ArevaEPRDCPEm Resource

From: BRYAN Martin (EXT) [Martin.Bryan.ext@areva.com]
Sent: Monday, June 21, 2010 9:43 AM
To: Tesfaye, Getachew
Cc: KOWALSKI David J (AREVA NP INC); WILLIFORD Dennis C (AREVA NP INC); BALLARD Robert W (AREVA NP INC); CONNELL Kevin J (AREVA NP INC); ROMINE Judy (AREVA NP INC); Hearn, Peter; GARDNER George Darrell (AREVA NP INC)
Subject: DRAFT RESPONSES FOR FSAR Chapter 9 Weekly NRC Telecon
Attachments: Blank Bkgrd.gif; DRAFT FSAR Markups RAI 361 All Questions Except 09.02.02-97.pdf; DRAFT RESPONSE RAI 417 Q.09.02.02-118.pdf; DRAFT RESPONSE RAI 361 All Questions Except 09.02.02-97.pdf

Importance: High

Getachew,

See attached for draft responses for tommorrow's Chapter 9 meeting.

Thanks,

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Subject: DRAFT RESPONSES FOR FSAR Chapter 9 Weekly NRC Telecon
Importance: High

Marty:

Please transmit to Getachew Tesfaye the attached partial set of DRAFT responses to RAI 361 and 417 questions. These responses will be discussed at tomorrow's (6/22/10) FSAR Chapter 9 Weekly Telecon/GoToMeeting with the NRC.

Attached DRAFT responses include the following:

- Responses to RAI 361 - All Questions except for 09.02.02-97.
- Response to RAI 417 Question 09.02.02-118 **ON LAST WEEK'S AGENDA - TO BE DISCUSSED TOMORROW.**

Note that none of these DRAFT responses has been through the final Licensing review/approval process; nor do any responses reflect technical editing.

Please call me if you have any questions. Thanks.

David J. Kowalski, P.E.
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isolation are above the floor level so only large flooding events can initiate an isolation. ~~Two level sensors in a one-out-of-two logic actuate the isolation. If a level sensor fails, that sensor is not considered for the voting, and the signal is activated when one sensor detects.~~

Flooding protection measures mitigate consequences resulting from a postulated failure in the fire water distribution system. A watertight physical protection door prevents water ingress into neighboring divisions through the interconnecting passageway between SB-1 and SB-2. This door is provided with position indication and monitoring of the locking and bolting status for control of the closed position. In the event of flooding, the door is considered closed. A flooding pit with a burst panel below the interconnecting passageway allows water to flow to lower building levels. This arrangement also exists for the passageways between SB-3 and SB-4 and between SB-2 and SB-3.

Elevation +15 Feet and Above

Physical separation for flooding is not provided for elevations +15 feet and above. Therefore, protection measures restrict flooding to the SB where the flooding event was initiated. Sufficient openings and thresholds direct water flow to the lower building levels.

Potential sources of flooding located on these building levels include the demineralized water distribution system, safety chilled water system (SCWS), fire water distribution system, CCWS including surge tank, and the potable and sanitary water disposal system. These systems have been reviewed for possible effects on the MCR and remote shutdown station (RSS) because they are located above the MCR, and measures are provided to protect the MCR and RSS from flooding. No water-carrying piping systems are located in the MCR or RSS. Thresholds are provided for doors entering the MCR and water resistant doors are provided for entry doors to the RSS. For the fire water distribution system, demineralized water distribution system, and the CCWS, multiple openings and flow paths direct flood water from pipe breaks to lower building levels. Surge tank water tightness is provided by a steel liner and leak detection system.

Replace w/ Insert 1

~~Each division of the SCWS contains a limited volume of water that can either be stored in the area where it was released or drained to the building sump or to the lowest building level. At higher building elevations (e.g., elevation +69 feet), the pumps are automatically stopped on loss of system pressure, limiting the volume of water released at these elevations. A common loss of the heating, ventilation, and air conditioning (HVAC) system trains for the MCR due to flooding from a pipe break in the SCWS is avoided by flow paths, drains, and by placing equipment that is sensitive to flooding above the expected flood water height. Consequences of a pipe failure of a SCWS drain in Division 1 on safety-related equipment in SB-2 are avoided because the drain~~

of Division 1 is located in areas where there are no safety-related components of Division 2 that are sensitive to flooding. Therefore, the consequences of a flooding event from the SGWS are restricted to one redundant division.

Leak detection is provided by level measurement in the NIDVS building sump. Specific leak detection measurements near the MCR detect pipe failures in the potable and sanitary water distribution system. Two remotely operated valves in the potable and sanitary water disposal system in SB-1 close automatically when the filled level is reached in the NIDVS building sumps. Generally, the water released from a break in the potable and sanitary water distribution system drains toward the NIDVS building sumps. However, for the restrooms this is not appropriate because of the possibility of sewage water ingress into the NIDVS. Therefore, there are additional local detection measures in rooms adjacent to the MCR, consisting of two level measurements that provide a close signal to the isolation valves in SB-1 and an alarm to the MCR. The released water can be stored in the affected area until system isolation without flooding to safety-related areas.

Fire fighting in the vicinity of the MCR, RSS, and the HVAC floor above the MCR complex is considered. Within a SB, the water released because of fire fighting is enveloped by the released water volumes from the postulated pipe failures. The flooding analysis of larger rooms (e.g., cable rooms, MCR, tagging room, and computer rooms) assumes that the fire is not extinguished by mobile extinguishers and that the wall hydrants for manual fire fighting are used. Individual extinguishing areas are limited to one SB; consequently, fire fighting will be performed from one SB. Divisional separation for flooding exists in the case of fire fighting by water. The effects of the extinguishing water are restricted to the rooms with the fire event and, in some cases, to adjacent corridors or rooms through the existence of thresholds and doors designed for a water column higher than the expected flood level.

Valve Compartment Flooding Analysis

The general flooding protection concept for the valve compartments is based on pressure relief openings for postulated breaks in the high-energy piping with the largest nominal diameter. This concept restricts the loadings on the outer reinforced concrete structure of the feedwater and the main steam valve compartments. The relevant effects of pipe breaks are also restricted to one of these valve compartments. Water flows from these release openings in the wall or bottom slab of the valve compartments and drains from the maintenance areas down the outer wall of the SBs. This drainage route also exists for postulated pipe failure outside the valve compartments in the pipe routing area. Water is prevented from spreading to other parts of the SB from the areas in front of the valve compartments by watertight doors leading to adjacent rooms.

RAI 361 Question 09.02.02-98

Insert 1:

The SCWS is a closed system with manual make up and therefore contains a limited volume of water. In the lower levels of the safeguard buildings the entire system contents is conservatively assumed to be released in the event of a pipe failure and directed within the division to the lowest building level through large openings and staircases. At higher building elevations (e.g. elevation +69 feet in SB-2 and SB-3) the released water volume from a pipe failure is further limited to the contents of two cross-tied SCWS trains. A common loss of the main control room air conditioning system (CRACS) in SB-2 or SB-3 is prevented by placing equipment sensitive to flooding above the expected flood water height resulting from the water released remaining in the area of the CRACS equipment rooms and adjoining service corridor.

9.2.8 Safety Chilled Water System

The safety chilled water system (SCWS) supplies refrigerated chilled water to the safety-related heating, ventilation and air conditioning (HVAC) systems and the low head safety injection system (LHSI) pumps and motors in Safeguard Buildings (SB) 1 and 4 and the fuel building ventilation system (FBVS). The SCWS consists of four trains, numbered 1 to 4. Train 1 and Train 2 can be interconnected and Train 3 and Train 4 can be interconnected. ~~The SCWS consists of four separate and independent divisions, numbered 1 to 4.~~

9.2.8.1 Design Bases

The SCWS provides chilled water as a heat sink to the LHSI pumps and the safety-related HVAC systems, which in turn provides an acceptable environment for safety-related equipment and main control room (MCR) habitability in the event of a design basis accident (DBA) (GDC 44). The SCWS is classified as a safety-related system and has safety-related design functions. The system is designed Seismic Category I. Safety-related systems are required to function following a DBA and are required to achieve and maintain a safe shutdown condition.

- Each SCWS ~~division~~train is protected from the effects of natural phenomena, such as earthquakes, tornadoes, hurricanes, and floods (GDC 2). The SCWS are located in Seismic Category I Safeguard Buildings, which are designed to withstand the effects of earthquakes, tornadoes, hurricanes, floods, external missiles, and other natural phenomena. ← Insert 2
- Each ~~division~~train remains functional and performs its intended functions for all postulated environmental conditions or dynamic effects, such as pipe breaks (GDC 4).
- Safety functions are performed assuming a single active component failure coincident with the loss of offsite power (GDC 44).
- The SCWS is not shared with any other plant unit (GDC 5).
- Active components of the SCWS ~~divisions~~trains are capable of being periodically tested and required inspections can be performed during plant operation (GDC 45 and GDC 46).

The SCWS ~~divisions~~trains use design and fabrication codes consistent with the safety classification and seismic design criteria provided in Section 3.2. The quality group classification meets the requirements of RG 1.26. The seismic design of the system components meets the guidance of RG 1.29. The power and control functions are designed in accordance with RG 1.32.

The SCWS operates continuously as described for the safety-related function when the plant is in normal conditions of startup, shutdown, power operation, and outages.

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9.2.8.2 System Description

9.2.8.2.1 General Description

The SCWS consists of four ~~separate, physically separated independent divisions,~~trains numbered 1 to 4. Each is located in one of the four SBs. Each SCWS ~~division~~train is a closed loop system that supplies chilled cooling water for specified area HVAC air handling units (AHU) and, where required, process systems cooling. Each ~~division~~train consists of a refrigeration chiller unit, two pumps, expansion tank, user loads, and the associated piping and controls.

Normally, open motor operated cross-tie valves (MOV) interconnect the supply and return piping of Train 1 with Train 2, and the supply and return piping of Train 3 with Train 4. Each SCWS chiller is sized to meet the system load requirements of two divisional trains.

The SCWS provides chilled water to the HVAC cooling coils of the main control room (MCR), the electrical division rooms (SBVSE) in the SBs, SB controlled-area ventilation system (SBVS), ~~Fuel Building (FB) ventilation system (~~FBVS~~)~~, and the low head safety injection system (LHSI) pump motors in SB Divisions 1 and 4. Insert 3

System design parameters are listed on Table 9.2.8-1—Safety Chill Water Design Parameters. The SCWS flow diagram is shown in Figure 9.2.8-1—Safety Chilled Water System Diagram.

Refer to Section 12.3.6.5.9 for safety chilled water system design features which demonstrate compliance with the requirements of 10 CFR 20.1406.

9.2.8.2.2 Component Description

The general description of the component design features for the SCWS is provided below. Refer to Section 3.2 for details of the seismic and system quality group classification of the SCWS.

Chilled Water Pumps

~~Two 100 percent SCWS pumps, with one in standby, in each of the four divisions circulates chilled water between the HVAC users and the evaporator of the chiller refrigeration unit in each division.~~Two SCWS pumps in each of the four trains circulate chilled water between the SCWS users and the evaporator of the chiller refrigeration unit in each division.

