ArevaEPRDCPEm Resource

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Sent: Thursday, September 23, 2010 6:03 PM
To: Tesfaye, Getachew
Cc: GARDNER Darrell (AREVA)
Subject: FW: Draft responses to RAI 351, Questions 9.2.5-30(e) and 9.2.5-32(3)
Attachments: Batch 351_Q090205-30e_FSAR markup.pdf; Batch 351_Q090205-30e_SCB.pdf; Batch 351_Q090205-32(3)_SCB.pdf; Batch 351_Q090205-32(3)_FSAR Markup.pdf

Importance: High

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Importance: High

Marty,
attached are draft responses to RAI 351, Questions 9.2.5-30(e) and 9.2.5-32(last paragraph) for transmittal to the NRC for review and discussion during the Friday call at 1:30. Please provide these to the NRC for their review in advance of tomorrows discussions.

thanks

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conditions, and with the highest essential service water (ESW) heat load for a 72-hour period, without incurring pump damage during operation.

UHS tower blowdown is automatically secured during the initial 72-hour post-accident period through system instrumentation and control design features, so the only significant system water inventory losses are due to evaporation, tower drift, and valve seat leakage and seepage.

Meteorological conditions resulting in the maximum evaporative and drift loss of water for the UHS over a 72-hour period are presented in Table 9.2.5-3—Design Values for Maximum Evaporation and Drift Loss of Water from the UHS[1].

Meteorological conditions for the U.S. EPR that result in minimum cooling tower cooling that are the worst combination of controlling parameters (wet bulb and dry bulb), including diurnal variations for the first 24 hours of a DBA LOCA, are presented in Table 9.2.5-4 and do not result in a maximum ESWS supply temperature from the UHS basin exceeding 95°F.

9.2.5.4 System Operation

The safety related ESWS pumps cooling water from the cooling tower basin to supply ESWS loads and back to the mechanical draft cooling tower. The four safety-related divisions of the UHS are powered by Class 1E electrical buses and are emergency powered by the emergency diesel generators (EDG).

The non-safety-related dedicated ESWS pumps cooling water from the division four cooling tower basin to the dedicated system heat load and back to the division four mechanical draft cooling tower during SA and beyond DBAs.

The cooling tower fans are driven with multi-speed drives that are capable of fan operation in the reverse direction. Consistent with vendor recommendations, the fan may be operated in the reverse direction for short periods to minimize ice buildup at the air inlets. Cooling tower fans operating in the reverse direction during normal operation are considered operable at the onset of a design basis accident (DBA). Upon receipt of a safety injection (SI) signal, any fans operating in the reverse direction are secured and brought to a complete stop before re-energizing to operate at full speed in the forward direction. Upon receipt of an SI signal, fans in the operating and standby trains are automatically set to full fan speed to dissipate the maximum heat load to the environment. The cooling tower bypass piping provides a means for diverting ESW return flow directly to the tower basin under low load/low ambient temperature conditions to maintain ESW cold water temperature within established limits and to protect against freezing.

Based on the increase in heat removal during a DBA, a temperature of less than or equal to 90°F is maintained in the UHS basin during normal operation, so that the cooling tower basin temperature does not exceed 95°F.

9.2.5.5 Safety Evaluation

The UHS pump buildings and cooling towers are designed to withstand the effects of earthquakes, tornadoes, hurricanes, floods, external missiles and other natural phenomena. Section 3.3, Section 3.4, Section 3.5, Section 3.7 and Section 3.8 provide the basis for the adequacy of the structural design of these structures. The aboveground piping and components are protected by the structures.

The UHS is designed to remain functional after a safe shutdown earthquake (SSE). Section 3.7 and Section 3.9 provide the design loading conditions that are considered. Section 3.5, Section 3.6 and Section 9.5.1 provide the hazards analyses to verify that a safe shutdown, as outlined in Section 7.4, can be achieved and maintained.

The four division design of the UHS provides complete redundancy; therefore a single failure will not compromise the UHS system safety-related functions. Each division of UHS is independent of any other division and does not share components with other divisions or with other nuclear power plant units.

Considering preventative maintenance and a single failure, two UHS divisions may be lost, but the ability to achieve the safe shutdown state under DBA conditions can be reached by the remaining two UHS divisions. In case of LOOP the four UHS cooling towers have power supplied by their respective division EDGs. Isolation valves can isolate non-safety-related portions of the system if necessary without compromising the safety-related function of the system.

