design. The cases analyzed include the rupture of one 8 inch direct vessel injection line and several smaller break sizes. Acceptable PXS performance was demonstrated.

For a larger LOCA, including a double ended RCS piping rupture, the PXS can provide a sufficiently large flow rate, assuming both accumulators are OPERABLE, to quickly fill the reactor vessel lower plenum and downcomer. Both accumulators, in conjunction with the CMTs, ensure rapid reflooding of the core. For a large LOCA, both lines are available since an 8 inch line break would be a small LOCA.

Following a non-LOCA event such as a steam line break, the RCS experiences a decrease in temperature and pressure due to an increase in energy removal by the secondary system. The cooldown results in a reduction of the core SHUTDOWN MARGIN with a potential for return to power. During such an event the accumulators provide injection of borated water to assist the CMT's boration to mitigate the reactivity transient and ensure the core remains shut down.

BASES

APPLICABLE SAFETY ANALYSES (continued)

The accumulators satisfy Criterion 3 of 10 CFR 50.36(c)(2)(ii).

LCO

This LCO establishes the minimum conditions necessary to ensure that sufficient accumulator flow will be available to meet the necessary acceptance criteria established for core cooling by 10 CFR 50.46 (Ref. 5). These conditions are:

- a. Maximum fuel element cladding temperature is $\leq 2200^{\circ}\text{F}$;
- b. Maximum cladding oxidation is ≤ 0.17 times the total cladding thickness before oxidation;
- c. Maximum hydrogen generation from a zirconium-water reaction is ≤ 0.01 times the hypothetical amount that would be generated if all of the metal in the cladding cylinders surrounding the fuel, excluding the cladding surrounding the plenum volume, were to react; and
- d. The core is maintained in a coolable geometry.

Since the accumulators discharge during the blowdown phase of a LOCA, they do not contribute to the long term cooling requirements of 10 CFR 50.46.

For an accumulator to be OPERABLE, the isolation valve must be fully open with power removed, and the limits established in the Surveillance Requirements for contained water, boron concentration, and nitrogen cover pressure must be met.

APPLICABILITY

In MODES 1 and 2, and in MODES 3 and 4 with RCS pressure > 1000 psig, the accumulator OPERABILITY requirements are based on full power operation. Although cooling requirements decrease as power decreases, the accumulators are still required to provide core cooling as long as elevated RCS pressures and temperatures exist.

This LCO is only applicable at pressures > 1000 psig. At pressures ≤ 1000 psig, the rate of RCS blowdown is such that adequate injection flow from other sources exists to retain peak clad temperatures below the 10 CFR 50.46 limit of 2200°F .

BASES

APPLICABILITY (continued)

In MODES 3 and 4 with RCS pressure \leq 1000 psig, and in MODES 5 and 6, the accumulator motor operated isolation valves are closed to isolate the accumulators from the RCS. This allows the RCS cooldown and depressurization without discharging the accumulators into the RCS or requiring depressurization of the accumulators.

ACTIONS**A.1**

If the boron concentration of one accumulator is not within limits, action must be taken to restore the parameter.

Deviations in boron concentration are expected to be slight, considering that the pressure and volume are verified once per 12 hours. For one accumulator, boron concentration not within limits will have an insignificant effect on the ability of the accumulators to perform their safety function. Therefore, a Completion Time of 72 hours is considered to be acceptable.

B.1

If one accumulator is inoperable for a reason other than boron concentration, the accumulator must be returned to OPERABLE status within 8 hours. With one accumulator inoperable, the remaining accumulator is capable of providing the required safety function, except for one low probability event (large cold leg LOCA) discussed in the background section. The effectiveness of one accumulator is demonstrated in analysis performed to justify PRA success criteria (Ref. 4). The analysis contained in this reference shows that for a range of other events including small LOCAs and large hot leg LOCAs that with one accumulator unavailable the core is adequately cooled. The incremental conditional core damage probability with this AOT is more than an order of magnitude less than the value indicated to have a small impact on plant risk (Ref. 7).

The 8 hour Completion Time to open the valve, remove power to the valve, or restore the proper water volume or nitrogen cover pressure ensures that prompt action will be taken to return the inoperable accumulator to OPERABLE status. The Completion Time is reasonable since the CMTs are required to be available to provide small break LOCA

BASES

ACTIONS (continued)

mitigation (i.e., concurrent entry into Condition C or E of LCO 3.5.2 has not occurred). The effectiveness of backup CMT injection is demonstrated in analysis performed to justify PRA success criteria (Ref. 3). The analysis contained in this reference shows that for a small LOCA, the injection from one CMT without any accumulator injection supports adequate core cooling. This analysis provides a high confidence that with the unavailability of one accumulator, the core can be cooled following design bases accidents.