The required flow rate of each SCWS pump is defined by the heat to be removed from the system loads. As a minimum, the pumps are designed to fulfill the corresponding minimal required design mass flow rate under the following conditions:

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9.2.8.2.2

- Fluctuations in the supplied electrical frequency.
- Increased pipe roughness due to aging and fouling.
- Fouled debris filters.
- Maximum pressure drop through the system heat exchangers.
- Minimum water level in the expansion tank considers net positive suction head to prevent cavitation of the SCWS pump and prevent vortex effects.

Determination of the discharge head of the pumps is based on dynamic pressure losses and head losses of the mechanical equipment of the associated SCWS at full load operation.

Air-Cooled Chiller Refrigeration Unit

Q-94

SCWS, ~~Divisions~~ Trains 1 and 4, each contain one ~~100 percent~~ air-cooled chiller refrigeration unit that functions to refrigerate chilled water to its design basis temperature of 41°F for supply to the ~~HVAC users~~system users. These chillers are located in dedicated rooms of the SBs. Each chiller contains a condenser, compressors, evaporator, and associated piping and controls. Environmentally safe refrigerants are used in these chillers.

Water-Cooled Chiller Refrigeration Unit

Q-94

SCWS, ~~Divisions~~ Trains 2 and 3, each contain one ~~100 percent~~ water-cooled chiller refrigeration unit that functions to refrigerate chilled water to its design bases temperature of 41°F for supply to the HVAC users. These chillers are located in dedicated rooms of the SBs. Each chiller contains a condenser, compressors, evaporator, and associated piping and controls. Environmentally safe refrigerants are used in these chillers.

Diaphragm Expansion Tank

Q-94

Each SCWS ~~division~~ train contains a diaphragm expansion tank with a nitrogen fill connection in each of the SBs. The expansion tank provides for changes in volume and establishes a point of reference pressure for the closed-loop system. These tanks are provided with overpressure protection.

Cooling Coils

Multiple HVAC cooling coils in each division receive chilled water for heat removal from selected HVAC users. The SCWS also cools Division 1 and Division 4 LHSI motor cooler and pump sealing cooler.

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9.2.8.2.2 SafetyRelief Valves train Q - 94

A safetyrelief valve located in each SCWS division protects the chilled water closed loop against high pressure.

Chiller Bypass Valve

The chiller bypass valve installed in the closed loop of each operating SWCS divisiontrain varies flow returning to the chiller to prevent freezing at the evaporator coil. Upstream filters are provided as a precaution to protect downstream control valves which contain internals sensitive to particle trapping.

Cross-Tie Valves

A cross-tie is established for normal operation between the supply and the return piping of each divisional pair (1/2 or 3/4) of SCWS trains that includes MOVs and associated controls. There are two isolation valves per division (one supply and one return) that are located in their respective Safeguards Buildings. The valves are divisionally powered. During normal operations the cross-tie isolation valves are normally open and only one chiller train is operating.

9.2.8.3 System Operation

9.2.8.3.1 Normal Operation

All four SGWS divisions supply chilled water to plant components when the plant is in power operation under normal conditions. Each of the four SBs is supplied by one of four divisions of the SGWS. Each SCWS division is designed with a closed single pumping loop and one refrigeration unit for chilled water production. Chilled water production and chilled water distribution are grouped together to form a single closed system. During normal operation, at least one train of the divisional pair is in operation. Either Train 1 or Train 2 chiller provides safety chilled water cooling for all SCW loads within Safeguard Building Divisions 1 and 2, and the associated FBVS load. Likewise, the chiller from either Train 3 or 4 provides safety chilled water cooling for both Safeguard Divisions 3 and 4 and the associated FBVS load. During normal operation, the cross-tie isolation valves (supply and return for both divisions) are normally open. The non-operating chiller and pump(s) are maintained in standby. This configuration also allows for maintenance on the non-operating chiller and pump(s). If the normal operating train pump or chiller fails, a switchover sequence to the standby train is automatically initiated. A planned switchover of the operating train is manually initiated from the MCR.

Each of the four divisions has one SCWS pump in service and one in standby, to circulate the chilled water in a closed loop between the HVAC users and the evaporator of the refrigeration unit. The chilled water distribution circuit operates

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9.2.8.3.1

with a variable flow rate that is governed by the position of the control valves associated with supplied user loads. A regulated chilled water bypass line is provided between the refrigeration–evaporator outlet line and the return line to prevent freezing. A diaphragm expansion tank is used for equalization of pressure and volumetric expansion and helps maintain the requisite static system pressure. A safetyrelief valve on the connecting line prevents the line design pressure from being exceeded. Piping voids associated with potential waterhammer are precluded by the constant pressure maintained in the nitrogen-charged expansion tank in each division train. Q-94

A manually operated make up demineralized water supply is used when water loss resulting from operational measures (e.g., venting and draining) is indicated by an expansion tank pressure instrument.

The SCWS is treated with hydrazine in low concentration for corrosion control. Monitoring of the water chemistry is provided by means of local sampling at the central chilled water station.

9.2.8.3.2 Abnormal Operation

In the event of a DBA, with one SCWS safety-related train down for maintenance, and in case of failure of a second SCWS safety-related train (e.g., refrigeration units or pumps), the back up is provided by the two remaining SCWS 100 percent trains of the corresponding divisions. In the event of a DBA with concurrent loss of offsite power (LOOP) the operating train of a divisional pair receives a "Start" signal to return the operating train to operation after load shed. If an active single failure occurs (assume either the EDG fails to start or the SCW train pump or chiller does not re-start), then the standby train receives a "Start" signal. This sequence confirms that one train of a divisional pair is operating. At or before the end of 24 hours post DBA, the cross-tie isolation valves are manually isolated to protect against a passive failure.

The SCWS is powered from the emergency diesel generators (EDG) and continues to function during a DBA. Divisions Trains 1 and 4 of the SCWS provide a heat sink to Division 1 and 4 system users and HVAC systems in the event of a severe accident or station blackout (SBO). Divisions 1 and 4 are powered from motor control centers that are re-powered by the station blackout diesels during an SBO event. Q-94

Under seismic or post-accident conditions, when demineralized water may be unavailable for SCWS makeup, a manual connection to the fire water distribution system is available to provide a seismic makeup source within a time frame consistent with the SCWS expansion tank capacity to accommodate expected out-leakage from the system for seven days.

A mechanical or electrical failure of the running SCWS pump results in a transfer to the standby pump.

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9.2.8.3.2 Each refrigeration chiller in the four ~~divisions~~ trains of the SCWS has three 50 percent capacity compressors to provide sufficient operating redundancy and flexibility in the event of a compressor failure. The two remaining chiller compressors provide 100 percent capacity. Q-94

To allow divisional maintenance (e.g., maintenance on ~~emergency~~ diesel generators), the required SCWS safety-related ~~components~~ are alternately fed from the adjacent division to ~~provide~~ adequate cooling of certain safety-related components during a design basis event. Insert 1 Q-95 a&b

9.2.8.4 Safety Evaluation

- The SCWS is designed as Seismic Category I as described in Section 3.2 to operate in all plant modes of operation including design basis events. The SCWS divisions are located in SBs 1 to 4, respectively. The SBs 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~~(B)~~, and Section 3.8 provide the bases for the adequacy of the structural design of these buildings.
- The SCWS is designed to remain functional after a safe shutdown earthquake. Section 3.7~~(B).2 and Section 3.9(B)~~ provide the design loading conditions that were considered. Section 3.5, Section 3.6, and Section 9.5.1 provide the hazards analyses to make sure that a safe shutdown, as outlined in Section 7.4, can be achieved and maintained.
- A four train design with interconnection of Train 1 and Train 2 or interconnection of Train 3 and Train 4 of the SCWS fulfills the single failure criteria. ~~Redundant safety systems (one per SB) are strictly separated within the SBs into four divisions. This divisional separation is provided for electrical and mechanical safety systems.~~ The four ~~divisions~~trains of safety-related systems are consistent with an N+2 safety concept. The four SCWS trains are backed up by the EDGs. Two of these trains, in Divisions 1 and 4, are also backed up by the SBO diesels. Delete Q-95 a&b
- Structures, systems and components important to safety in the SCWS are not shared with any other co-located nuclear reactor units.
- Preoperational testing of the SCWS is performed as described in Chapter 14.0. Periodic inservice functional testing is done in accordance with Section 9.2.8.5.
- Section 6.6 provides the ASME Boiler and Pressure Vessel (BPV) Code, Section XI (Reference 1) requirements that are appropriate for the SCWS.
- Section 3.2 delineates the quality group classification and seismic category applicable to the safety-related portion of this system. Table 9.5.4-1 shows that the components meet the design and fabrication codes given in Section 3.2. All the power supplies and control functions necessary for safe function of the SCWS are Class IE, as described in Chapter 7 and Chapter 8.

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9.2.8.4 Q-94

- Cooling diversity is created between the load heat sinks of ~~Divisions~~ Trains 1 and 4, and ~~Divisions~~ Trains 2 and 3. ~~Division~~ Train 1 and 4 chillers are air cooled, and ~~Division~~ Train 2 and 3 chillers are water cooled by the component cooling water system (CCWS).

- A process radiation monitor is provided in Trains 1 and 4 of the SCWS, downstream of the LHSI pump mechanical seal heat exchanger to monitor for possible leakage of radioactive fluid from the heat exchanger. Otherwise, migration of radioactive material from potentially radioactive systems is prevented with a minimum of two heat exchanger barriers. Radiation monitors are in the CCWS to detect radioactive contamination entering and exiting the system.

9.2.8.5 Inspection and Testing Requirements

Prior to initial plant startup, a comprehensive performance test will be performed to verify that the design performance of the system and individual components is attained. Refer to Section 14.2, Test #052, for initial plant testing of the SCWS.

After the plant is brought into operation, periodic tests and inspections of the SCWS components and subsystems are performed to verify proper operation. Scheduled tests and inspections are necessary to verify system operability.

The installation and design of the SCWS provides accessibility for the performance of periodic inservice inspection and testing. Periodic inspection and testing of safety-related equipment verifies its structural and leak tight integrity and its availability and ability to fulfill its functions.

Inservice inspection and testing requirements are in accordance with Section XI of the ASME BPV Code and the ASME OM Code.

Section 3.9.6 and Section 6.6 describe the inservice testing and inspection requirements, respectively. Refer to Section 16.0, Surveillance Requirement (SR) 3.7.9 for surveillance requirements that verify continued operability of the SCWS.

9.2.8.6 Instrumentation Requirements

The SCWS system is controlled by the safety automation system (SAS). The normal indication, manual control, and alarm functions are provided by the process information and control system (PICS).

System pressure is monitored with the aid of two pressure measurements for each train. The two measurements are combined in one measuring point. If the pressure falls below a set limit, an alarm is issued for operators to check nitrogen charge or provide makeup with demineralized water.