The cooling towers must operate for a nominal 30 days following a LOCA without requiring any makeup water to the source or it must be demonstrated that replenishment or use of an alternate or additional water supply can provide continuous capability of the heat sink to perform its safety-related functions. The tower basin contains a minimum 72-hour supply of water. After the initial 72 hours, the site specific makeup water system will provide sufficient flow rates of makeup water to compensate for system volume losses for the remaining 27 days. The normal and emergency blowdown isolation valves provide automatic isolation of the ESWS from downstream non-safety-related blowdown piping under DBA conditions to prevent loss of ESW inventory. The ESW emergency makeup water system also provides isolation of the normal makeup water system from the tower basins under DBA conditions to prevent loss of ESW inventory.

The heat load after 72 hours post-DBA is lower than the peak heat load due to a reduction in the decay heat from the reactor. Consequently, the makeup flow rate required after 72 hours is lower than the peak condition. Since the UHS basin contains

Response to

Request for Additional Information No. 351(4112, 4163), Revision 1

01/15/2010

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 09.02.05 - Ultimate Heat Sink
SRP Section: 09.05.01 - Fire Protection Program

Application Section: FSAR Chapter 9

QUESTIONS for Balance of Plant Branch 1 (AP1000/EPR Projects) (SBPA)

Question 09.02.05-30:

Follow-up to RAI 175, Question 9.2.5-17:

Standard Review Plan (SRP) 9.2.5 Section III, paragraph 1 requires confirmation of the overall arrangement of the ultimate heat sink (UHS). The staff reviewed the descriptive information, arrangement, design features, environmental qualification, performance requirements, and interface information provided in Tier 1 Final Safety Analysis Report (FSAR) Section 2.7.11 to confirm completeness and consistency with the plant design basis as described in Tier 2 Section 9.2.5. The staff found that the Tier 1 information is incomplete, inconsistent, inaccurate, or that clarification is needed with respect to the following considerations:

a. Although the Introduction Section in Chapter 1 of the Tier 1 FSAR states that the information in the Tier 1 portion of the FSAR is extracted from the detailed information contained in Tier 2, the staff found that much of the information provided in FSAR Tier 1 is not described in Tier 2 FSAR Section 9.2.5 (e.g., equipment locations, valve functional requirements, indication and control information, priority actuation and control system description and functions, automatic actuation and interlock details, valve failure modes, and harsh environment considerations). This Tier 1 information needs to be added to Tier 2.

b. FSAR Tier 1 does not stipulate that the ultimate heat sink (UHS) is accessible for performing periodic inspections as required by General Design Criteria (GDC) 45.

c. FSAR Tier 1 does not stipulate that the UHS design provide for flow testing of makeup water for accident and emergency conditions.

d. FSAR Tier 1 does not stipulate that the essential service water system (ESWS) pumps are protected from debris from the cooling towers.

e. FSAR Tier 1 does not stipulate that the safety related UHS outdoor piping is adequately protected from the elements and postulated hazards.

f. Tier 1, Figure 2.7.11-1, “Essential Service Water System Functional Arrangement,” does not show nominal pipe sizes for the UHS, which are necessary for design certification. This table does not show design information for the UHS fans.

g. Tier 1, Table 2.7.11-2, “Essential Service Water System Equipment I&C and Electrical Design,” does not include information pertaining to the UHS fans and corresponding power supplies.

h. The point of Note 2 for Tier 1, Table 2.7.11-2 is not clear since it does not appear to pertain to anything on the table. However, this appears to be due to an oversight whereby dedicated ESWS components are not listed in the table.

i. The discussion under Item 6 Tier 1 of Table 2.7.11-2 related to environmental qualification is inconsistent with the information provided in Table 2.7.11-2 in that no equipment is listed in the table for harsh environment considerations.

Based on the staff’s review of the applicant's response to RAI 9.2.5-17 (ID1817/6814) AREVA #175, Supplement 3, the following were determined as unresolved and needed further clarification/resolution by the applicant.

The applicant's response to Item (b) focuses on inservice inspection requirements, while the question that was asked focuses on the requirement specified by 10 CFR 50, Appendix A, General Design Criterion (GDC) 45. GDC 45 requires that “the cooling water system shall be designed to permit appropriate periodic inspections of important components, such as heat exchangers and piping, to assure the integrity and capability of the system.” Therefore, the capability to perform periodic inspections of important components needs to be described in FSAR Tier 2 and ITAAC need to be established to confirm this aspect of the design.

