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Our ref: DCP_NRC_002993

August 2, 2010

Subject: AP1000 Response to Request for Additional Information (SRP 23)

Westinghouse is submitting a response to the NRC request for additional information (RAI) on SRP Section 23. This RAI response is submitted in support of the AP1000 Design Certification Amendment Application (Docket No. 52-006). The information included in this response is generic and is expected to apply to all COL applications referencing the AP1000 Design Certification and the AP1000 Design Certification Amendment Application.

Enclosure 1 provides the response for the following RAI(s):

RAI-DCP-CN66-CTSB-05

Questions or requests for additional information related to the content and preparation of this response should be directed to Westinghouse. Please send copies of such questions or requests to the prospective applicants for combined licenses referencing the AP1000 Design Certification. A representative for each applicant is included on the cc: list of this letter.

Very truly yours,

for/ John J. DeBlasio

Robert Sisk, Manager
Licensing and Customer Interface
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/Enclosure

1. Response to Request for Additional Information on SRP Section 23

D066
NRO

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ENCLOSURE 1

Response to Request for Additional Information on SRP Section 23

RAI Response Number: RAI-DCP-CN66-CTSB-05
Revision: 0

***Question:***

The NRC has completed its review of the final information on proposed changes for the AP1000 Design Control Document (DCD), Revision 18, dated May 25, 2010. Based on a review of the information that was provided, additional information is needed to address the following considerations related to change number 66:

1. LCO 3.5.6, IRWST – Operating

   This LCO requires two IRWST injection flow paths to be operable, each with two redundant actuation paths when the plant is in Modes 1 through 4. During a loss of coolant accident (LOCA) event, flow in one injection path is assumed to go to the break.

   Two new Conditions B and C are added to address accumulation of noncondensible gases in each of the four IRWST actuation paths (high points at the squib valve outlet piping). For Condition C with one IRWST injection line inoperable due to presence of noncondensible gases in both parallel actuation paths, a completion time of 24 hours is allowed for venting activities. This condition appears to indicate the potential for loss of safety function and the STS suggests a CT of 8 hours for such a condition. The staff requests Westinghouse to provide further justifications in the TS Bases B 3.5.6 for the proposed CT of 24 hours or revise the TS 3.5.6 and its associated bases to reflect a justifiable completion time.

2. LCO 3.5.7, IRWST – Shutdown, MODE 5

   This LCO requires one IRWST injection flow path to be operable with two redundant actuation paths when the plant is in Mode 5. A LOCA is not postulated for plant shutdown events.

   Two new Conditions B and C are added to address accumulation of noncondensible gases in each of the two required IRWST actuation paths (high points at the squib valve outlet piping). For Condition B with the required IRWST injection line inoperable due to presence of noncondensible gases in one parallel actuation path, a completion time of 24 hours is allowed for venting activities. In this condition, the safety function of the IRWST is maintained with no consideration for an active single failure during any plant shutdown event and the STS suggests a CT of 72 hours. The staff requests Westinghouse to provide further clarifications for consistency with a similar Condition B proposed in LCO 3.5.6.

3. LCO 3.5.8, IRWST – Shutdown, MODE 6

   The staff requests Westinghouse to provide additional clarifications, as described in item 2 above, for LCO 3.5.8.

4. The staff notes the following items which appear to be editorial errors that require correction:

   - Page B 3.5.6-3, in APPLICABILITY Section, First paragraph, Second sentence: "In MODES 1, 2, 3, 4, and 5" should be "In MODES 1, 2, 3, and 4".

- Page B 3.5.6-5, in ACTIONS Section, Subheading F.1 and F.2, First sentence: "for reasons other than Conditions A, B, or C" should be "for reasons other than Conditions A, B, C, D, or E".

- Page B 3.5.7-3, in ACTIONS Section, Subheading F.1 and F.2, First sentence: "for reasons other than Conditions A, B, or C" should be "for reasons other than Conditions A, B, C, D, or E".

- Page B 3.5.8-3, in ACTIONS Section, Subheading F.1 and F.2, First sentence: "for reasons other than Conditions A, B, C, or D" should be "for reasons other than Conditions A, B, C, D, or E".

The staff requests Westinghouse to correct the apparent errors identified above, or justify why no correction is necessary.

**Westinghouse Response:**

1. LCO 3.5.6, IRWST – Operating

   The Action C.1 Completion Time has been changed from 24 to 8 hours.

   The Action C.1 Bases discussion has been expanded to provide additional justification of the 8-hour Completion Time and to address the mitigation of a break in the DVI line connected to the OPERABLE injection line by the injection line with gas accumulation.

   The 8-hour Completion Time is based on the OPERABILITY of the other injection line, a conservative gas volume limit that permits additional accumulation prior to significantly affecting the injection flow and the slow rate of gas accumulation. The 8-hour time is necessary to permit containment entry for gas venting.

   In the event of a break in the DVI line connected to the OPERABLE injection line, the injection line with gas accumulation will be capable of providing the required injection flow with some voiding.

   The Action C.1 Completion Time and Bases changes are included in the attached specification and Bases markups.