If the system experiences excessive leakage in excess of system makeup capability, the cross-tie isolation MOVs close on Low-2 system pressure. The non-operating standby train automatically starts on Low-2 pressure. The train without excessive leakage

Next File

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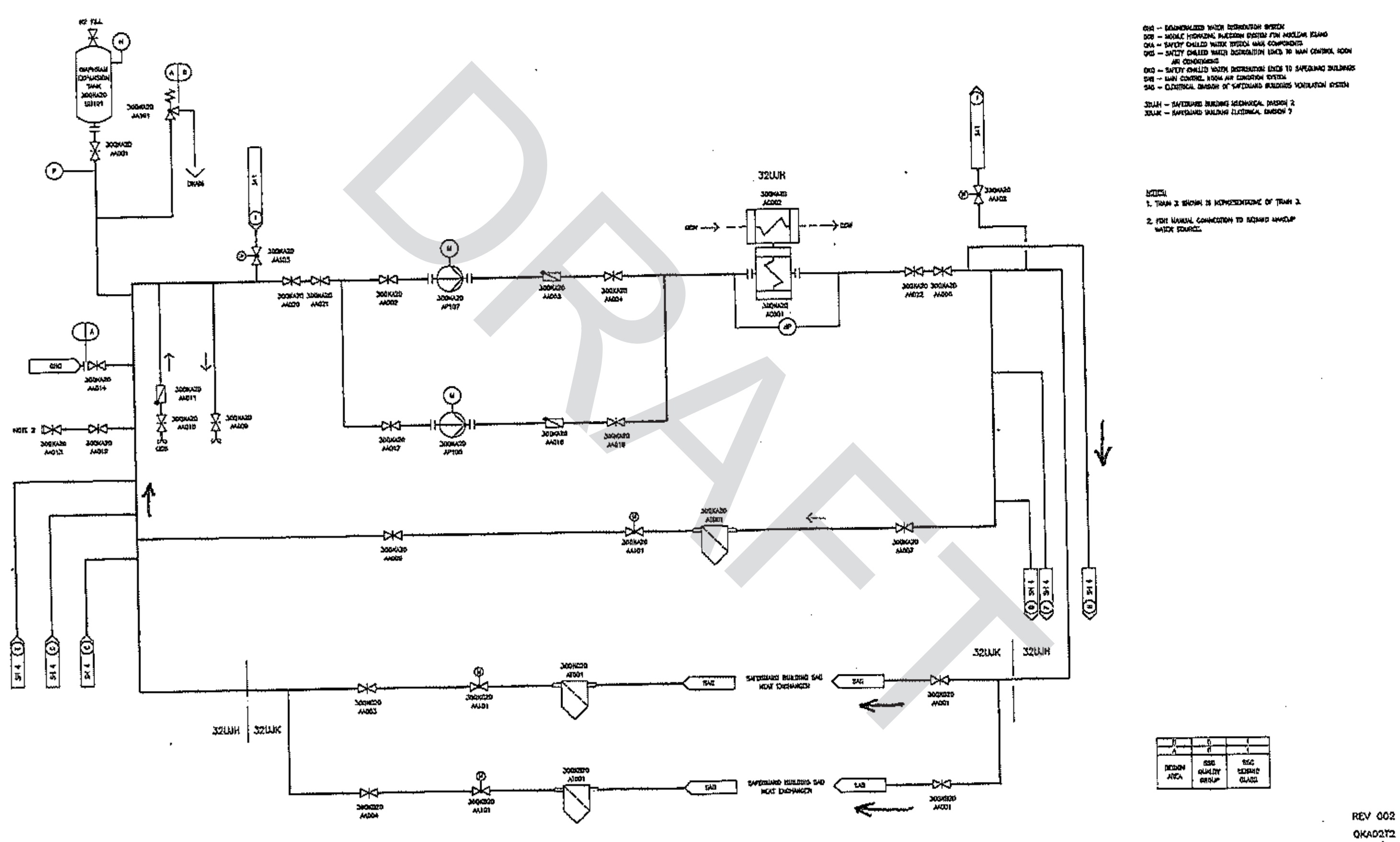
Figure 9.2.8-1—Safety Chilled Water System Diagram
Sheet 2 of 4



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4.3 Valve position indication.

4.4 Temperature and relative humidity trend data.

4.5 Setpoints at which alarms and interlocks occur.

4.6 Cooling fan air flow rates.

5.0 ACCEPTANCE CRITERIA

5.1 The UHS meets design requirements (refer to Section 9.2.5):

5.1.1 Verify that control logic starts forced draft fans and aligns critical components for UHS operation for the entire design range.

5.1.2 Verify that valve performance tests (e.g., valve position response of valves to loss of motive power, thrust, stroke time) meet design requirements.

5.1.3 Verify that UHS makeup flow rate meets design flow requirements.

5.1.4 Verify that UHS blowdown flow rate meets design flow requirements.

5.1.5 Verify that the operation of UHS level and temperature instruments and alarms meet design requirements.

5.1.6 Verify that the UHS tower bypass function meets design requirements.

5.1.7 Verify that the chemical treatment system meets design requirements.

5.2 Verify that safety-related components meet electrical independence and redundancy requirements.

14.2.12.5.9 Reserved (Test #050)

14.2.12.6 General Supply Systems

14.2.12.6.1 Reserved (Test #051)

14.2.12.6.2 Safety Chilled Water System (Test #052)

1.0 OBJECTIVE

1.1 To demonstrate proper operation of the safety chilled water system (SCWS).

1.2 To demonstrate electrical independence and redundancy of power supplies.

1.3 To demonstrate proper operation of safety chilled water pumps in single and parallel operation.

2.0 PREREQUISITES

2.1 Construction activities on the SCWS have been completed.

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

2.3 Test instrumentation available and calibrated per applicable procedures.

2.4 The flow instrumentation downstream of each SCWS pump is functional.

2.~~4~~5 The CCWS is available for chiller operation, where necessary.

2.~~5~~6 Appropriate AC and DC power sources are available.

2.~~6~~7 Interfacing system loads are connected and available.

2.~~7~~8 SCWS support systems (makeup, nitrogen) are available.

2.~~8~~9 SCWS has been filled and pressurized.

3.0 TEST METHOD

3.1 Verify pump performance characteristics (e.g., head versus flow, motor current) for the SCWS pumps.

3.1.1 $NPSH_a \geq NPSH_R$.

3.1.2 Discharge head.

3.1.3 Flow corresponding to head at each point.

3.1.4 Starting time (motor start time and time to reach flow).

3.2 Demonstrate that each SCWS division can be operated from its local and remote manual control station.

3.3 Demonstrate that each SCWS division starts automatically in response to each appropriate signal.

3.4 Verify that the chillers supply chilled water at the rated flow and design conditions.

3.5 Verify chilled water flow to each supplied component.

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

3.7 Verify system baseline performance during HFT.

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

3.9 Operate the SCWS pumps in each division in parallel and throttle system flow over the entire design range using a single common throttle valve while recording individual pump flow data.

4.0 DATA REQUIRED

4.1 Record flows as required to components and throttle valve positions.

4.2 Record alarm, interlocks, and control setpoints.

4.3 Record chiller normal operating parameters.

4.4 Record pump head versus flow and operating data. for single and parallel pump operation.

4.5 System operating parameters during HFT.

DRAFT

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5.0 ACCEPTANCE CRITERIA

5.1 The SCWS operates as described in Section 9.2.8.

5.1.1 Verify pump performance characteristics for the SCWS pumps meets design requirements. for single and parallel pump operation.

5.1.2 Verify that each SCWS division controls meet design requirements.

5.1.3 Verify that each SCWS division starts automatically in response to each appropriate signal.

5.1.4 Verify that the chillers supply chilled water at the rated flow and design conditions.

5.1.5 Verify chilled water flow to each supplied component.

5.1.6 Verify alarms, interlocks, indicating instruments, and status lights meet design requirements.

5.2 Verify that safety-related components meet electrical independence and redundancy requirements.

14.2.12.6.3 Reserved (Test #053)

14.2.12.6.4 Fire Water Distribution System (Test #054)

1.0 OBJECTIVE

1.1 To demonstrate the ability of the fire water distribution system (FWDS) to provide water at acceptable flows and pressures to protected areas.

2.0 PREREQUISITES

2.1 Construction activities on the FWDS have been completed.

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

2.3 Support systems required for operation of the FWDS are complete and functional.

2.4 Test instrumentation is available and calibrated.

2.5 Verify that the fire water distribution system has two separate fresh water storage tanks that meet design requirements.

2.5.1 Table 14.3-3 Item 3-7.

3.0 TEST METHOD

3.1 Demonstrate the head and flow characteristics of the fire water pumps and the operation of auxiliaries.

3.2 Verify control logic.

Revised JAN RAI 381 Q 09.02.02-1006

B 3.7 PLANT SYSTEMS

B 3.7.9 Safety Chilled Water (SCW) System

BASES

BACKGROUND

The SCW System provides a heat sink for the removal of process and operating heat from safety related components during an anticipated operational occurrence (AOO) or postulated accident. During normal operation, and a normal shutdown, the SCW System also provides this function for the associated safety related systems. The safety related function is covered by this LCO.

The SCW System consists of four independent trains. Each train consists of a chiller refrigeration unit (three 50% compressors per unit), chilled water pumps (two 100% pumps), surge tank, piping, valving, and instrumentation. Normally open motor operated cross-tie valves interconnect the supply and return of Train 1 with Train 2 and interconnect the supply and return of Train 3 with Train 4. Each SCW System chiller is sized to meet the system load requirements of two divisional trains. Heat is rejected to the system chilled water as it passes through the cooling coils of the system users. This heat is rejected from the system as it is pumped through the train chiller refrigeration units. Trains 1 and 4 reject this energy to ambient via air cooled condensers while trains 2 and 3 have condensers cooled by the Component Cooling Water (CCW) System. Each refrigeration chiller in the four divisions of the SCWS has three 50 percent capacity compressors to provide sufficient operating redundancy and flexibility in the event of a compressor failure. The two remaining chiller compressors provide 100 percent capacity.

~~The SCW System is normally operating and cools the Control Room Air Conditioning System (CRACS), Safeguards Building Ventilation System Electrical Division (SBVSED), and the train 1 and 4 Low Head Safety Injection (LHSI) pump motor and seal coolers. The combined HVAC function of the SBVSED and SCW systems is backed by a non-safety related, 100% capacity maintenance train which is cooled by the Operational Chilled Water System.~~ During normal operation, at least one train of the divisional pair is in operation. Either Train 1 or Train 2 chiller provides safety chilled water cooling for all SCW loads within Safeguard Building Divisions 1 and 2, and the (associated) Fuel Building Ventilation System (FBVS) (load). Likewise, the chiller from either Train 3 or 4 provides safety chilled water cooling for both Safeguard Divisions 3 and 4 and the associated FBVS load. During normal operation, the cross-tie isolation valves (supply and return for both divisions) are normally open. The non-operating chiller and pump(s) are maintained in standby. This configuration also allows for maintenance on the non-operating chiller and pump(s). If the normal operating train pump or chiller fails, a switchover

Revised IAW RAI 361, Q 09.02.02-99c

RAI 361, Markup, Inserts

[Q 09.02.02-95 a & b]

1. In case of loss of off-site power, each SCWS division is powered from its associated emergency diesel generator (EDG). To allow divisional maintenance (e.g., maintenance on EDGs), the SCWS safety-related motor operated flow control valves and the motor operated cross-tie valves are powered from the normal 1E power division or alternately fed from the adjacent class 1E power division. In cross-tie operation, this provides the capability to operate the SCWS flow control valves in two cross-tied trains, if necessary switch to the standby train in the divisional pair, or if necessary close the cross-tie valves. Division 2 is the alternate feed for Division 1 and vice versa. Division 4 is the alternate feed for Division 3 and vice versa.