With regard to the response to Item (d), the staff does not agree that screens and filters that are solely for equipment protection are not safety significant. Filters and screens are relied upon to ensure that debris, aquatic organisms, and other material that find their way into the cooling tower basins do not adversely impact the capability of the essential service water system and ultimate heat sink to perform their safety functions. Without the screens and filters, pumps and valves can be damaged and rendered inoperable, heat exchanger tubes and cooling tower spray nozzles can become clogged, and heat transfer surfaces can become fouled. Therefore, ITAAC are needed to confirm the installation and proper mesh size of the filters and screens that are relied upon. Additionally, FSAR Tier 2 Sections 9.2.1 and 9.2.5 need to be revised to describe important filter and screen design specifications such as maximum allowed differential pressure and mesh size, including the bases for these specifications.

The response to Item (e) indicates that the UHS does not have any safety-significant outdoor piping within the scope of design certification. Based on this, the staff agrees that ITAAC are not needed to confirm adequate protection of exposed equipment. However, ITAAC are needed to confirm that ESWS and UHS piping and components are not exposed to the elements and postulated hazards. Additionally, based upon further review, the staff found that additional information needs to be included in the FSAR to address freeze protection considerations, especially for divisions that are in standby and for those parts of the cooling tower that are exposed and vulnerable to cold weather conditions.

The response to Item (f) refers to a response that was provided to RAI 9.2.1-22 (AREVA RAI No. 119, Supplement 1). The response indicates that line sizing details will be identified later in the design process. Consequently, this item remains open pending submittal of the information that was requested and a schedule for providing this information needs to be established.

In response to second part of Item (f), the applicant stated that design information for the UHS fans will be added to FSAR Tier 1, Table 2.7.11-2, “Essential Service Water System Equipment I&C and Electrical Design,” as part of the response to Item (g) of this RAI. The staff noted that the FSAR markup of Table 2.7.11-2 does not specify alternate power supplies for the two fans in Essential Service Water (ESW) Building 4. In this regard, additional information is needed to explain why an alternate power source is not specified for the ESW Building 4 cooling tower fans since they are necessary to support operation of the dedicated ESW train. The dedicated ESW train is provided to mitigate accidents that are beyond the design basis when normal backup power may not be available. Therefore, the applicant should specify an alternate power source for these fans similar to that shown for several other dedicated ESW train components in FSAR Tier 1 Table 2.7.11-2.

Response to Question 09.02.05-30:

Item (e)

Pumps, piping, valves and other components essential to the operation of the UHS are located within the boundary of the ESWPB, except the short section of emergency blowdown pipe exiting the building that is protected by the building structure (as stated in the response to RAI 351 9.2.5-22). As stated in Tier 2 Section 9.4.11, the ESWPB ventilation system maintains a minimum temperature. Moreover, the ESWS riser is located within the ESWPB and then branches off laterally to the spray nozzle header. The first of the self draining spray nozzles are attached to the header immediately after the header exits the ESWPB. As needed, any other piping and components subject to freezing conditions are provided with freeze protection design features, such as heat tracing. FSAR section 9.2.5.4 will be revised to include this freeze protection design feature.

ITAAC 2.1 and 2.2 in Tier 1 Table 2.7.11-3 confirm the as-built ESWS and UHS conform to the functional arrangement as shown on Tier 1 Figure 2.7.11-1 and are located as listed in Tier 1 Table 2.7.11-1. ITAAC 6.1 in Tier 1 Table 2.6.13-3 verifies the capability of the ESWPB ventilation system to maintain the ambient temperature in the ESWPB. Thus, ITAAC 2.1, 2.2 and 6.1 confirm the arrangement of the design and the capability of the ventilation system.

As stated in Tier 2 Section 9.2.5.4, "The cooling tower bypass piping provides a means for diverting ESW return flow directly to the tower basin under low load/low ambient temperature conditions to maintain ESW cold water temperature within the established limits and to protect against freezing." Moreover, Tier 2 Section 2.4.7 explains that the cooling tower basin water temperature is monitored for all four ESW trains, regardless of operational status. In the event that basin water temperature drops to 40°F, an alarm alerts the operator to bring the train into bypass operation to prevent the formation of ice in the basin.

ITAAC 2.1 Tier 1 Table 2.7.11-3 confirms the as-built ESWS and UHS conforms to the functional arrangement as shown on Tier 1 Figure 2.7.11-1. Thus, ITAAC 2.1 confirms the arrangement of the cooling tower bypass.