2. LCO 3.5.7, IRWST – Shutdown, MODE 5, and
3. LCO 3.5.8, IRWST – Shutdown, MODE 6

   Westinghouse agrees that a 72-hour Completion Time for Condition B in both LCO 3.5.7 and LCO 3.5.8 is consistent with Condition B of LCO 3.5.6 and similar STS Conditions in which one ECCS train is inoperable.

   The LCO 3.5.7 and 3.5.8 Condition B Completion Times have been changed from 24 hours to 72 hours as shown in the attached specification and Bases markups.

4. Editorial Errors

   The noted errors have been corrected in the attached markups.

**Design Control Document (DCD) Revision:**

Markups of the affected DCD Chapter 16.1 Technical Specifications are attached.

**PRA Revision:**
None

**Technical Report (TR) Revision:**
None

3.5 PASSIVE CORE COOLING SYSTEM (PXS)

3.5.6 In-containment Refueling Water Storage Tank (IRWST) – Operating

LCO 3.5.6 The IRWST, with two injection flow paths and two containment recirculation flow paths, shall be OPERABLE.

APPLICABILITY: MODES 1, 2, 3, and 4.

ACTIONS

| CONDITION | REQUIRED ACTION | COMPLETION TIME |
|---|---|---|
| A. One IRWST injection line actuation valve flow path inoperable.<br><br>OR<br><br>One containment recirculation line actuation valve flow path inoperable. | A.1 Restore the inoperable actuation valve flow path to OPERABLE status. | 72 hours |
| B. One IRWST injection line inoperable due to presence of noncondensible gases in one high point vent. | B.1 Vent noncondensible gases. | 72 hours |
| C. One IRWST injection line inoperable due to presence of noncondensible gases in both high point vents. | C.1 Vent noncondensible gases from one high point vent. | 8 hours |
| D. IRWST boron concentration not within limits.<br><br>OR<br><br>IRWST borated water temperature not within limits.<br><br>OR | D.1 Restore IRWST to OPERABLE status. | 8 hours |

ACTIONS (continued)

| CONDITION | REQUIRED ACTION | COMPLETION TIME |
|---|---|---|
| IRWST borated water volume < 100% and > 97% of limit. | | |
| E. One motor operated IRWST isolation valve not fully open.<br><br>OR<br><br>Power is not removed from one or more motor operated IRWST isolation valves. | E.1 Restore motor operated IRWST isolation valve to fully open condition with power removed from both valves. | 1 hour |
| F. Required Action and associated Completion Time not met.<br><br>OR<br><br>LCO not met for reasons other than A, B, C, D, or E. | F.1 Be in MODE 3.<br><br>AND<br><br>F.2 Be in MODE 5. | 6 hours<br><br><br>36 hours |

SURVEILLANCE REQUIREMENTS

| SURVEILLANCE | | FREQUENCY |
|---|---|---|
| SR 3.5.6.1 | Verify the IRWST water temperature is < 120°F. | 24 hours |
| SR 3.5.6.2 | Verify the IRWST borated water volume is > 73,100 cu. ft. | 24 hours |
| SR 3.5.6.3 | Verify the volume of noncondensible gases in each of the four IRWST injection squib valve outlet line pipe stubs is $\leq 0.2\ ft^3$. | 24 hours |

SURVEILLANCE REQUIREMENTS (continued)

| SURVEILLANCE | | FREQUENCY |
|---|---|---|
| SR 3.5.6.4 | Verify the IRWST boron concentration is ≥2600 ppm and ≤2900 ppm. | 31 days<br><br>AND<br><br>Once within 6 hours after each solution volume increase of 15,000 gal |
| SR 3.5.6.5 | Verify each motor operated IRWST isolation valve is fully open. | 12 hours |
| SR 3.5.6.6 | Verify power is removed from each motor operated IRWST isolation valve. | 31 days |
| SR 3.5.6.7 | Verify each motor operated containment recirculation isolation valve is fully open. | 31 days |
| SR 3.5.6.8 | Verify each IRWST injection and containment recirculation squib valve is OPERABLE in accordance with the Inservice Testing Program. | In accordance with the Inservice Testing Program |
| SR 3.5.6.9 | Verify by visual inspection that the IRWST screens and the containment recirculation screens are not restricted by debris. | 24 months |
| SR 3.5.6.10 | Verify IRWST injection and recirculation system flow performance in accordance with the System Level OPERABILITY Testing Program. | 10 years |

3.5 PASSIVE CORE COOLING SYSTEM (PXS)

3.5.7 In-containment Refueling Water Storage Tank (IRWST) – Shutdown, MODE 5

LCO 3.5.7 The IRWST, with one injection flow path and one containment recirculation flow path, shall be OPERABLE.

APPLICABILITY: MODE 5.