If LCO 3.5.2 Condition C or E is also entered concurrent with this Condition B, then a 1 hour Completion Time from discovery of LCO 3.5.1 Condition B entry concurrent with LCO 3.5.2 Condition C or E entry also applies. This 1 hour Completion Time requires very prompt actions to restore either the accumulator or the CMT (per LCO 3.5.2 Condition C or E) to OPERABLE status. This Completion Time is considered reasonable because of the low probability of simultaneously entering these multiple PXS Conditions and the very small likelihood of a LOCA occurring at the same time.

C.1 and C.2

If the Required Action and associated Completion Time of Conditions A or B are not met, the plant must be placed in a MODE or condition in which the LCO does not apply. This is done by placing the plant in MODE 3 within 6 hours and with pressurizer pressure to ≤ 1000 psig within 12 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required plant conditions from full power conditions in an orderly manner and without challenging plant systems.

D.1

If more than one accumulator is inoperable, the plant is in a condition outside the accident analyses; therefore, LCO 3.0.3 must be entered immediately.

BASES

**SURVEILLANCE
REQUIREMENTS**SR 3.5.1.1

Each accumulator valve should be verified to be fully open every 12 hours. This verification ensures each accumulator isolation valve is fully open, as indicated in the control room, and timely discovery if a valve should be less than fully open. If an isolation valve is not fully open, the rate of injection to the RCS would be reduced. Although a motor operated valve position should not change with power removed, a partially closed valve could result in not meeting DBA analyses assumptions (Ref. 3). A 12 hour Frequency is considered reasonable in view of the other administrative controls which ensure that a mispositioned isolation valve is unlikely.

SR 3.5.1.2 and 3.5.1.3

Verification every 12 hours of the borated water volume and nitrogen cover pressure in each accumulator is sufficient to ensure adequate injection during a LOCA. Because of the static design of the accumulator, a 12 hour Frequency usually allows the operator to identify changes before limits are reached. Considering that control room alarms are provided for both parameters these limits are effectively subject to continuous monitoring. The 12 hour Frequency is considered reasonable considering the availability of the control room alarms and the likelihood that, with any deviation which may occur, the accumulators will perform their safety function with slight deviations in these parameters.

SR 3.5.1.4

The boron concentration should be verified to be within required limits for each accumulator every 31 days, since the static design of the accumulators limits the ways in which the concentration can be changed. The 31 day Frequency is adequate to identify changes that could occur from mechanisms such as in-leakage. Sampling the affected accumulator within 6 hours after a 51 cu. ft. (i.e., 3% of nominal required borated water volume of 1700 cu. ft.) volume increase will promptly identify whether the volume change has caused a reduction of boron concentration to below the required limit. It is not necessary to verify boron concentration if the added water inventory is from the in-containment refueling water storage tank (IRWST), because the water contained in the IRWST is within the accumulator boron concentration requirements. This is consistent with the recommendation of NUREG-1366 (Ref. 6).

BASES

SURVEILLANCE REQUIREMENTS (continued)SR 3.5.1.5

Verification every 31 days that power is removed from each accumulator isolation valve operator when the pressurizer pressure is ≥ 2000 psig ensures that an active failure could not result in the undetected closure of an accumulator motor operated isolation valve. If this were to occur, reduced accumulator capacity might be available for injection following a DBA that required operation of the accumulators. Since power is removed under administrative control, the 31 day Frequency will provide adequate assurance that power is removed.

This SR allows power to be supplied to the motor operated isolation valves when pressurizer pressure is < 2000 psig, thus allowing operational flexibility by avoiding unnecessary delays to manipulate the breakers during unit startup or shutdowns.

Should closure of a valve occur, the safeguard actuation signal provided to the valve would open a closed valve, if required.

SR 3.5.1.6

This SR requires performance of a system performance test of each accumulator to verify flow capabilities. The system performance test demonstrates that the accumulator injection line resistance assumed in accident analyses is maintained. Although the likelihood that system performance would degrade with time is low, it is considered prudent to periodically verify system performance. The System Level Operability Testing Program provides specific test requirements and acceptance criteria.

REFERENCES

1. IEEE Standard 603-1991, "Criteria for Safety Systems for Nuclear Power Generating Stations."
2. Section 6.3 "Passive Core Cooling System."
3. Section 15.6 "Decrease in Reactor Coolant Inventory."
4. AP1000 PRA.

BASES

REFERENCES (continued)

5. 10 CFR 50.46.
 6. NUREG-1366, February 1990.
 7. Regulatory Guide 1.177, 8/98, "An Approach for Plant-Specific, Risk-Informed Decisionmaking: Technical Specifications."
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