The cooling tower fans provide freeze protection for the cooling tower air inlets as explained in the previously accepted response to RAI 351 9.2.5-25 part 4.

As stated in Tier 2 Section 14.2 Test 049 and Section 16 SR 3.7.19.3, an initial test and a periodic surveillance confirm the fan is capable of operating in the reverse direction.

FSAR Impact:

U.S. EPR FSAR, Tier 2, Section 9.2.5.4 will be revised as described in the response and indicated on the enclosed markup.

Insert 1

Pumps, piping, valves and other components essential to the operation of the UHS are located within the boundary of the ESWPB, except the short section of emergency blowdown pipe exiting the building that is protected by the building structure. As stated in Tier 2 Section 9.4.11, the ESWPB ventilation system maintains a minimum temperature. Moreover, the ESWS riser is located within the ESWPB and then branches off laterally to the spray nozzle header. The first of the self draining spray nozzles are attached to the header immediately after the header exits the ESWPB. As needed, any other piping and components subject to freezing conditions are provided with freeze protection design features, such as heat tracing.

Response to

Request for Additional Information No. 351(4112, 4163), Revision 1

01/15/2010

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 09.02.05 - Ultimate Heat Sink
SRP Section: 09.05.01 - Fire Protection Program

Application Section: FSAR Chapter 9

QUESTIONS for Balance of Plant Branch 1 (AP1000/EPR Projects) (SBPA)

Question 09.02.05-32:

Follow-up to RAI 176, Question 14.2.94:

Final Safety Analysis Report (FSAR) Tier 2 Section 14.2.12.5.8 describes initial test for the UHS (Test #049). The NRC staff identified the following issues with test abstract #049:

1. Section 14.2.12.5.8.4.1, “Data Required,” includes “UHS makeup, blowdown air flowrates.” Blowdown air flowrates are not described in the FSAR. Please clarify what is meant by blowdown air flowrates.
2. The following design features and functions identified in Section 9.2.5 of the EPR FSAR are not included in test abstract #049. Please revise the abstract to include the following tests or justify their exclusion:
    a. Confirmation that “normal and emergency” makeup flowrate meets design flow
    b. Confirmation that chemical injection meets design flow
    c. Confirmation that cooling tower fan performance at various speeds (including the reverse direction for cold weather deicing purposes) is satisfactory
    d. Confirmation that the cooling tower flow bypass functions properly (also for cold weather protection)

Based on the staff’s review of the applicant's response to RAI 14.2.94 (ID1833/7333) AREVA #176, the following were determined as unresolved and needed further clarification/resolution by the applicant.

In Item 2.c, the staff requested that the applicant expand FSAR Tier 2 Chapter 14.2, Pre Operational Test 049, Paragraph 3.1, to confirm the capability of the cooling tower fans to operate in all speeds, including the reverse direction. This will demonstrate fan functionality in all operating modes prior to plant operation, and Technical Specification Surveillance 3.7.19.3 will provide continued assurance of fan operability after the initial test program has been completed. In response to this RAI, Paragraph 3.1.2 was added to Test #049 to verify fan operation in reverse, but fan testing to confirm functionality in the forward speeds was not included. The applicant needs to address functionality testing in the forward speeds in Test #049.

Additionally, based upon further review, the staff also determined that confirmation of cooling tower performance during the power ascension test program is necessary. A substantial heat load is needed to adequately confirm that the cooling tower heat removal and water usage rates satisfy design basis considerations. Consequently, UHS cooling tower performance testing should be completed during the power ascension test program. Design-basis conditions should be simulated to the extent possible and the actual cooling tower water usage and heat removal rates should be monitored, extrapolated, and analyzed as necessary to confirm satisfactory performance. This will also serve to establish a benchmark that can be used for periodically assessing performance and determining when actions are needed to address degraded conditions. Therefore, a test procedure needs to be developed and included in FSAR Tier 2, Chapter 14 for testing performance of the UHS cooling towers during the power ascension test program consistent with the guidance provided by Regulatory Guide 1.68, “Initial Test Programs for Water-Cooled Nuclear Power Plants,” Appendix A, Items 1.f and 5.x.

Response to Question 09.02.05-32:

New Item (3)

Tier 2 Section 14.2.12.5.5 will be revised to include performance testing of the UHS during a normal cooldown condition in hot functional testing, as described in Insert 1. The performance test would place one train of RHR into service when the RCS temperature is within the upper RHR operating band. Each train of the cooling chain, including the UHS, would be employed and the thermal-hydraulic performance would be monitored. Cooling chain performance would be determined by extrapolating test data using design data. Conducting the performance test during a cooldown in hot functional testing is recommend because the most significant heat load on the UHS can be provided during this time.