ACTIONS

| CONDITION | REQUIRED ACTION | COMPLETION TIME |
|---|---|---|
| A. Required motor operated containment recirculation isolation valve not fully open. | A.1 Open required motor operated containment recirculation isolation valve. | 72 hours |
| B. Required IRWST injection line inoperable due to presence of noncondensible gases in one high point vent. | B.1 Vent noncondensible gases. | 72 hours |
| C. Required IRWST injection line inoperable due to presence of noncondensible gases in both high point vents. | C.1 Vent noncondensible gases from one high point vent. | 8 hours |
| D. IRWST boron concentration not within limits.<br><br>OR<br><br>IRWST borated water temperature not within limits.<br><br>OR<br><br>IRWST borated water volume < 100% and > 97% of limit. | D.1 Restore IRWST to OPERABLE status. | 8 hours |

ACTIONS (continued)

| CONDITION | REQUIRED ACTION | COMPLETION TIME |
|---|---|---|
| E. Required motor operated IRWST isolation valve not fully open.<br><br>OR<br><br>Power is not removed from required motor operated IRWST isolation valve. | E.1 Restore required motor operated IRWST isolation valve to fully open condition with power removed. | 1 hour |
| F. Required Action and associated Completion Time not met.<br><br>OR<br><br>LCO not met for reasons other than A, B, C, D, or E. | F.1 Initiate action to be in MODE 5 with the RCS pressure boundary intact and ≥20% pressurizer level.<br><br>AND<br><br>F.2 Suspend positive reactivity additions. | Immediately<br><br><br><br><br><br>Immediately |

SURVEILLANCE REQUIREMENTS

| SURVEILLANCE | | FREQUENCY |
|---|---|---|
| SR 3.5.7.1 | For the IRWST and flow paths required to be OPERABLE, the SRs of Specification 3.5.6, "In-containment Refueling Water Storage Tank (IRWST) – Operating" are applicable. | In accordance with applicable SRs |

3.5 PASSIVE CORE COOLING SYSTEM (PXS)

3.5.8 In-containment Refueling Water Storage Tank (IRWST) – Shutdown, MODE 6

LCO 3.5.8 The IRWST, with one injection flow path and one containment recirculation flow path, shall be OPERABLE.

APPLICABILITY: MODE 6.

ACTIONS

| CONDITION | REQUIRED ACTION | COMPLETION TIME |
|---|---|---|
| A. Required motor operated containment recirculation isolation valve not fully open. | A.1 Open required motor operated containment recirculation isolation valve. | 72 hours |
| B. Required IRWST injection line inoperable due to presence of noncondensible gases in one high point vent. | B.1 Vent noncondensible gases. | 72 hours |
| C. Required IRWST injection line inoperable due to presence of noncondensible gases in both high point vents. | C.1 Vent noncondensible gases from one high point vent. | 8 hours |
| D. IRWST and refueling cavity boron concentration not within limits.<br><br>OR<br><br>IRWST and refueling cavity borated water temperature not within limits.<br><br>OR<br><br>IRWST and refueling cavity borated water volume < 100% and > 97% of limit. | D.1 Restore IRWST to OPERABLE status. | 8 hours |

ACTIONS (continued)

| CONDITION | REQUIRED ACTION | COMPLETION TIME |
|---|---|---|
| E. Required motor operated IRWST isolation valve not fully open.<br><br>OR<br><br>Power is not removed from required motor operated IRWST isolation valve. | E.1 Restore required motor operated IRWST isolation valve to fully open condition with power removed. | 1 hour |
| F. Required Action and associated Completion Time not met.<br><br>OR<br><br>LCO not met for reasons other than A, B, C, D, or E. | F.1 Initiate action to be in MODE 6 with the water level ≥23 feet above the top of the reactor vessel flange.<br><br>AND<br><br>F.2 Suspend positive reactivity additions. | Immediately<br><br><br><br><br><br>Immediately |

SURVEILLANCE REQUIREMENTS

| SURVEILLANCE | | FREQUENCY |
|---|---|---|
| SR 3.5.8.1 | Verify the IRWST and refueling cavity water temperature is < 120°F. | 24 hours |
| SR 3.5.8.2 | Verify the IRWST and refueling cavity water total borated water volume is > 73,100 cu. ft. | 24 hours |
| SR 3.5.8.3 | Verify the IRWST and refueling cavity boron concentration is ≥2600 ppm and ≤2900 ppm. | 31 days<br><br>AND<br><br>Once within 6 hours after each solution volume increase of 15,000 gal |

SURVEILLANCE REQUIREMENTS (continued)

| SURVEILLANCE | | FREQUENCY |
|---|---|---|
| SR 3.5.8.4 | For the IRWST and flow paths required to be OPERABLE, the following SRs of Specification 3.5.6, "In-containment Refueling Water Storage Tank (IRWST) – Operating" are applicable:<br><br>SR 3.5.6.3 SR 3.5.6.6 SR 3.5.6.8 SR 3.5.6.10<br>SR 3.5.6.5 SR 3.5.6.7 SR 3.5.6.9 | In accordance with applicable SRs |

B 3.5 PASSIVE CORE COOLING SYSTEM (PXS)
B 3.5.6 In-containment Refueling Water Storage Tank (IRWST) – Operating