[Q 09.02.02-96]

2. The SCWS cross-tie piping will be routed through the stair tower structures between Safeguard Building 1 and Safeguard Building 2 and between Safeguard Building 3 and Safeguard Building 4. The stair tower structures are Seismic Category I and designed to withstand the effects of earthquakes, tornadoes, hurricanes, floods, external missiles, and other natural phenomena.

[Q 09.02.02-99]

3. The capacity of each SCWS train is sufficient to provide the maximum demand of the user heat exchangers in two divisions. For example, if SCWS Train 1 is the operating train in divisional pair 1 & 2, Train 1 supplies chilled water to the user heat exchangers in Safeguard Building 1, Safeguard Building 2 and Division 1 of the Fuel Building Ventilation System. Likewise, if SCWS Train 3 is the operating train in divisional pair 3 & 4, Train 3 supplies chilled water to the user heat exchangers in Safeguard Building 3, Safeguard Building 4 and second of two divisions (Division 4) of the Fuel Building Ventilation System. There are three compressors in each train. Two compressors operate to supply the required capacity. Both pumps in the operating train operate to provide the required capacity.

3.7 PLANT SYSTEMS

3.7.9 Safety Chilled Water (SCW) System

RAI 361
Q 9.2.2-[redacted]104

LCO 3.7.9 Four SCW trains shall be OPERABLE ~~and in operation~~.

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

ACTIONS

~~NOTE~~
~~Enter applicable Conditions and Required Actions of LCO 3.4.6, "RCS Loops - MODE 4," for residual heat removal loops made inoperable by SCW System.~~

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. One SCW train inoperable ~~or not in operation.~~	A.1	Restore SCW train to OPERABLE status ~~and in operation.~~	~~72 hours~~30 days
B. Required Action and associated Completion Time not met.	B.1	Be in MODE 3.	6 hours
	AND		
	B.2	Be in MODE 5.	36 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
~~SR 3.7.9.1~~	~~Verify each SCW train is in operation.~~	~~24 hours~~

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.7.9.~~2~~1	-----NOTE----- Isolation of SCW flow to individual components does not render the SCW System inoperable. ----- Verify each SCW manual, power operated, and automatic valve in the flow path servicing safety related equipment, that is not locked, sealed, or otherwise secured in position, is in the correct position.	31 days
~~SR 3.7.9.3~~ 2	~~Verify each SCW train has the capability to remove the design heat load.~~	~~24 months~~
SR 3.7.9.~~4~~2 3	Verify, on an actual or simulated loss of offsite power signal, each SCW train restarts following re-energization of the associated AC electrical power division.	24 months

Put back in

RAI 361, Sup 1
Q 09.02.02-~~[illegible]~~ 104

BASES

SURVEILLANCE REQUIREMENTS (continued)

Verifying the correct alignment for manual, power operated, and automatic valves in the SCW flow path provides assurance that the proper flow paths exist for SCW System operation. This SR does not apply to valves that are locked, sealed, or otherwise secured in position, since they are verified to be in the correct position prior to being locked, sealed, or secured. This SR does not require any testing or valve manipulation; rather, it involves verification that those valves capable of being mispositioned are in the correct position. This SR does not apply to valves that cannot be inadvertently misaligned, such as check valves.

The 31 day Frequency is based on engineering judgment, is consistent with the procedural controls governing valve operation, and ensures correct valve positions.

RAI 361, Sup 1 09.02.02-104

Put back in

~~SR 3.7.9.3~~ 2

~~This SR verifies that the heat removal capability of the system is sufficient to remove the heat load assumed in the control room heat load calculation. This SR consists of a combination of testing and calculations. The 24 month Frequency is appropriate since significant degradation of the SCW system is slow and is not expected over this time period.~~ system

SR 3.7.9.~~4~~ 3

This SR verifies proper automatic operation of the SCW train on an actual or simulated actuation signal. The SCW System is a normally operating system that cannot be fully actuated as part of routine testing during normal operation. The 24 month Frequency is based on the need to perform this Surveillance under the conditions that apply during a unit outage. Operating experience has shown that these components usually pass the Surveillance when performed at the 24 month Frequency. Therefore, the Frequency is acceptable from a reliability standpoint.

REFERENCES 1. FSAR Section 9.2.8.

Request for Additional Information No. 417(4741), Revision 0

6/8/2010

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 09.02.02 - Reactor Auxiliary Cooling Water Systems
Application Section: 9.2.2

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

09.02.02-118

Follow-up to RAI 334, Question 9.2.2-66 and RAI 174, Question 9.2.2-17:

The staff's review of the applicant's response and found that the FSAR markup was incomplete in that it did not fully address the basis and requirements for the special single failure requirements applied for RCP Thermal Barrier Cooling. AREVA is requested to expand the proposed FSAR markup to address at least the following key points:

a. Since all four RCP thermal barriers are cooled by one of two common headers, describe the maintaining of this configuration by train separation. Failure-modes and effects analysis have not been provided in the FSAR for any CCWS active failures, in particular the common thermal barrier cooling headers. Single failure includes, but not limited to, operator errors, spurious activation of a valve operator and loss of a cooling water pump.

b. To clarify, SRP 9.2.2, Section III, part 6 states that the SAR description information, P&IDs, CWS drawings, and failure-modes and effects analysis are reviewed by the primary review organization for whether essential portions of the system function following design-basis accidents, assuming a concurrent single active component failure. The applicant should incorporate this information into the FSAR.

c. In addition, this intrusion of air from the surge tank or failures of CCWS users should also be considered into the failure-modes and effects analysis base on operating experience at St. Luice (LER3352010001R0), from October 16, 2008.

Response to Question 09.02.02-118:

a. To maintain strict CCWS train separation for RCP thermal barrier cooling, an interlocking function is required. The Containment Isolation Valves (CIVs) in the RCP thermal barrier cooling path on the supply and return side of CCWS common 1b cannot be opened unless the CIVs on both the supply and return side of common 2b are closed and vice versa. Refer to FSAR section 9.2.2.6.1.1 "CCWS Containment Isolation Valve Interlock" for a complete discussion on the valve interlock. A review of the CCWS confirmed the Failure Modes and Effects. This information will be added to Section 9.2.2 of the U.S EPR FSAR.

b. Refer to the response to RAI 417, Question 9.2.2-118, Part (a).

c. The CCWS FMEA is included in the Response to Part (a) of RAI 417, Question 9.2.2-118. To prevent air intrusion and vortexing in the CCWS surge tanks, a minimum submergence of the tank discharge line will be maintained in accordance with ANSI/HI 9.8-1998. The MIN4 setpoint at which the CCWS pump trips will be equal to the minimum submergence depth. A review of St. Lucie LER-2010-00, Docket Number 05000335 revealed that the St. Lucie Unit 1 CCWS system observed air intrusion from the connection to a containment instrument air compressor due to a failed check valve. The CCWS system for the U.S. EPR has no connection to the compressed air system therefore there is no chance of air intrusion from compressed air. All portions of the CCWS will be maintained pressure positive to avoid sucking air in through packing.

FSAR Impact:

U.S. EPR FSAR Section 9.2.2 will be revised as described in the response and indicated on the enclosed markup.

9.2.2.6.1.4 CCWS Pump Control, Protection and Monitoring

High Bearings Temperatures

An alarm is relayed to the operator in the MCR when the pump bearing temperature or the motor bearing temperature is near the first threshold value. The second threshold value trips the pump.

High Windings Temperatures

An alarm is relayed to the operator in the MCR when the motor stator windings temperature is near the first threshold value. The second threshold value trips the pump.

9.2.2.6.1.5 Additional Control Features and Interlocks

- Each CCWS pump is interlocked with its associated LHSI/RHR HX supply valve so that when the pump is stopped the supply valve closes, following a delay to allow for pump coast down. This action prevents potential leakage of the CCWS into the SIS train.
- In the event of a pump low flow condition, the associated LHSI HX isolation valve automatically opens to provide a minimum flow path for CCWS pump protection. In the event of a pump high flow condition, the FPCS HX outlet flow control valve is closed to its minimum opening mechanical stop position to reduce the CCWS flow rate and to maintain normal pump operation.
- The CCWS surge tanks are instrumented with level indication and graduated level control and equipment protection set points designated from lowest to highest level (MIN4, MIN3, MIN2, MIN1, MAX1, MAX2, MAX3 and MAX4). A CCWS train can operate continuously so long as the water level in its surge tank is maintained between MIN1 and MAX1.
- Detection of increasing radiation in the CCWS from the CVCS HP coolers indicates leakage and triggers automatic isolation of the affected CVCS HP cooler via motor-operated valves (KBA11/12 AA001/003) in the CVCS. Leakage of reactor coolant into the CCWS from such users as the LHSI HXs is also indicated by increasing radiation in the CCWS and prompts isolation of the user. Only the RCP thermal barrier and CVCS HP cooler leaks result in automatic isolation of the failed users.

9.2.2.7 References

1. ASME Boiler and Pressure Vessel Code, Section III: "Rules for Construction of Nuclear Facility Components," Class 2 and 3 Components, The American Society of Mechanical Engineers, 2004.
2. ANSI/ASME B31.1-2004, "Power Piping," The American Society of Mechanical Engineers, 2004.

RAI 417, Q 9.2.2-118

9.2.7 CCWS Failure Modes and Effects Analysis

A Failure Modes and Effects Analysis (FMEA) for the Component Cooling Water System is provided in Table 9.2-7.

Mission Success Criteria for the Component Cooling Water System:

1) Following a Design Basis Event: Any two CCWS supply trains operating, with supply to the associated SIS/RHR loads, supply to at least one set of Common 1.A/2.A Fuel Pool Cooling loads and supply to the Safety-Related loads (RCP Thermal Barriers, CVCS pump motor coolers, CVCS letdown HP cooler) on at least on set of Common 1.B/2.B operating loads.
2) During Normal Power Operation (NPO): At least one CCWS supply train operating for each pair of common Fuel Pool Cooling and common operating loads (one CCW train carrying the Common 1.A and Common 1.B loads and one CCW train carrying the Common 2.A and 2.B loads).