FSAR Impact:

U.S. EPR FSAR, Tier 2, Section 14.2.12.5.5 will be revised as described in the response and indicated on the enclosed markup.

Insert 1

1.1.2.1 Simulate a significant heat load on the CCW system and downstream systems (essential service water and ultimate heat sink) during hot functional testing.

Insert 2

2.5 Hot functional testing is in process for those sections that measure thermal-hydraulic performance.

2.6 Performance curves are available for the following components:

2.6.2 RHR heat exchanger.

2.6.3 CCW heat exchanger.

2.6.4 Ultimate heat sink tower.

Insert 3

3.37 [Added in response to RAI 406 Question 114]

3.38 [Added in response to RAI 406 Question 114]

3.39 Ensure that RCS temperature is within the upper operating band for placing RHR into service.

3.40 Ensure that the other CCW trains are providing the minimum amount of cooling to RHR, chilled water, and other plant loads.

3.41 Ensure that CCW Train 1 is loaded with all available loads.

3.42 Ensure make-up water flow and blowdown flow are isolated.

3.43 Place RHR Train 1 cooling into service.

3.44 Monitor thermal-hydraulic performance of the cooling chain including:

3.44.2 RHR heat exchanger.

- RHR flow through the heat exchanger.
- CCW flow through the heat exchanger.
- Inlet and outlet RHR temperature.
- Inlet and outlet CCW temperature on the RHR heat exchanger.

3.44.3 CCW heat exchanger.

- CCW flow through the heat exchanger.
- Essential service water flow through the heat exchanger.
- Inlet and outlet CCW temperature.
- Inlet and outlet essential service water temperature on the CCW heat exchanger.

3.44.4 Essential service water.

- Essential service water flow to the UHS tower.
- Essential service water flow from the UHS basin.
- Inlet and outlet essential service water temperature at the ultimate heat sink.

3.44.5 Ultimate heat sink.

- Fan power.
- Inlet wet bulb and dry bulb air temperature for the ultimate heat sink.
- Barometric Pressure.

3.45 Determine cooling chain performance by extrapolating available data using design data.

3.46 Perform step 3.39 through 3.44 for CCWS Trains 2, 3, and 4 to measure thermal-hydraulic performance.

Insert 4

4.7 ~~Temperature~~ Thermal hydraulic performance data during cooldown.

Insert 5

5.1.9 Verify the ability of the CCWS in conjunction with the RHRS, ~~and~~ essential service water system (ESWS), and ultimate heat sink (UHS) to perform a plant cooldown during HFT.

2.2 Potable and sanitary water systems instrumentation has been calibrated and is functional for performance of the following test.

2.3 Support system required for operation of the potable and sanitary water systems are complete and functional.

2.4 Test instrumentation available and calibrated.

2.5 The potable and sanitary water systems suction supplies are being maintained at the water level (pressure) specified in the design documents.

3.0 TEST METHOD

3.1 Verify potable and sanitary water systems measured pump and system flow meet design specifications.

3.2 Verify that potable and sanitary water systems interlocks and protective features perform as designed.

4.0 DATA REQUIRED

4.1 Pump operating data.

4.2 Setpoints at which alarms and interlocks occur.

5.0 ACCEPTANCE CRITERIA

5.1 The potable and sanitary water systems meet design requirements (refer to Section 9.2.4):

5.1.1 System flow is within design limits.

5.1.2 Supplied water meets design requirements.

14.2.12.5.5 Component Cooling Water System (Test #046)

1.0 OBJECTIVE

1.1 To demonstrate the capability of the CCWS to provide treated cooling water under the following conditions:

1.1.1 Normal unit operation.

1.1.2 During unit cooldown.

1.1.3 During refueling.

1.1.4 During an emergency situation.

1.2 To demonstrate that system response to a simulated ESF actuation signal is as designed.

1.3 To demonstrate electrical independence and redundancy of safety-related power supplies.

1.4 To demonstrate the CCWS is adequately designed and constructed to prevent water hammer.

2.0 PREREQUISITES

2.1 Construction activities on the CCWS have been completed.

2.2 CCWS instrumentation has been calibrated and is functional for performance of the following test.

2.3 Test instrumentation is available and calibrated.

2.4 Plant systems required to support testing are functional, or temporary systems are installed and functional.

3.0 TEST METHOD

3.1 Demonstrate that operation of the surge tanks and their controls is within design limits.

3.2 Demonstrate that system and component flow paths, flow rates, and pressure drops including head versus flow verification for the CCW pumps is within design limits.