BASES

| | |
|---|---|
| BACKGROUND | The IRWST is a large stainless steel lined tank filled with borated water (Ref. 1). It is located below the operating deck in containment. The tank is designed to meet seismic Category 1 requirements. The floor of the IRWST is elevated above the reactor coolant loop so that borated water can drain by gravity into the Reactor Coolant System (RCS). The IRWST is maintained at ambient containment pressure.<br>The IRWST has two injection flow paths. The injection paths are connected to the reactor vessel through two direct vessel injection lines which are also used by the accumulators and the core makeup tanks. Each path includes an injection flow path and a containment recirculation flow path. Each injection path includes a normally open motor operated isolation valve and two parallel actuation lines each isolated by one check valve and one squib valve in series.<br>The IRWST has two containment recirculation flow paths. Each containment recirculation path contains two parallel actuation flow paths, one path is isolated by a normally open motor operated valve in series with a squib valve and one path is isolated by a check valve in series with a squib valve.<br>During refueling operations, the IRWST is used to flood the refueling cavity.<br>During abnormal events, the IRWST serves as a heat sink for the passive residual heat removal heat exchangers, as a heat sink for the depressurization spargers,.and as a source of low head (ambient containment pressure) safety injection during loss of coolant accidents (LOCAs) and loss of decay heat removal in MODE 5 (loops not filled). The IRWST can be cooled by the Normal Residual Heat Removal System (RNS) system.<br>The IRWST size and injection capability is selected to provide adequate core cooling for the limiting Design Basis Accidents (DBAs) (Ref. 2). |
| APPLICABLE SAFETY ANALYSES | During non-LOCA events, the IRWST serves as the initial heat sink for the PRHR Heat Exchanger (PRHR HX) if used during reactor cooldown to MODE 4. If RNS is available, it will be actuated in MODE 4 and used to continue the plant cooldown to MODE 5. If RNS is not available, cooldown can continue on PRHR. Continued PRHR HX operation will result in the water in the IRWST heating up to saturation conditions and |

BASES

APPLICABLE SAFETY ANALYSES (continued)

boiling. The steam generated in the IRWST enters the containment through the IRWST vents. Most of the steam generated in the IRWST condenses on the inside of the containment vessel and drains back to the IRWST.

For events which involve a loss of primary coolant inventory, such as a large break LOCA, or other events involving automatic depressurization, the IRWST provides low pressure safety injection (Ref. 2). The IRWST drain down time is dependent on several factors, including break size, location, and the return of steam condensate from the passive containment cooling system. During drain down, when the water in the IRWST reaches the Low 5 level, the containment sump will be sufficiently flooded, to initiate containment sump recirculation. This permits continued cooling of the core by recirculation of the spilled water in the containment sumps via the sump recirculation flow paths. In this situation, core cooling can continue indefinitely.

When the plant is in midloop operation, the pressurizer Automatic Depressurization System (ADS) valves are open, and the RNS is used to cool the RCS. The RNS is not a safety related system, so its failure must be considered. In this situation, with the RCS drained and the pressure boundary open, the PRHR HX cannot be used. In such a case, core cooling is provided by gravity injection from the IRWST, venting the RCS through the ADS. Injection from the IRWST provides core cooling until the tank empties and gravity recirculation from the containment starts. With the containment closed, the recirculation can continue indefinitely, with the decay heat generated steam condensing on the containment vessel and draining back into the IRWST.

The IRWST satisfies Criteria 2 and 3 of 10 CFR 50.36(c)(2)(ii).

LCO

The IRWST requirements ensure that an adequate supply of borated water is available to act as a heat sink for PRHR and to supply the required volume of borated water as safety injection for core cooling and reactivity control.

To be considered OPERABLE, the IRWST must meet the water volume, boron concentration, and temperature limits defined in the surveillance requirements. The motor operated injection isolation valves must be open with power removed, and the motor operated sump recirculation isolation valves must be open. The absence of noncondensible gases in the high point vents is necessary for system OPERABILITY.

BASES

APPLICABILITY

In MODES 1, 2, 3, and 4, a safety related function of the IRWST is to provide a heat sink for PRHR. In MODES 1, 2, 3, and 4, a second safety related function is the low head safety injection of borated water following a LOCA for core cooling and reactivity control. Both of these functions must be available to meet the initial assumptions of the safety analyses. These assumptions require the specified boron concentration, the minimum water volume, and the maximum water temperature.

The requirements for the IRWST in MODES 5 and 6 are specified in LCO 3.5.7, In-containment Refueling Water Storage Tank (IRWST) – Shutdown, MODE 5 and LCO 3.5.8, In-containment Refueling Water Storage Tank (IRWST) – Shutdown, MODE 6.

ACTIONS

A.1

If an IRWST injection line actuation valve flow path or a containment recirculation line actuation valve flow path is inoperable, then the valve actuation flow path must be restored to OPERABLE status within 72 hours. In this condition, three other IRWST injection or containment sump recirculation flow paths are available and can provide 100% of the required flow assuming a break in the direct vessel injection line associated with the other injection train, but with no single failure of the actuation valve flow path in the same injection or sump recirculation flow path. The 72 hour Completion Time is consistent with times normally applied to degraded two train ECCS systems which can provide 100% of the required flow without a single failure.

B.1

Excessive amounts of noncondensible gases in one of the high point vents in one IRWST injection line may interfere with the passive injection of IRWST water into the reactor vessel from the associated parallel flow path in the affected injection line. Analyses have shown that with enough noncondensible gas accumulation, IRWST injection through the affected flow path could be delayed. However, the presence of some noncondensible gases does not mean that the IRWST injection capability is immediately inoperable, but that gases are collecting and should be vented. The venting of these gases requires containment entry to manually operate the vent valves. In this Condition, the parallel flow path in the affected injection line is capable of providing 100% of the required injection flow and the other IRWST injection line remains fully OPERABLE. These IRWST flow paths can provide the credited flow in the event of a DVI line break downstream of the fully OPERABLE injection line, provided a single failure of the remaining parallel isolation

ACTIONS (continued)

valve does not occur. A Completion Time of 72 hours is acceptable for two train ECCS systems, which are capable of performing their safety function without a single failure.