RAI 417; Q 9.2.2-118 FSAR Insert

Table 9.2.2-7 – Failure Modes and Effects Analysis - CCWS with One CCW Train Unavailable at Normal Power Operation

Component Name	Identifier	Component Function	Failure Mode	Failure Mechanism	Failure Effect	Mission Success	Comments / Actions
CCW Pump	KAA10 AP001 KAA20 AP001 KAA30 AP001 KAA40 AP001	Prime mover to provide cooling water flow through system piping of respective train. Automatically started on Safety Injection Signal to align CCW trains to remove heat from associated LHSI trains for DBA cooldown.	Fails to start on demand	Mechanical, Electrical, I&C	One CCW pump does not start, taking one CCW train out of service. This renders the associated SIS/RHR train and the associated Essential Service Water trains ineffective.	**1) Mission Success Criteria are met**. In normal power operation (NPO), loss of one CCW train leaves: 3 of 4 CCW trains operable, 2 SFP Cooling HX operable 2 CVCS Charging Pumps operable 2 CVCS Letdown HP Coolers operable CCW supplying flow to RCP thermal barriers	CCW system is designed to allow one of the four CCW trains to be taken out of service for maintenance during NPO while retaining full flow to all Common (1/2) A/B loads.
					If a CCW train is already out of service for maintenance, and CCW pump fails to start in complementary CCW train, then only one side of the CCW system (two CCW trains) is operational.	**2) Mission Success Criteria are met.** With one CCW train out for maintenance, failure of complementary CCW train during/after a DBA leaves at minimum: 2 CCW trains operable on one side of the plant, 1 SFP Cooling HX operable 1 CVCS charging pump operable 1 CVCS letdown HP cooler operable, and CCW able to supply flow to all RCP thermal barriers – **but may require operator action to restore cooling flow.**	Some DBA scenarios, such as those involving a SB LOCA without a LOOP, may result in a loss of CCW flow to the RCP thermal barriers AND a loss of CVCS flow to RCP seals. **Operating procedures should require shifting RCP thermal barrier source and operating CVCS charging pump to the side of the plant with two operable CCW trains before a CCW train is secured for maintenance on the other side.**
			Fails while running	Mechanical, Electrical	One CCW pump fails while in service. In NPO, loss of the CCW pump and/or loss of flow in the Common 'B' loop served by that pump initiate an Automatic Backup Switchover Sequence (EBSS). The sequence automatically: Closes all supply and return switchover isolation valves in the affected CCW train. Opens the Common 'B' loop supply and return switchover isolation valves on the complementary CCW train. Opens the SIS/RHR HX CCW inlet flow control valve on the complementary train. Starts the complementary CCW pump, restoring flow to the Common 'B' operating loads on that side of the plant.	**3) Mission Success Criteria are met.** If one CCW pump is lost while running with plant in NPO, the Automatic Backup Switchover Sequence switches operation to the complementary CCW pump and restores cooling flow to Common 'B' operating loads. Thermal inertia provides delay window for operators to manually restore cooling flow to the Common 'A' loads. 3 of 4 CCW trains operable, 2 SFP Cooling HX operable (may require operator action to restore flow) 2 CVCS Charging Pumps operable 2 CVCS Letdown HP Coolers operable CCW maintains flow to RCP thermal barriers	

Component Name	Identifier	Component Function	Failure Mode	Failure Mechanism	Failure Effect	Mission Success	Comments / Actions
CCW Pump (Continued)	KAA10 AP001 KAA20 AP001 KAA30 AP001 KAA40 AP001	Prime mover to provide cooling water flow through system piping of respective train. Automatically started on SIS signal to align CCW trains to remove heat from associated LHSI trains for DBA cooldown.	Fails while running	Mechanical, Electrical	If a CCW train is already out of service for maintenance, and failure occurs to complementary CCW pump while in operation, one side of CCW is lost but both CCW trains on other side remain operable. Identical to DBA case for pump fails to start.	**4) Mission Success Criteria are met**. Results bounded by 2) above.	
			Fails to stop on demand	Electrical, I&C	Pump remains running, but can be isolated from Common (1/2) A/B loops and allowed to recirculate flow through the associated SIS/RHR HX until de-energized.	**5) Mission Success Criteria are met**. Plant/system conditions permitted stopping the affected CCW pump before it failed in RUN. Therefore, pump can be isolated from the Common (1/2) A/B loads without impact on the plant.	Affected CCW train will be out of service until maintenance resolves electrical / I&C fault that kept pump running.
CCW Heat Exchangers	KAA10 AC001 KAA20 AC001 KAA30 AC001 KAA40 AC001	Rejects heat from CCW system to ESW system for transfer to UHS	Tube rupture: CCW leak to ESW	Mechanical	CCW Surge tank level on affected train lowers; possibly initiating makeup flow from GHC. ESW inventory increases.	**6) Mission Success Criteria are met**. With one CCW train out for maintenance, loss of a single CCW heat exchanger in another train leaves two trains operable, and able to carry at least one side of the plant. This event is bounded by 2) above because the affected CCW HX can continue to provide partial cooling, and the water inventory in the affected CCW train can be made up.	Affected CCW train may be isolated, but could remain in service if plant conditions necessitate
			Tube rupture: ESW to CCW	Mechanical	Not Credible: CCW design pressure (175 psig) > ESW design pressure (100 psig); CCW nominal pump discharge pressure (87psig) > ESW required pump head (75 psig)		
			Loss of ESW cooling flow	Mechanical, Electrical, I&C	Loss of heat sink for CCW (and for systems which are heat source to CCW). Design separation of ESW trains limits credible failures to those affecting a single CCW train. Final effect is similar to loss of a CCW pump for the same train, but proceeds over a longer period of time.	**7) Mission Success Criteria are met**. With one CCW train out for maintenance, loss of a single CCW heat exchanger in another train leaves two trains operable, and able to carry at least one side of the plant. This event is bounded by 2) above because the affected CCW HX can continue to provide partial cooling until the ESW temperature in the affected CCW HX rises above the CCW inlet temperature. By engineering judgment, the time delay for loss of CCW cooling in a train is longer for loss of heat sink flow than for loss of a CCW pump.	Affected CCW train may provide heat sink for a finite period of time after loss of ESW cooling flow.

Component Name	Identifier	Component Function	Failure Mode	Failure Mechanism	Failure Effect	Mission Success	Comments / Actions
CCW Heat Exchanger Bypass Valves	KAA10 AA112 KAA20 AA112 KAA30 AA112 KAA40 AA112	Maintains minimum CCW temperature of 59.0ºF by opening to increase bypass flow around CCW Heat Exchanger	Fails to Open	Mechanical, Electrical, I&C	Design condition is allowed mode 1, with no CCW service to Common heat loads. CCW train operation temperatures below the 59ºF minimum may result in maximum thermal stress (one thermal fatigue cycle) to LHSI/RHR HX heat transfer surface if RCS flow through LHSI/RHR HX initiates for SB LOCA. Calculation of thermal stresses in LHSI/RHR HX is not explicitly cited for this case.	**8) Mission Success Criteria are met**. With one CCW train out for maintenance, loss of minimum CCW temperature control in another train does not prevent heat transfer to CCW system. At least three CCW trains remain operable, including the affected train. However, the affected CCW train may experience a thermal fatigue cycle affecting the service life of the LHSI/RHR HX heat transfer interface.	Operator may be able to return affected train to normal temperature range by shifting some Common loop loads to the affected train.
		Maintains maximum CCW temperature of 100.4ºF by closing to reduce or stop bypass flow around CCW Heat Exchanger	Fails to Close	Mechanical, Electrical, I&C	Design condition is allowed mode 6, with a single CCW train providing flow to associated SIS/RHR loop and both sets of Common loop heat loads. CCW train operation at temperature above the 100.4ºF maximum limits the heat removal from various loads on service. The effect is similar to, but less severe than, the loss of a CCW pump. CCW HX maximum design temp is 225ºF	**9) Mission Success Criteria are met**. With one CCW train out for maintenance, loss of maximum CCW temperature control in one train leaves two trains operable with ability to carry loads on at least one side of the plant. This event is bounded by 2) above because the heat load on the affected train may be restored by splitting the Common loops so that some loads are carried by the complementary CCW train.	Operator may be able to return affected train to normal temperature range by splitting some of the Common loop loads to another CCW train.
CCW Heat Exchanger Outlet Temperature Sensors	KAA10/20/30/40 CT893 CT894 CT895	Monitor CCW HX Outlet temperature for adjustment of associated CCW Heat Exchanger Bypass Valve to control CCW Heat Exchanger outlet temperature.	Spurious High Spurious Low	Electrical, I&C	Control system uses input from three CCW HX Outlet temperature sensors to preclude a spurious signal from one failed sensor from causing change to CCW HX Bypass Valve position.	**10) Mission Success Criteria are met**. With one CCW train out for maintenance, loss of one CCW HX Outlet temperature sensor has no effect on CCW train operability. Three CCW trains, including the affected train, remain operable.	

Component Name	Identifier	Component Function	Failure Mode	Failure Mechanism	Failure Effect	Mission Success	Comments / Actions
SIS/RHR Heat Exchangers	JNG10 AC001 JNG20 AC001 JNG30 AC001 JNG40 AC001	Transfers heat from RCS to CCW during normal (RHR) and DBA (LHSI) cooldowns. In standby during normal power operation.	Tube rupture: LHSI (RCS) leak to CCW	Mechanical	SB LOCA from RCS (via LHSI) to CCW may occur during normal or DBA cooldown. SB LOCA not credible during NPO because LHSI/RHR in standby, and not pressurized. Rising level in CCW Surge tank on affected train (KAAi0 CL094/CL099/CL598). Rising CCW LHSI/RHR HX return temperature on affected train (KAAi2 CT555). Rising CCW HX inlet/outlet temperatures on affected train (KAAi0 CT092/CT090). Activity detected in CCW pump recirculation line (KAAi0 CR001). No SIS or CI signal if initiates as accident during cooldown, no heat loads are shed. If single failure following LB LOCA or other SB LOCA during NPO, SIS and CI signals actuate shedding of some heat loads.	**11) Mission Success Criteria are met.** With one CCW train out for maintenance, failure of SIS/RHR HX in complementary CCW train during/after a DBA leaves at minimum: 2 CCW trains operable on one side of the plant, 1 SFP Cooling HX operable 1 CVCS charging pump operable 1 CVCS letdown HP cooler operable, and CCW able to supply flow to all RCP thermal barriers – **but may require operator action to restore cooling flow.**	Operator action to assess indications may be necessary to identify LHSI (RCS) leak to CCW. Diversity of sensors rules out single failure of any one sensor preventing detection of LHSI (RCS) leak to CCW. Some DBA scenarios, such as those involving a SB LOCA without a LOOP, may result in a loss of CCW flow to the RCP thermal barriers AND a loss of CVCS flow to RCP seals. **Operating procedures should require shifting RCP thermal barrier source and operating CVCS charging pump to the side of the plant with two operable CCW trains before a CCW train is secured for maintenance on the other side.**
			Tube rupture: CCW leak to RCS	Mechanical	Potential for CCW leak to LHSI/RHR when CCW is running, with flow through LHSI/RHR HX for CCW pump flow protection, and LHSI/RHR in standby. CCW dilutes RCS in the affected LHSI/RHR train, but does not immediately affect RCS because RCS pressure prevents backflow from LHSI/RHR. However, a subsequent reactivity excursion may occur when flow is initiated in the affected LHSI/RHR train. CCW surge tank level decreasing on affected train.	**12) Mission Success Criteria are met.** With one CCW train out for maintenance, CCW to LHSI/RHR train leak does NOT require affected CCW train be taken out of service. At least three CCW trains remain operable, including the affected train.	Affected CCW train can continue to supply Common loop loads without constraint. Operator can stop potential CCW leakage into LHSI/RHR by closing the SIS/RHR Heat Exchanger CCW Supply Isolation Valve on the affected train (CCW system pressure seats check valve KAAi0 AA011 downstream of the affected LHSI/RHR HX).