3.2.1 Verify that pump starts/stops, valve realignments resulting from automatic switchover, RCP thermal barrier transfer, automatic valve closures and pump trips occur without introducingObserve the system during operation for the following water hammer indications:

- Noise.
- Pipe movement.
- Pipe support or restraint damage.
- Leakage.
- Damaged valves or equipment.
- Pressure spikes or waves.

3.3 Perform a pump head versus flow verification for CCW pumps.

3.3.1 $NPSH_a \geq NPSH_R$.

3.3.2 Starting time (motor start time and time to reach rated flow).

3.4 Verify the stroke closure time of the CCWS switchover valves.

3.5 Verify that the start of a CCWS pump generates a starting of the corresponding ESWS train.

3.6 Operate control valves remotely while:

a. Observing each valve operation and position indication.

b. Measuring valve performance data (e.g., thrust, opening and closing times).

3.7 Observe response of power-operated valves upon loss of motive power (refer to Section 9.2.2 for anticipated response).

3.8 Verify alarms, interlocks, indicating instruments, and status lights are functional.

3.9 Verify pump control from the PICS.

3.10 Demonstrate the ability of the CCWS in conjunction with the RHRS and essential service water system to perform a plant cooldown during HFT.

3.11 Verify that the RCP thermal barriers can be supplied by either the 1.b or 2.b common header. Demonstrate that the supply can be realigned with the RCPs operating during HFT.

3.12 Verify that the fire protection makeup to the CCW surge tank meets design flow rates.

3.13 Check electrical independence and redundancy of power supplies for safety-related functions by selectively removing power and determining loss of function.

3.14 Verify that CCWS Train 1 is supplying the common 1.b header (main common user group), then perform test of CCWS common 1.b ~~Emergency~~Automatic Backup Switchover function.

3.14.1 Initiate a failure of CCWS Train 1 by simulating a signal for CCWS Train 1 discharge pressure less than or equal to MIN1. Verify the following actions occur:

- CCWS Train 1 common 1.b supply and return switchover valves close.
- CCWS Train 1 LHSI heat exchanger isolation valve opens.
- CCWS Train 2 common 1.b supply and return switchover valves open.
- CCWS Train 2 pump starts.
- RCP thermal barrier flow returns to normal.

3.14.2 Initiate a failure of CCWS Train 1 by simulating a signal for loss of ESWS Train 1. Verify the following actions occur:

- CCWS Train 1 common 1.b supply and return switchover valves close.
- CCWS Train 1 LHSI heat exchanger isolation valve opens.
- CCWS Train 2 common 1.b supply and return switchover valves open.
- CCWS Train 2 pump starts.
- RCP thermal barrier flow returns to normal.

3.14.3 Initiate a failure of CCWS Train 1 by simulating a signal for main train (flow through CCW pump and heat exchanger, with or without flow through common headers) flow rate less than or equal to MIN1. Verify the following actions occur:

- CCWS Train 1 common 1.b supply and return switchover valves close.
- CCWS Train 1 LHSI heat exchanger isolation valve opens.

- CCWS Train 2 common 1.b supply and return switchover valves open.
- CCWS Train 2 pump starts.
- RCP thermal barrier flow returns to normal.

3.15 Perform step 3.14 for CCWS Trains 2, 3, and 4 to verify appropriate responses.

3.16 Verify that CCWS Train 1 is supplying the common 1.b header (main common user group), then perform test of CCWS Emergency Temperature Control function by simulating two out of three Train 1 temperature sensors greater than MAX1. Verify the following action occurs:

- CCWS Train 1 heat exchanger bypass valve closes until MAX1 is cleared (or the valve is fully closed).

3.17 Perform step 3.16 for CCWS Trains 2, 3, and 4 to verify appropriate responses.

3.18 Verify that CCWS Train 1 is supplying the common 1.b header (main common user group), then perform test of CCWS Emergency Leak Detection function.

3.18.1 Simulate a CCWS Train 1 surge tank level signal less than or equal to MIN2 and simulate a flow mismatch between the inlet and outlet of the common 1.b header (~~main common user group~~non-safety related branches). Verify the following actions occur:

- KAB80 AA015/016/019~~CCWS common 1.b non-safety users isolation~~ valves close.
- Normal and Automatic Switchover functions are inhibited~~CCWS common 1.b supply outer RB isolation valve closes~~.