C.1

Excessive amounts of noncondensible gases in both of the high point vents in one IRWST injection line may affect the passive injection of IRWST water into the reactor vessel from the affected injection line. Sufficient gas accumulation could potentially challenge IRWST injection capability. However, the presence of some noncondensible gases does not immediately render the IRWST injection capability inoperable, but that gases are collecting and should be vented.

The specified gas volume limit ($\leq 0.2$ ft$^3$) has been established to permit additional gas accumulation before injection flow is significantly affected, so that adequate time may be provided to permit containment entry for venting the gas. Anticipated noncondensible gas accumulation in this piping segment is expected to be relatively slow.

In this Condition the remaining OPERABLE IRWST injection line is capable of performing the safety function, except for the one specific event of a direct vessel injection (DVI) line break. In this case, the line with gas accumulation in both high point vents will be capable of performing the safety function with a small amount of voiding that is not expected to significantly challenge the required injection flow.

The venting of these gases requires containment entry to manually operate the vent valves. Considering the relatively slow rate of gas accumulation, venting within 8 hours should normally prevent accumulation of amounts of noncondensible gases that could significantly challenge IRWST injection capability. A Completion Time of 8 hours is permitted for venting noncondensible gases and is acceptable, since the injection capability of the other IRWST injection line is sufficient to ensure event mitigation, or, in the event of a break in the DVI line connected to the OPERABLE injection line, the injection line with gas accumulation will be capable of providing the required injection flow with some voiding. If only one of the affected high point vents is vented, then Condition B will apply to the remaining high point vent with noncondensible gas accumulation.

D.1

If the IRWST water volume, boron concentration, or temperature are not within limits, the core cooling capability from injection or PRHR HX heat transfer and the reactivity benefit of injection assumed in safety analyses may not be available. Due to the large volume of the IRWST, online monitoring of volume and temperature, and frequent surveillances, the deviation of these parameters is expected to be minor. The allowable deviation of the water volume is limited to 3%. This limit prevents a significant change in boron concentration and is consistent with the long-term cooling analysis performed to justify PRA success criteria (Ref. 3), which assumed multiple failures with as many as 3 CMTs/Accum not injecting. This analysis shows that there is significant margin with respect to the water supplies that support containment recirculation operation. The 8-hour Completion Time is acceptable, considering that the IRWST will be fully capable of performing its assumed safety function in response to DBAs with slight deviations in these parameters.

ACTIONS (continued)

E.1
If the motor operated IRWST isolation valves are not fully open or valve power is not removed, injection flow from the IRWST may be less than assumed in the safety analysis. In this situation, the valves must be restored to fully open with valve power removed in 1 hour. This Completion Time is acceptable based on risk considerations.

F.1 and F.2
If the IRWST cannot be returned to OPERABLE status within the associated Completion Times or the LCO is not met for reasons other than Conditions A, B, C, D, or E, the plant must be brought to a MODE in which the LCO does not apply. To achieve this status, the plant must be brought to at least MODE 3 within 6 hours and to MODE 5 within 36 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.

SURVEILLANCE REQUIREMENTS

SR 3.5.6.1
The IRWST borated water temperature must be verified every 24 hours to ensure that the temperature is within the limit assumed in the accident analysis. This Frequency is sufficient to identify a temperature change that would approach the limit and has been shown to be acceptable through operating experience.

SR 3.5.6.2
Verification every 24 hours that the IRWST borated water volume is above the required minimum level will ensure that a sufficient initial supply is available for safety injection and floodup volume for recirculation and as the heat sink for PRHR. During shutdown with the refueling cavity flooded with water from the IRWST, this Surveillance requires that the combined volume of borated water in the IRWST and refueling cavity meet the specified limit. Since the IRWST volume is normally stable, and is monitored by redundant main control indication and alarm, a 24 hour Frequency is appropriate.

SURVEILLANCE REQUIREMENTS (continued)

SR 3.5.6.3
Verification that excessive amounts of noncondensible gases are not present in the four IRWST injection line squib valve lines is required every 24 hours. The 8x8x8 inch tee after the outlet of the IRWST injection line squib valve lines has a vertical section of pipe which serves as a high point collection point for noncondensible gases. Control room indication of the water level in this high point collection point is available to verify that noncondensible gases have not collected to the extent that the water level is depressed below the allowable level. The 24 hour Frequency is based on the expected low rate of gas accumulation and the availability of control room indication.

SR 3.5.6.4
Verification every 31 days that the boron concentration of the IRWST is greater than the required limit, ensures that the reactor will remain subcritical following a LOCA. Since the IRWST volume is large and normally stable, the 31 day Frequency is acceptable, considering additional verifications are required within 6 hours after each solution volume increase of 15,000 gal. In addition, the relatively frequent surveillance of the IRWST water volume provides assurance that the IRWST boron concentration is not changed.