Component Name	Identifier	Component Function	Failure Mode	Failure Mechanism	Failure Effect	Mission Success	Comments / Actions
SIS/RHR Heat Exchanger CCW Supply Isolation Valves	KAA12 AA005 KAA22 AA005 KAA32 AA005 KAA42 AA005	Protects the associated CCW pump from approaching shutoff head during low flow conditions by providing a flow path through the SIS/RHR HX. Automatically opened on SIS signal to align available CCW trains to remove heat from associated LHSI trains for DBA cooldown.	Fails to Open	Mechanical, Electrical, I&C	Affected CCW pump runs at/near shutoff head, with low flow in CCW train and risking damage to pump and motor. Without operator intervention, pump may eventually be lost. Because affected train approaches shutoff head, low flow condition implies that CCW cooling function has been lost even while pump may still be running.	**13) Mission Success Criteria are met.** With one CCW train out for maintenance, failure of a SIS/RHR HX CCW Supply Isolation Valve in complementary CCW train during/after a DBA leaves at minimum: 2 CCW trains operable on one side of the plant, 1 SFP Cooling HX operable 1 CVCS charging pump operable 1 CVCS letdown HP cooler operable, and CCW able to supply flow to all RCP thermal barriers – **but may require operator action to restore cooling flow.**	In event that low CCW flow pump protection feature fails, operator can take remote manual action to place additional Common loop loads on the affected pump, providing additional flow paths to move pump operating point away from shutoff head.
SIS/RHR Heat Exchanger CCW Supply Isolation Valves (Continued)	KAA12 AA005 KAA22 AA005 KAA32 AA005 KAA42 AA005	Normally closed when associated LHSI pump is not running to prevent potential RCS dilution if CCW leaks to LHSI/RHR. Automatically closed by time delay after CCW pump is secured to prevent potential RCS dilution if CCW leaks to LHSI/RHR.	Fails to Close	Mechanical, Electrical, I&C	SIS/RHR HX CCW Supply Isolation Valve closure is precautionary; it provides added means of protection in the UNLIKELY event that a leak develops at the heat transfer interface in the SIS/RHR HX. LHSI/RHR train must be in standby and associated CCW must be on service for potential CCW leak to LHSI/RHR to occur. No immediate effect on RCS because in standby, LHSI/RHR train does not have sufficient pressure to inject into RCS. However, dilution could cause a subsequent reactivity transient when LHSI/RHR flow is initiated from affected train during normal or DBA cooldown.	**14) Mission Success Criteria are met.** With one CCW train already out for maintenance, failure of the SIS/RHR HX CCW Supply Isolation Valve to close in another train does NOT prevent the affected train from performing any safety function. At least three CCW trains remain operable, including the affected train.	

Component Name	Identifier	Component Function	Failure Mode	Failure Mechanism	Failure Effect	Mission Success	Comments / Actions
LHSI Pump 2/3 Seal Water Cooler CCW Supply Isolation Valve	KAA22 AA013 KAA32 AA013	Open when respective LHSI pump is in operation to provide cooling for LHSI pump 2/3 seal water when respective pump is in operation.	Fails to Open	Mechanical, Electrical, I&C	Loss of CCW supply to a LHSI/RHR pump sealwater cooler will cause steady elevation of sealwater temperatures and eventual loss of the pump seals, resulting in a SBLOCA at the affected LHSI/RHR pump seal and loss of the LHSI pump. Since the LHSI/RHR pump is normally in standby, and only required for normal cooldown (reactor already shutdown and SBLOCA primarily a contamination source in the safeguards building of the affected train) or for DBA cooldown (reactor shutdown and LHSI/RHR seal SBLOCA is a complication to a more serious event) this is not a controlling event.	**15) Mission Success Criteria are met.** With one CCW train out for maintenance, failure of a LHSI/RHR Pump Seal Water Cooler CCW Supply Isolation Valve in the complementary CCW train to open would prevent LHSI/RHR flow to the LHSI/RHR HX in the affected LHSI/RHR train, effectively removing that heat transfer train from service during/after a DBA. This leaves at minimum: 2 CCW trains operable on one side of the plant, 1 SFP Cooling HX operable 1 CVCS charging pump operable 1 CVCS letdown HP cooler operable, and CCW able to supply flow to all RCP thermal barriers – **but may require operator action to restore cooling flow.**	In event that the LHSI/RHR Pump Seal Water Cooler CCW Supply isolation valve fails to open, the operator can secure the affected LHSI/RHR pump and continue cooldown with remaining assets.
		Closed when respective LHSI pump is not in operation to prevent potential LHSI (RCS) dilution from CCW in event of a Seal Water cooler failure (tube leak)	Fails to Close	Mechanical, Electrical, I&C	LHSI/RHR Pump Seal Water Cooler CCW Supply Isolation Valve closure is precautionary; it provides added means of protection in the UNLIKELY event that a leak develops at the heat transfer interface in the Seal Water Cooler. A leak in the Seal Water Cooler when the LHSI/RHR pump is in standby could result in dilution of the static RCS volume present in the associated LHSI/RHR pump header.	**16) Mission Success Criteria are met.** With one CCW train already out for maintenance, failure of the SIS/RHR HX CCW Supply Isolation Valve to close in another train does NOT prevent the affected train from performing any safety function. At least three CCW trains remain operable, including the affected train. Bounded by 14) above.	

Component Name	Identifier	Component Function	Failure Mode	Failure Mechanism	Failure Effect	Mission Success	Comments / Actions
Common SFP Cooling Switchover Isolation Valves	KAA10 AA033 KAA20 AA033 KAA30 AA033 KAA40 AA033 (Supply) KAA10 AA032 KAA20 AA032 KAA30 AA032 KAA40 AA032 (Return)	Open to provide CCW cooling flow to Common (1.A/2.A) SFP cooling loads. Closed to prevent CCW cooling flow to Common (1.A/2.A) SFP cooling loads. Interlocked to prevent both CCW trains from providing flow to Common (1.A/2.A) SFP cooling loads at the same time. Fast-acting (<10 seconds) to minimize interruption of cooling flow to Common (1.A/2.A) during switchover.	Fails to Open	Mechanical, Electrical, I&C	Failure of ONE Common SFP Cooling switchover isolation valve (Supply or Return) to OPEN on demand prevents the affected CCW train from providing cooling flow to the Common SFP cooling (1.A/2.A) loads. IF the complementary CCW train is operable, that train can supply cooling flow to Common SFP cooling (1.A/2.A) loads that have temporarily lost CCW supply.	**17) Mission Success Criteria are met.** With one CCW train out for maintenance, failure of one Common SFP Cooling (1.A/2.A) supply or return switchover isolation valve to OPEN in the complementary CCW train prevents CCW flow to the SFP cooling loads from one side of the plant. This leaves at minimum: 3 CCW trains operable, including the affected train 1 SFP Cooling HX operable 2 CVCS charging pump operable 2 CVCS letdown HP cooler operable, and CCW supplying flow to all RCP thermal barriers.	Operator action is required to restore SFP cooling, since the Automatic Back-Up Switchover Sequence does not actuate these valves. Given the thermal inertia of the SFP, immediate action is not required; the delay time available before operator action is required varies with initial SFP temperature and decay heat load imposed by the spent fuel stored in the pool.
			Fails to Close	Mechanical, Electrical, I&C	Failure of ONE Common SFP Cooling switchover isolation valve (Supply or Return) to CLOSE on demand prevents transfer of cooling supply to the complementary CCW train. IF the affected CCW train is otherwise operable, that train may continue to supply cooling flow to Common SFP cooling (1.A/2.A) loads.	**18) Mission Success Criteria are met.** With one CCW train out for maintenance, failure of one Common SFP Cooling (1.A/2.A) supply or return switchover isolation valve in the complementary train to CLOSE does not prevent that train from providing cooling flow to those loads. This leaves at minimum: 3 CCW trains operable, including the affected train 2 SFP Cooling HX operable 2 CVCS charging pump operable 2 CVCS letdown HP cooler operable, and CCW supplying flow to all RCP thermal barriers.	
			Fails in Intermediate Position	Mechanical, Electrical, I&C	Interlock prevents opening the oncoming switchover isolation valves until the off-going isolation valves are closed. Valve failure in an intermediate position may reduce CCW flow to the affected Common SFP Cooling (1.A/2.A) loads, but still allows some flow from the affected CCW train.	**19) Mission Success Criteria are met.** With one CCW train out for maintenance, failure of one Common SFP Cooling (1.A/2.A) supply or return switchover isolation valve in the complementary train to CLOSE does not prevent that train from providing cooling flow to those loads. Bounded by 17) above.	

Component Name	Identifier	Component Function	Failure Mode	Failure Mechanism	Failure Effect	Mission Success	Comments / Actions
Fuel Pool Cooling HX 1/2	FAK10 AC001 FAK20 AC001	Transfers heat from Spent Fuel Pool to CCW	Heat transfer interface failure: CCW leaks to FAK	Mechanical	CCW leakage into SFP still provides cooling, but reduces CCW inventory from the CCW surge tank for CCW train on service. CCW leakage increases SFP water inventory, but dilutes SFP boron concentration. CCW nominal operating pressure (87 psig) > FPC nominal shutoff head pressure (61 psig). Therefore, leakage continues until CCW flow is isolated from affected Fuel Pool Cooling HX.	**20) Mission Success Criteria are met.** With one CCW train out for maintenance, failure of a Fuel Pool Cooling Heat Exchanger on either side of the plant leaves at minimum: 3 CCW trains operable, 1 SFP Cooling HX operable 2 CVCS charging pump operable 2 CVCS letdown HP cooler operable, and CCW supply to all RCP thermal barriers (capable from either side of the plant)	Operator cannot stop leakage by switching Common (1.A/2.A) supply to complementary CCW train. Operator can stop leakage by shifting operation to the redundant FPC HX. Operator can isolate leakage by directing manual isolation of CCW supply/return to affected FPC HX.
Fuel Pool Cooling HX 1/2 CCW Flow Control Valve	KAB10 AA134 KAB20 AA134	Operator action to jog valve closed protects CCW pump from approaching runout (high flow) conditions by reducing CCW flow through the Fuel Pool Cooling HX.	Fails to Open	Mechanical, Electrical, I&C	Failure of a Fuel Pool Cooling HX CCW Flow Control Valve to OPEN prevents cooling flow through the associated Fuel Pool Cooling Heat Exchanger from either of the CCW trains for that side of the plant.	**21) Mission Success Criteria are met**. Results bounded by 20) above.	
			Fails to Close	Mechanical, Electrical, I&C	Failure of a Fuel Pool Cooling HX CCW Flow Control Valve to CLOSE prevents desired reduction to CCW train flow.	**22) Mission Success Criteria are met.** With one CCW train out for maintenance, failure of the Fuel Pool Cooling HX Flow Control Valve to close prevents only the preferred method of reducing CCW flow in the affected CCW train. This leaves at minimum: 3 CCW trains operable, 2 SFP Cooling HX operable 2 CVCS charging pump operable 2 CVCS letdown HP cooler operable, and CCW supplying flow to all RCP thermal barriers.	Excess CCW flow demand is only a problem when a single CCW train is supplying ALL cooling loads on one side of the plant (allowed mode 6). If it is not possible to reduce CCW flow through the Fuel Pool Cooling HX on service, operator can reduce CCW flow by realigning the loads carried by the operating and available CCW trains.
			Fails in Intermediate Position	Mechanical, Electrical, I&C	Failure of a Fuel Pool Cooling HX CCW Flow Control Valve in an intermediate position still allows partial CCW cooling flow through the affected FPC HX, while providing some reduction to that CCW flow. This scenario is bounded by the scenarios in which the valve fails to fully OPEN or CLOSE.	**23) Mission Success Criteria are met**. Results bounded by 21) above for valve failure to move more OPEN. Results bounded by 22) above for valve failure to move more CLOSED.	