3.18.2 Simulate a CCWS Train 1 surge tank level signal less than or equal to MIN3. Verify the following actions occur:

- CCWS Train 1 common 1.a supply and return switchover valves close.
- CCWS Train 1 common 1.b supply and return switchover valves close.

3.18.3 Simulate a CCWS Train 1 surge tank level signal less than or equal to MIN4. Verify the following actions occur:

- DWDS supply isolation valve closes.
- CCWS common 1.b Automatic~~Emergency~~ Backup Switchover function is enabled.
- CCWS Train 1 pump trips and CCWS Train 2 pump automatically starts~~CCWS Emergency Temperature Control function is enabled~~.

3.19 Perform step 3.18 for CCWS Trains 2, 3, and 4 to verify appropriate responses. For common 2.b testing with Trains 3 and 4 valves KAB50 AA001/004/006 close.

3.20 Verify that CCWS Train 1 is supplying the common 1.b header (main common user group), then perform test of CCWS Actuation from Safety Injection function by simulating a safety injection signal to CCWS. Verify the following actions occur:

- CCWS Train 1/2/3/4 pumps start automatically (if not previously running).
- CCWS Train 1/2/3/4 LHSI heat exchanger isolation valves KAA12/22/32/42 AA005 open.
- Isolation valves for non-safety-related users outside the Reactor Building (KAB50 AA001/004/006 and KAB80 AA015/016/019) closeCCWS common 2 non-safety users supply isolation valve closes.
- LHSI pump seal cooler isolation valves (KAA22/32 AA013) openCCWS common 2 non-safety users upstream and downstream isolation valves close.
- CCWS common 1.b NAB non-safety users isolation valves close.

3.21 Perform step 3.20 for CCWS Trains 2, 3 and 4 to verify appropriate responses.

3.22 Verify that CCWS Train 1 is supplying the common 1.b header (main common user group), then perform test of CCWS Operation from Stage 1 Containment Isolation signal and CCWS Operation from Stage 2 Containment Isolation signal functions.

3.22.1 Simulate a containment stage 1 isolation signal to CCWS. Verify the following actions occur:

- CCWS containment isolation valves KAB40 AA001/006/012 closeCCWS common 1 supply outer containment isolation valve closes.
- CCWS common 1 return inner and outer containment isolation valves close.

3.22.2 Simulate a containment stage 2 isolation signal to CCWS. Verify the following actions occur:

- CCWS containment isolation valves KAB60/70 AA013/018/019 closeCCWS common 1 safety users supply outer containment isolation valve closes.
- CCWS common 1 safety users return inner and outer containment isolation valves close.
- CCWS common 2 safety users supply outer containment isolation valve closes.
- CCWS common 2 safety users return inner and outer containment isolation valves close.

3.23 Perform step 3.22 for CCWS Trains 2, 3, and 4 to verify appropriate responses.

3.24 Verify that CCWS Train 1 is supplying the common 1.a header (fuel pool cooling and safety injection loads) and the common 1.b header (main common user group) then perform test of CCWS Response to a LOOP function by simulating a loss of offsite power to CCWS. Verify the following actions occur:

- CCWS common 2 safety users return inner and outer containment isolation valves close.
- CCWS Train 1 starts upon receipt of a Protection System signal.

3.25 Perform step 3.24 for CCWS Trains 2, 3, and 4 to verify appropriate responses.

3.26 Verify that CCWS Train 1 is supplying the common 1.a header (fuel pool cooling and safety injection loads) and the common 1.b header (main common user group) then perform test of CCWS Switchover Valve Interlock function. Verify the following groupings of valves cannot be simultaneously opened to prohibit more than one train from being connected to a common header:

- KAA10 AA033/032 with KAA20 AA033/32.CCWS Train 1 common 1.a switchover valves with Train 2 common 1.a switchover valves
- KAA30 AA033/032 with KAA40 AA033/32.CCWS Train 3 common 2.a switchover valves with Train 4 common 2.a switchover valves
- KAA10 AA006/010 with KAA20 AA006/010.CCWS Train 1 common 1.b switchover valves with Train 2 common 1.b switchover valves
- KAA30 AA006/010 with KAA40 AA006/010.CCWS Train 3 common 2.b switchover valves with Train 4 common 2.b switchover valves

3.27 Verify that CCWS Train 1 or 2 is supplying the common 1.b header (main common user group), then perform test of CCWS RCP Thermal Barrier Containment Isolation Valve Interlock function. Verify the following action occurs:

- KAB30 AA049/051/052 must be closed prior to opening KAB30 AA053/055/056 and vice versaCCWS common Train 1.b and 2.b can not be placed into service at the same time.