SR 3.5.6.5
This surveillance requires verification that each motor operated isolation valve is fully open. This surveillance may be performed with available remote position indication instrumentation. The 12 hour Frequency is acceptable, considering the redundant remote indication and alarms and that power is removed from the valve operator.

SR 3.5.6.6
Verification is required to confirm that power is removed from each motor operated IRWST isolation valve each 31 days. Removal of power from these valves reduces the likelihood that the valves will be inadvertently closed. The 31 day Frequency is acceptable considering frequent surveillance of valve position and that the valve has a confirmatory open signal.

SR 3.5.6.7
Each motor operated containment recirculation isolation valve must be verified to be fully open. This valve is required to be open to improve containment recirculation reliability. The 31 day Frequency is acceptable

SURVEILLANCE REQUIREMENTS (continued)

considering the valve has a confirmatory open signal. This surveillance may be performed with available remote position indication instrumentation.

SR 3.5.6.8

This Surveillance requires verification that each IRWST injection and each containment recirculation squib valve is OPERABLE in accordance with the Inservice Testing Program. The Surveillance Frequency for verifying valve OPERABILITY references the Inservice Testing Program.

The squib valves will be tested in accordance with the ASME OM Code. The applicable ASME OM Code squib valve requirements are specified in paragraph 4.6, Inservice Tests for Category D Explosively Actuated Valves. The requirements include actuation of a sample of the installed valves each 2 years and periodic replacement of charges.

SR 3.5.6.9

Visual inspection is required each 24 months to verify that the IRWST screens and the containment recirculation screens are not restricted by debris. A Frequency of 24 months is adequate, since there are no known sources of debris with which the gutters could become restricted.

SR 3.5.6.10

This SR requires performance of a system inspection and performance test of the IRWST injection and recirculation flow paths to verify system flow capabilities. The system inspection and performance test demonstrates that the IRWST injection and recirculation capabilities 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. Section 6.3, "Passive Core Cooling."
2. Section 15.6, "Decrease in Reactor Coolant Inventory."
3. AP1000 PRA.

B 3.5 PASSIVE CORE COOLING SYSTEM (PXS)
B 3.5.7 In-containment Refueling Water Storage Tank (IRWST) – Shutdown, MODE 5

BASES

| | |
|---|---|
| BACKGROUND | A description of the IRWST is provided in LCO 3.5.6, "In-containment Refueling Water Storage Tank – Operating." |
| APPLICABLE SAFETY ANALYSES | For postulated shutdown events in MODE 5 with the Reactor Coolant System (RCS) pressure boundary intact, the primary protection is Passive Residual Heat Removal (PRHR), where the IRWST serves as the initial heat sink for the PRHR heat exchanger (PRHR HX). For events in MODE 5 with the RCS pressure boundary open, PRHR is not available and RCS heat removal is provided by IRWST injection and containment sump recirculation.<br><br>IRWST injection could be required to mitigate some events by providing RCS inventory makeup.<br><br>No loss of coolant accidents (LOCAs) are postulated during plant operation in MODE 5; therefore, the rupture of the direct vessel injection line (DVI) is not assumed. Since the DVI rupture is not assumed, only one train of IRWST injection and recirculation flow paths is required to mitigation postulated events, assuming a single failure.<br><br>The IRWST satisfies Criteria 2 and 3 of 10 CFR 50.36(c)(2)(ii). |
| LCO | The IRWST requirements ensure that an adequate supply of borated water is available to act as a heat sink for PRHR and to supply the required volume of borated water as safety injection for core cooling and reactivity control.<br><br>To be considered OPERABLE, the IRWST must meet the water volume, boron concentration, and temperature limits defined in the Surveillance Requirements, and one path of injection and recirculation must be OPERABLE (the motor operated injection isolation valve must be open with power removed, and the motor operated sump recirculation isolation valves must be open). The absence of noncondensible gases in the high point vents is necessary for system OPERABILITY. |
| APPLICABILITY | In MODE 5 with the RCS pressure boundary intact or with the RCS open with pressurizer level ≥20%, the IRWST is an RCS injection source of borated water for core cooling and reactivity control. Additionally, in MODE 5 with the RCS pressure boundary intact, the IRWST provides the heat sink for PRHR. |

BASES

APPLICABILITY (continued)

The requirements for the IRWST in MODES 1, 2, 3, and 4 are specified in LCO 3.5.6, In-containment Refueling Water Storage Tank (IRWST) – Operating. The requirements for the IRWST in MODE 6 are specified in LCO 3.5.8, In-

containment Refueling Water Storage Tank (IRWST) – Shutdown, MODE 6.

ACTIONS

A.1

If a motor operated containment sump isolation valve in the required sump recirculation flow path is not fully open, the valve must be fully opened within 72 hours. The 72 hour Completion Time is consistent with times normally applied to degraded two train ECCS systems which can provide 100% of the required flow without a single failure.

B.1

Excessive amounts of noncondensible gases in one of the high point vents in the required IRWST injection line may interfere with the passive injection of IRWST water into the reactor vessel from the associated parallel flow path in the affected injection line. Analyses have shown that with enough noncondensible gas accumulation, IRWST injection through the affected flow path could be delayed. However, the presence of some noncondensible gases does not mean that the IRWST injection capability is immediately inoperable, but that gases are collecting and should be vented. Venting of these gases requires containment entry to manually operate the vent valves. In this Condition the parallel flow path in the affected injection line is capable of providing 100% of the required injection. A DVI line break is not postulated in MODE 5. A Completion Time of 72 hours is acceptable since the IRWST is capable of performing the safety function without a single failure of the remaining parallel isolation valve. In addition, the 72-hour Completion Time is consistent with the time normally applicable to one inoperable train in a two train ECCS system.