Component Name	Identifier	Component Function	Failure Mode	Failure Mechanism	Failure Effect	Mission Success	Comments / Actions
CCW Pump Flow Instrument	KAA10 CF053 KAA20 CF053 KAA30 CF053 KAA40 CF053	Monitors CCW pump flow; low flow signal automatically opens KAA12/22/32/42 AA005 to increase CCW flow; high flow signal prompts operator action to close KAB10/20 AA134 to reduce CCW flow.	Fails to recognize low flow condition OR Fails to generate low flow signal	Mechanical, I&C	Affected CCW pump will approach shutoff head conditions, with low flow in associated CCW piping and consequent loss of cooling to loads on service. Continued operation near shutoff head can result in pump overheating, eventually causing loss of the CCW train.	**24) Mission Success Criteria are met.** With one CCW train out for maintenance, failure of CCW pump in the complementary train is bounded by 2) above and leaves at minimum: 2 CCW trains operable on one side of the plant, 1 SFP Cooling HX operable 1 CVCS charging pump operable 1 CVCS letdown HP cooler operable, and CCW able to supply flow to all RCP thermal barriers – **but may require operator action to restore cooling flow.**	
			Fails to recognize high flow condition OR Fails to generate high flow signal	Mechanical, I&C	Affected CCW pump will approach run-out conditions, with high flow in associated CCW piping. Continued operation near pump run-out can result in damage to pump and motor, eventually causing loss of the CCW train.	**25) Mission Success Criteria are met**. Results same as 24) above and bounded by 2) above.	
			Spurious high flow signal	I&C	Alarms in control room to prompt Operator to take action to reduce FPC flow.	**26) Mission Success Criteria are met.** With one CCW train out for maintenance, spurious high flow signal from the CCW Pump Flow Instrument for the complementary train prompts operator to act to reduce CCW flow to the FPC HX. This leaves at minimum: 3 CCW trains operable (one with spurious high flow signal), 2 SFP Cooling HX operable 2 CVCS charging pump operable 2 CVCS letdown HP cooler operable, and CCW supplying flow to all RCP thermal barriers.	Operator action to reduce CCW flow to the FPC HX will not clear the spurious alarm signal, which may be initial indication that the signal is spurious. Review of relevant plant parameters will corroborate determination. If all CCW trains are operable, the affected CCW train may be taken out of service for maintenance; if one CCW train is already out for maintenance, operators may continue to operate the train with the spurious alarm but must exercise increased vigilance in monitoring associated plant conditions.

Component Name	Identifier	Component Function	Failure Mode	Failure Mechanism	Failure Effect	Mission Success	Comments / Actions
CCW Pump Flow Instrument (Continued)	KAA10 CF053 KAA20 CF053 KAA30 CF053 KAA40 CF053	Monitors CCW pump flow; low flow signal automatically opens KAA12/22/32/42 AA005 to increase CCW flow; high flow signal prompts operator action to close KAB10/20 AA134 to reduce CCW flow.	Spurious low flow signal	I&C	Opens SIS/RHR HX CCW Supply Isolation Valve on affected train. If affected CCW train was carrying both sets of Common cooling loads (allowed mode 5) then the spurious low flow signal may cause automatic realignment to allowed mode 6, **which can then cause a valid high flow condition in the affected train that may be masked by the spurious low flow signal.**	**27) Mission Success Criteria are met.** With one CCW train out for maintenance, spurious low flow signal from the CCW Pump Flow Instrument for the complementary train automatically opens the associated SIS/RHR HX CCW Supply Isolation Valve. This leaves at minimum: 3 CCW trains operable (one with spurious low flow signal), 2 SFP Cooling HX operable 2 CVCS charging pump operable 2 CVCS letdown HP cooler operable, and CCW supplying flow to all RCP thermal barriers.	Operator vigilance to identify flow signals that are not chronologically correlated to operations that realign CCW system configuration may help recognize spurious low CCW flow signals. Operator action may be necessary to mitigate unwarranted automatic response to spurious low CCW flow signals. SPF thermal inertia provides margin for operation with reduced FPC HX flow until Operator recognizes and counteracts the spurious low CCW flow signal.
Common Operating Load Cooling Switchover Isolation Valves	KAA10 AA006 KAA20 AA006 KAA30 AA006 KAA40 AA006 (Supply) KAA10 AA010 KAA20 AA010 KAA30 AA010 KAA40 AA010 (Return)	Open to provide CCW cooling flow to Common (1.B/2.B) operating loads. Closed to prevent CCW cooling flow to Common (1.B/2.B) operating loads. Interlocked to prevent both CCW trains from providing flow to Common (1.B/2.B) operating loads at the same time. Fast-acting (<10 seconds) to minimize interruption of cooling flow to Common (1.B/2.B) during switchover.	Fails to Open	Mechanical, Electrical, I&C	Failure of ONE Common Operating Load (1.B/2.B) B switchover isolation valve (Supply or Return) to OPEN on demand prevents the affected CCW train from providing cooling flow to the Common Operating Loads (1.B/2.B) B. IF the complementary CCW train is operable, then the Automatic Backup Switchover Sequence will act to restore cooling flow to the Common Operating Loads (1.B/2.B) B I that have temporarily lost CCW supply.	**29) Mission Success Criteria are met.** With one CCW train out for maintenance, failure of one Common Operating Load (1.B/2.B) supply or return switchover isolation valve to OPEN in the complementary CCW train prevents CCW flow to the Common Operating Loads on one side of the plant. This leaves at minimum: 3 CCW trains operable, including affected train 2 SFP Cooling HX operable 1 CVCS charging pump operable 1 CVCS letdown HP cooler operable, and CCW able to supply flow to all RCP thermal barriers – **but may require operator action to restore cooling flow.**	

Component Name	Identifier	Component Function	Failure Mode	Failure Mechanism	Failure Effect	Mission Success	Comments / Actions
Common Operating Load Cooling Switchover Isolation Valves (Continued)	KAA10 AA006 KAA20 AA006 KAA30 AA006 KAA40 AA006 (Supply) KAA10 AA010 KAA20 AA010 KAA30 AA010 KAA40 AA010 (Return)	Open to provide CCW cooling flow to Common (1.B/2.B) operating loads. Closed to prevent CCW cooling flow to Common (1.B/2.B) operating loads. Interlocked to prevent both CCW trains from providing flow to Common (1.B/2.B) operating loads at the same time. Fast-acting (<10 seconds) to minimize interruption of cooling flow to Common (1.B/2.B) during switchover.	Fails to Close	Mechanical, Electrical, I&C	Failure of ONE Common Operating Load (1.B/2.B) switchover isolation valve (Supply or Return) to CLOSE on demand prevents transfer of cooling supply to the complementary CCW train. IF the affected CCW train is otherwise operable, that train may continue to supply cooling flow to Common Operating Loads (1.B/2.B).	**30) Mission Success Criteria are met.** With one CCW train out for maintenance, failure of one Common Operating Load (1.B/2.B) supply or return switchover isolation valve in the complementary train to CLOSE does not prevent that train from providing cooling flow to those loads. This leaves at minimum: 3 CCW trains operable, including affected train 2 SFP Cooling HX operable 2 CVCS charging pump operable 2 CVCS letdown HP cooler operable, and CCW supplying flow to all RCP thermal barriers.	
			Fails in Intermediate Position	Mechanical, Electrical, I&C	Interlock prevents opening the oncoming switchover isolation valves until the off-going isolation valves are closed. Valve failure in an intermediate position may reduce CCW flow to the affected Common Operating Loads (1.B/2.B) loads, but still allows some flow from the affected CCW train.	**31) Mission Success Criteria are met.** With one CCW train out for maintenance, failure of one Common Operating Load (1.B/2.B) supply or return switchover isolation valve in the complementary train to CLOSE does not prevent that train from providing cooling flow to those loads. Bounded by 28) above.	
Containment Isolation Valves in CCW Supply/Retur n to Containment Ventilation and RCS Drain coolers	KAB40 AA001 (CCW Supply Outer CIV) KAB40 AA012 (CCW Return Inner CIV) KAB40 AA006 (CCW Return Outer CIV)	Normally open, automatically closed to prevent potential release of radioactive material from containment. Actuated by Containment Isolation – Stage 1 signal.	Fails to Open	Mechanical, Electrical, I&C	If any ONE of these containment isolation valves fails to OPEN, then CCW cooling cannot be provided to the Containment Ventilation coolers (KLA61 AC001/003 and KLA63 AC003/004) or to the primary effluent heat exchanger (KTA10 AC001). In NPO, these valves are normally open, but may be cycled to test operability of Containment Isolation. Although the equipment is NOT relied upon for mitigation of DBAs, failure to restore cooling to containment ventilation after valve testing would likely initiate unplanned outage for repairs to preserve EQ margins for equipment inside containment.	**32) Mission Success Criteria are met.** With one CCW train out for maintenance, failure of one Containment Isolation valve in the supply or return lines to the Containment Ventilation coolers and the RCS drain cooler does not further constrain any safety-related cooling loads. This leaves at minimum: 3 CCW trains operable, including affected train 2 SFP Cooling HX operable 2 CVCS charging pump operable 2 CVCS letdown HP cooler operable, and CCW supplying flow to all RCP thermal barriers.	Check valve KAB40 AA002 provides second isolation valve on CCW Supply line (Inner CIV)