3.28 Perform step 3.27 for CCWS Train 3 or 4 supplying common 2.b header to verify appropriate responses.

3.29 Verify that CCWS Train 1 is supplying the common 1.b header (main common user group), then perform test of CCWS Switchover Valve Leakage or Failure function by simulating CCWS Train 1 surge tank level less than MIN3 and CCWS surge tank 2 level greater than MAX2. Verify the following actions occur:

- CCWS Train 1 common 1.a supply and return switchover valves close.
- CCWS Train 1 common 1.b supply and return switchover valves close.

3.30 Perform step 3.29 for CCWS Train 2 supplying common 2.b header to verify appropriate responses.

3.31 Verify that CCWS Train 1 is supplying the common 1.b header (main common user group), then perform test of CCWS Surge Tank Makeup function. Verify the following action occurs:

- DWDS supply isolation valve responds to CCWS surge tank level changes.

3.32 Perform step 3.31 for CCWS Trains 2, 3, and 4 to verify appropriate responses.

3.33 Verify that CCWS Train 1 is supplying the common 1.b header (main common user group), then perform test of CCWS Temperature Control function.

3.33.1 Simulate two of three CCWS Train 1 temperature sensors less than MIN1. Verify that the Train 1 heat exchanger bypass valve opens by 10 percent of its 0-100 percent range at 1 minute intervals until 2 of 3 temperature measurements are greater than MIN1, or the valve is fully open.

3.33.2 Simulate two out of three CCWS Train 1 temperature sensors greater than MAX1. Verify that the Train 1 heat exchanger bypass valve closes by 10 percent of its 0-100 percent range at 1 minute intervals until 2 of 3 temperature measurements are less than MAX1, or the valve is fully closed.

3.34 Perform step 3.33 for CCWS Trains 2, 3, and 4 to verify appropriate responsesPerform Steps 3.14 through 3.24 for CCWS Trains 2, 3, and 4 to verify appropriate responses.

3.35 Verify that CCWS common 1.b header is supplying RCP thermal barrier cooling, then perform test of RCP thermal barrier isolation function.

3.35.1 Simulate high flow above threshold value on the return of RCP1 thermal barrier. Verify that RCP1 thermal barrier isolation valves close.

3.35.2 Simulate high pressure above threshold value on the return of RCP1 thermal barrier. Verify that RCP1 thermal barrier isolation valves close.

3.35.3 Perform steps 3.35.1 and 3.35.2 for RCP 2, 3, and 4 thermal barriers.

3.36 Perform step 3.35 for common 2.b header supplying RCP thermal barrier cooling to verify appropriate responses.

4.0 DATA REQUIRED

4.1 Record pump head versus flow and operating data for each pump.

4.2 Flow balancing data including flow to each component and throttle valve positions.

4.3 Setpoints of alarms interlocks and controls.

4.4 Valve performance data, where required.

4.5 Valve position indication.

4.6 Position response of valves to loss of motive power.

4.7 Temperature data during cooldown.

4.8 Response of CCW System to SIAS, CIAS, surge tank level signal, and CCW header differential flow signal.

5.0 ACCEPTANCE CRITERIA

5.1 The CCWS meets design requirements (refer to Section 9.2.2):

5.1.1 Operation of the surge tanks and their controls is within design limits.

5.1.2 System and component flow paths, flow rates, and pressure drops including head versus flow verification for the CCW pumps is within design limits.

5.1.3 Pump head versus flow verification for CCW pumps is within design limits.

5.1.4 Response to safety-related simulated signals meets design requirements.

5.1.5 Non-safety-related headers and RCP headers are isolated on simulated signals.

5.1.6 System valves meet design requirements.

5.1.7 Alarms, interlocks, indicating instruments, and status lights meet design requirements.

5.1.8 Verify pump control from the PICS.

5.1.9 Verify the ability of the CCWS in conjunction with the RHRS and essential service water system (ESWS) to perform a plant cooldown during HFT.

5.1.10 Verify none of the following water hammer indications are present for all operational tests (3.14 through 3.36):

- Noise.
- Pipe movement.
- Pipe support or restraint damage.
- Leakage.
- Damaged valves or equipment.
- Pressure spikes or waves.