C.1

Excessive amounts of noncondensible gases in both of the high point vents in the required IRWST injection line may interfere with the passive injection of IRWST water into the reactor vessel from the affected injection line. Analyses have shown that with enough noncondensible gas accumulation, IRWST injection could be delayed long enough to cause core uncover. However, the presence of some noncondensible gases does not mean that the IRWST injection capability is immediately inoperable, but that gases are collecting and should be vented. Venting of these gases requires containment entry to manually operate the vent valves. Considering the slow rate of gas accumulation, venting within 8 hours should normally prevent accumulation of amounts of noncondensible gases that could interfere with IRWST injection. A

ACTIONS (continued)

Completion Time of 8 hours is permitted for venting noncondensible gases and is acceptable since the injection capability is not significantly affected. If only one of the affected high point vents is vented, then Condition B will apply to the remaining high point vent with noncondensible gas accumulation.

D.1

If the IRWST water volume, boron concentration, or temperature are not within limits, the core cooling capability from injection or PRHR heat transfer and the reactivity benefit of injection assumed in safety analyses may not be available. Due to the large volume of the IRWST, online monitoring of volume and temperature, and frequent surveillances, the deviation of these parameters is expected to be minor. The allowable deviation of the water volume is limited to 3%. This limit prevents a significant change in boron concentration and is consistent with the long-term cooling analysis performed to justify PRA success criteria (Ref. 3), which assumed multiple failures with as many as 3 CMTs/Accum not injecting. This analysis shows that there is significant margin with respect to the water supplies that support containment recirculation operation. The 8-hour Completion Time is acceptable, considering that the IRWST will be fully capable of performing its assumed safety function in response to DBAs with slight deviations in these parameters.

E.1

If the required motor operated IRWST isolation valve is not fully open or valve power is not removed, injection flow from the IRWST may be less than assumed in the safety analysis. In this situation, the valve must be restored to fully open with valve power removed in 1 hour. This Completion Time is acceptable based on risk considerations.

F.1 and F.2

If the IRWST cannot be returned to OPERABLE status within the associated Completion Times or the LCO is not met for reasons other than Conditions A, B, C, D, or E, the plant must be placed in a condition in which the probability and consequences of an event are minimized to the extent possible. This is done by immediately initiating action to place the plant in MODE 5 with the RCS intact with ≥20% pressurizer level. The time to RCS boiling is maximized by maintaining RCS inventory at ≥20% pressurizer level and maintaining RCS temperature as low as practical. With the RCS intact, the availability of the PRHR HX is maintained. Additionally, action to suspend positive reactivity additions is required to ensure that the SDM is maintained. Sources of positive reactivity addition include boron dilution, withdrawal of reactivity control assemblies, and excessive cooling of the RCS.

BASES

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| SURVEILLANCE REQUIREMENTS | SR 3.5.7.1<br>The LCO 3.5.6 Surveillance Requirements and Frequencies (SR 3.5.6.1 through 3.5.6.10) are applicable to the IRWST and the flow paths required to be OPERABLE. Refer to the corresponding Bases for LCO 3.5.6 for a discussion of each SR. |
| REFERENCES | None. |

B 3.5 PASSIVE CORE COOLING SYSTEM (PXS)
B 3.5.8 In-containment Refueling Water Storage Tank (IRWST) – Shutdown, MODE 6

BASES

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|---|---|
| BACKGROUND | A description of the IRWST is provided in LCO 3.5.6, "In-containment Refueling Water Storage Tank (IRWST) – Operating." |
| APPLICABLE SAFETY ANALYSES | For MODE 6, heat removal is provided by IRWST injection and containment sump recirculation.<br>IRWST injection could be required to mitigate some events by providing RCS inventory makeup.<br>One line with redundant, parallel valves is required to accommodate a single failure (to open) of an isolation valve.<br>The IRWST satisfies Criteria 2 and 3 of 10 CFR 50.36(c)(2)(ii). |
| LCO | The IRWST requirements ensure that an adequate supply of borated water is available to supply the required volume of borated water as safety injection for core cooling and reactivity control.<br>To be considered OPERABLE, the IRWST in combination with the refueling cavity must meet the water volume, boron concentration, and temperature limits defined in the Surveillance Requirements, and one path of injection and recirculation must be OPERABLE. The motor operated injection isolation valve must be open and power removed, and the motor operated sump recirculation isolation valves must be open and OPERABLE. Any cavity leakage should be estimated and made up with borated water such that the volume in the IRWST plus the refueling cavity will meet the IRWST volume requirement. The absence of noncondensible gases in the high point vents is necessary for system OPERABILITY. |
| APPLICABILITY | In MODE 6, the IRWST is an RCS injection source of borated water for core cooling and reactivity control.<br>The requirements for the IRWST in MODES 1, 2, 3, and 4 are specified in LCO 3.5.6, In-containment Refueling Water Storage Tank (IRWST) – Operating. The requirements for the IRWST in MODE 5 are specified in LCO 3.5.7, In-containment Refueling Water Storage Tank (IRWST) – Shutdown, MODE 5. |

BASES

ACTIONS

A.1

With the required motor operated containment sump isolation valve not fully open, the valve must be fully opened within 72 hours. The 72 hour Completion Time is consistent with times normally applied to degraded two train ECCS systems which can provide 100% of the required flow without a single failure.

B.1

Excessive amounts of noncondensible gases in one of the high point vents in the required IRWST injection line may interfere with the passive injection of IRWST

water into the reactor vessel from the associated parallel flow path in the affected injection line. Analyses have shown that with enough noncondensible gas accumulation, IRWST injection through the affected flow path could be delayed. However, the presence of some noncondensible gases does not mean that the IRWST injection capability is immediately inoperable, but that gases are collecting and should be vented. Venting of these gases requires containment entry to manually operate the vent valves. In this Condition, the parallel flow path in the affected injection line is capable of providing 100% of the required injection. A DVI line break is not postulated in MODE 6. A Completion Time of 72 hours is acceptable since the IRWST is capable of performing the safety function without a single failure of the remaining parallel isolation valve. In addition, the 72-hour Completion Time is consistent with the time normally applicable to one inoperable train in a two train ECCS system.

C.1

Excessive amounts of noncondensible gases in both of the high point vents in the required IRWST injection line may interfere with the passive injection of IRWST water into the reactor vessel from the affected injection line. Analyses have shown that with enough noncondensible gas accumulation, IRWST injection could be delayed long enough to cause core uncover. However, the presence of some noncondensible gases does not mean that the IRWST injection capability is immediately inoperable, but that gases are collecting and should be vented. Venting of these gases requires containment entry to manually operate the vent valves. Considering the slow rate of gas accumulation, venting within 8 hours should normally prevent accumulation of amounts of noncondensible gases that could interfere with IRWST injection. A Completion Time of 8 hours is permitted for venting noncondensible gases and is acceptable since the injection capability is not significantly affected. If only one of the affected high point vents is vented, then Condition B will apply to the remaining high point vent with noncondensible gas accumulation.

D.1

If the IRWST and refueling cavity water volume, boron concentration, or temperature are not within limits, the core cooling capability from injection or PRHR HX heat transfer and the reactivity benefit of injection assumed

ACTIONS (continued)

in safety analyses may not be available. Due to the large volume of the IRWST, online monitoring of volume and temperature, and frequent surveillances, the deviation of these parameters is expected to be minor. The allowable deviation of the water volume is limited to 3%. This limit prevents a significant change in boron concentration and is consistent with the long-term cooling analysis performed to justify PRA success criteria (Ref. 3), which assumed multiple failures with as many as 3 CMTs/Accum not injecting. This analysis shows that there is significant margin with respect to the water supplies that support containment recirculation operation. The 8-hour Completion Time is acceptable, considering that the IRWST will be fully capable of performing its assumed safety function in response to DBAs with slight deviations in these parameters.

E.1

If the required motor operated IRWST isolation valve is not fully open or valve power is not removed, injection flow from the IRWST may be less than assumed in the safety analysis. In this situation, the valve must be restored to fully open with valve power removed in 1 hour. This Completion Time is acceptable based on risk considerations.

F.1 and F.2

If the IRWST cannot be returned to OPERABLE status within the associated Completion Times or the LCO is not met for reasons other than Conditions A, B, C, D, or E, the plant must be placed in a Condition in which the probability and consequences of an event are minimized to the extent possible. In MODE 6, action must be immediately initiated to be in MODE 6 with the cavity water level ≥23 feet above the top of the reactor vessel flange.

The time to RCS boiling is maximized by maximizing the RCS inventory and maintaining RCS temperature as low as practical. With the RCS intact, another means of removing decay heat is available (the PRHR HX). Additionally, action to suspend positive reactivity additions is required to ensure that the SDM is maintained. Sources of positive reactivity addition include boron dilution, withdrawal of reactivity control assemblies, and excessive cooling of the RCS. These Actions place the plant in a condition which maximizes the time to IRWST injection, thus providing time for repairs or application of alternative cooling capabilities.

BASES

SURVEILLANCE REQUIREMENTS

SR 3.5.8.1

The IRWST and refueling cavity borated water temperature must be verified every 24 hours to ensure that the temperature is within the limit assumed in accident analysis. This Frequency is sufficient to identify a temperature change that would approach the limit and has been shown to be acceptable through operating experience.

SR 3.5.8.3

Verification every 31 days that the boron concentration of the IRWST and refueling cavity is greater than the required limit ensures that the reactor will remain subcritical following shutdown events. Since the IRWST volume is large and normally stable, the 31 day Frequency is acceptable, considering additional verifications are required within 6 hours after each solution volume increase of 15,000 gal.

SR 3.5.8.4

LCO 3.5.6 Surveillance Requirements and Frequencies SR 3.5.6.3 and 3.5.6.5 through 3.5.6.10 are applicable to the IRWST and the flow paths required to be OPERABLE. Refer to the corresponding Bases for LCO 3.5.6 for a discussion of each SR.

REFERENCES None.