Component Name	Identifier	Component Function	Failure Mode	Failure Mechanism	Failure Effect	Mission Success	Comments / Actions
			Fails to Close	Mechanical, Electrical, I&C	If any ONE of these containment isolation valves fails to CLOSE, the containment isolation function is fulfilled by the redundant containment isolation valve on the supply or return side.	**33) Mission Success Criteria are met**. Results bounded by 32) above.	
Containment Isolation Valves in CCW cooling Supply/Return to CVCS HP Cooler 1/2 and to RCP 1/2/3/4 motor coolers	KAB60 AA013 KAB70 AA013 (CCW Supply Outer CIV) KAB60 AA018 KAB70 AA018 (CCW Return Inner CIV) KAB60 AA019 KAB70 AA019 (CCW Return Outer CIV)	Normally open, automatically closed to prevent release of radioactive material from containment. Actuated by Containment Isolation – Stage 2 signal.	Fails to Open	Mechanical, Electrical, I&C	If any ONE of these containment isolation valves fails to OPEN, then CCW cooling cannot be provided to the CVCS letdown High Pressure Cooler (KBA11/12 AC001) or to the various motor and oil coolers for RCPs 1/2/3/4 on the affected side of the plant. In NPO, these valves are normally open.	**34) Mission Success Criteria are met.** With one CCW train out for maintenance, failure of one Containment Isolation valve in the supply or return lines to the RCP motor and oil coolers (four coolers each RCP) and to the CVCS letdown HP Cooler does not further constrain any other safety-related cooling loads. This leaves at minimum: 3 CCW trains operable, including affected train 2 SFP Cooling HX operable 2 CVCS charging pump operable **1 CVCS letdown HP cooler operable**, and CCW supplying flow to all RCP thermal barriers.	Check valves KAB60 AA014 and KAB70 AA014 provide second isolation valve on respective CCW Supply lines (Inner CIV)
			Fails to Close	Mechanical, Electrical, I&C	If any ONE of these containment isolation valves fails to CLOSE, the containment isolation function is fulfilled by the redundant containment isolation valve on the supply or return side.	**35) Mission Success Criteria are met**. Results bounded by 34) above.	
CVCS letdown High Pressure coolers 1/2	KBA11 AC001 KBA12 AC001	Protects coolant purification equipment from thermal damage by cooling RCS letdown flow	Tube Rupture: CVCS letdown (RCS) leaks to CCW	Mechanical	During NPO, nominal pressure at CVCS letdown HP Cooler, 2250 psia >> CCW system design pressure, 190 psia. RCS leakage into CCW at CVCS letdown HP Cooler will increase CCW temperature, flow, activity, and surge tank level. In the event of an RCS leak to CCW at the CVCS letdown HP Cooler, CCW outlet flow sensed by KAB60/70 CF050 and CCW activity sensed by KAB60/70 CR002 automatically generate signals that close the CVCS isolation valves for the cooler. Since isolation occurs on the CVCS side, the CCW cooling flow to RCP motor and oil coolers continues uninterrupted.	**36) Mission Success Criteria are met.** With one CCW train out for maintenance, failure of a CVCS letdown HP Cooler supported by the by complementary CCW train during/after a DBA is bounded by 2) above and leaves at minimum: 3 CCW trains operable, 2 SFP Cooling HX operable 2 CVCS charging pump operable 1 CVCS letdown HP cooler operable, and CCW supplying flow to all RCP thermal barriers.	CCW relief valves KAB60/70 AA191 protect CCW side of CVCS letdown HP Cooler from over pressurization by the CVCS (RCS) leak to CCW. The CVCS letdown HP Cooler can be manually isolated from the RCP motor and oil coolers served by the same Common Operating Loop header, but this requires a containment entry.

Component Name	Identifier	Component Function	Failure Mode	Failure Mechanism	Failure Effect	Mission Success	Comments / Actions
CVCS letdown High Pressure coolers 1/2 (Continued)	KBA11 AC001 KBA12 AC001	Protects coolant purification equipment from thermal damage by cooling RCS letdown flow.	Tube Rupture: CCW leaks to CVCS letdown (RCS):	Mechanical	This event is unlikely due to the smaller pressure differential and the limited time for which CVCS letdown pressure is less than CCW pressure. During cooldown and shutdown operations after the HP Cooler and RCPs have been secured, CCW flow is no longer required in this operating loop, and will normally be isolated by closing the containment isolation valves. If the loop is not isolated and a leak occurs, the volume of CCW leakage to the CVCS letdown head will be constrained by the limited compressibility of water in the static letdown header.	**37) Mission Success Criteria are met**. Results bounded by 34) above.	
CVCS letdown HP Cooler 1/2 Temperature Control Valve	KAB60 AA116 KAB70 AA116	Controls letdown temperature at outlet of CVCS letdown HP coolers by adjusting CCW cooling flow through the coolers. Actuated by CVCS process flow and temperature signals from: KBA11/12 CF751 KBA11/12 CF752A/B KBA34 CF851A/B KBA34 CF852A/B KBA11/12 CT750 KBA11/12 CT751 KBA11/12 CT752	Fails to Open	Mechanical, Electrical, I&C	CCW temperature control valve failure to OPEN on demand allows CVCS letdown temperature to increase. When CVCS letdown temperature exceeds 150ºF, CVCS automatically bypasses letdown flow around purification equipment to protect thermally-sensitive components. CCW temperature control valve failure does not affect performance of the balance of the CCW system.	**38) Mission Success Criteria are met.** With one CCW train out for maintenance, failure of a CVCS letdown HP Cooler temperature control valve to OPEN during/after a DBA is bounded by 2) above and leaves at minimum: 3 CCW trains operable, 2 SFP Cooling HX operable 2 CVCS charging pump operable 1 CVCS letdown HP cooler operable, and CCW supplying flow to all RCP thermal barriers.	CVCS letdown HP Cooler outlet temperature control CCW valve failure only affects CVCS system operation.
			Fails to Close	Mechanical, Electrical, I&C	CCW temperature control valve failure to CLOSE on demand cools CVCS letdown temperature. This does not pose an operational limit on CVCS, but will result in a reduced CVCS water temperature when CVCS flow returns to RCS. This may increase thermal stress at the CVCS inlet nozzle to RCS, and impose slight effects on bulk RCS density and temperature as CVCS return flow mixes with RCS flow. CCW temperature control valve failure does not affect performance of the balance of the CCW system.	**39) Mission Success Criteria are met**. Results bounded by 38) above. With one CCW train out for maintenance, failure of a CVCS letdown HP Cooler temperature control valve to CLOSE on demand during/after a DBA is bounded by 2) above and leaves at minimum: 3 CCW trains operable, 2 SFP Cooling HX operable 2 CVCS charging pump operable 2 CVCS letdown HP cooler operable, and CCW supplying flow to all RCP thermal barriers.	

Component Name	Identifier	Component Function	Failure Mode	Failure Mechanism	Failure Effect	Mission Success	Comments / Actions
			Fails in Intermediate Position	Mechanical, Electrical, I&C	CCW temperature control valve failure in intermediate position is bounded by failure to OPEN on demand.	**40) Mission Success Criteria are met**. Results bounded by 38) above.	
CVCS letdown HP Cooler 1/2 CCW Outlet Flow Instrument	KAB60 CF050 KAB70 CF050	Monitor CCW outlet flow rate from CVCS letdown HP Cooler. Provide indication of CVCS (RCS) leak to CCW.	Fails to recognize low flow condition OR Fails to generate low flow signal	Mechanical, I&C	No operational requirement for low flow signal on CCW outlet from CVCS letdown HP Coolers.	**41) Mission Success Criteria are met**. Results bounded by 1) above.	
			Fails to recognize high flow condition OR Fails to generate high flow signal	Mechanical, I&C	Failure prevents automatic isolation of CVCS letdown flow through leaking CVCS letdown HP Cooler. RCS leakage into CCW at CVCS letdown HP Cooler will increase CCW temperature, flow, activity, and surge tank level. Results in contamination of affected CCW Common Operating Load (1.B/2.B) and CCW train on service, and loss of CCW cooling for affected CVCS letdown HP Cooler. CCW relief valve KAB60/70 AA191 protects CCW side of CVCS letdown HP Cooler from CVCS (RCS) pressure.	**42) Mission Success Criteria are met.** With one CCW train out for maintenance, failure of a CVCS letdown HP Cooler CCW flow outlet instrument to process a high flow signal in event of a CVCS (RCS) leak to CCW allows the leak to continue; during/after a DBA is bounded by 2) above and leaves at minimum: 3 CCW trains operable, including affected train 2 SFP Cooling HX operable 2 CVCS charging pump operable 1 CVCS letdown HP cooler operable, and CCW supplying flow to all RCP thermal barriers.	
			Spurious high flow signal	I&C	Spurious high flow signal automatically isolates the CVCS supply and return lines for the CVCS letdown HP Cooler. Loss of HP Cooler temporarily interrupts letdown flow until operator places the standby HP Cooler in operation. CVCS Charging pumps can draw water from volume control tank (and coolant storage tanks) in absence of letdown flow.	**43) Mission Success Criteria are met.** With one CCW train out for maintenance, a spurious high CCW outlet flow signal during/after a DBA isolates the operating CVCS letdown HP Cooler. This scenario is bounded by 2) above, and leaves at minimum: 3 CCW trains operable, including affected train 2 SFP Cooling HX operable 2 CVCS charging pump operable 1 CVCS letdown HP cooler operable, and CCW supplying flow to all RCP thermal barriers.	Although CCW cooling flow is maintained on the standby CVCS letdown HP Cooler, **operator action is required to shift CVCS letdown flow to that cooler.**

Component Name	Identifier	Component Function	Failure Mode	Failure Mechanism	Failure Effect	Mission Success	Comments / Actions
			Spurious low flow signal	I&C	Spurious low flow signal could mask recognition of high flow condition associated with CVCS (RCS) to CCW leak	**44) Mission Success Criteria are met**. Results bounded by 42) above.	No DBA involved, since CVCS HP Cooler constitutes the accident condition and spurious low flow signal constitutes the (independent) single failure.
CVCS letdown HP Cooler 1/2 CCW Outlet Activity Sensor	KAB60 CR002 KAB70 CR002	Monitor activity of CCW outlet flow from CVCS letdown HP Cooler. Provide indication of CVCS (RCS) leak to CCW.	Fails to recognize high activity OR Fails to generate high activity signal	I&C	Failure prevents automatic isolation of CVCS letdown flow through leaking CVCS letdown HP Cooler. RCS leakage into CCW at CVCS letdown HP Cooler will increase CCW temperature, flow, activity, and surge tank level. Results in contamination of affected CCW Common Operating Load (1.B/2.B) and CCW train on service, and loss of CCW cooling for affected CVCS letdown HP Cooler. CCW relief valve KAB60/70 AA191 protects CCW side of CVCS letdown HP Cooler from CVCS (RCS) pressure.	**45) Mission Success Criteria are met**. Results bounded by 42) above.	
			Spurious high activity signal	I&C	Spurious high activity signal automatically isolates the CVCS supply and return lines for the CVCS letdown HP Cooler. Loss of HP Cooler temporarily interrupts letdown flow until operator places the standby HP Cooler in operation. CVCS Charging pumps can draw water from volume control tank (and coolant storage tanks) in absence of letdown flow.	**46) Mission Success Criteria are met**. Results bounded by 43) above.	Although CCW cooling flow is maintained on the standby CVCS letdown HP Cooler, **operator action is required to shift CVCS letdown flow to that cooler.**

Component Name	Identifier	Component Function	Failure Mode	Failure Mechanism	Failure Effect	Mission Success	Comments / Actions
Containment Isolation Valves in CCW Supply/Return lines to RCP 1/2/3/4 Thermal Barriers	KAB30 AA049 KAB30 AA053 (CCW Supply Outer CIV) KAB30 AA051 KAB30 AA055 (CCW Return Inner CIV) KAB30 AA052 KAB30 AA056 (CCW Return Outer CIV)	Control CCW cooling flow to the RCP thermal barriers protects RCP seals IF seal flow is also lost. The thermal barriers on the four RCPs are cross connected so they are supplied from the same CCW Common Operating (1.B/2.B) loop. Normally all open, OR all closed on one side of plant. Manually operated by a Group Command to minimize interruption of cooling flow when changing source of cooling flow. Group Command switches source of CCW cooling flow between Common 1B and Common 2B loops. Group Command sends "Close" signal to all CIVs in off-going loop; when the last valve indicates closed, Group Command automatically sends "Open" signal to all CIVs in oncoming loop. No automated action in response to SIS, CI-1, or CI-2 signals.	Fails to Open	Mechanical, Electrical, I&C	If any ONE of these containment isolation valves fails to OPEN, then CCW cooling cannot be provided to the RCP thermal barriers from the affected side of the plant. In NPO, one group of these valves is normally open and the other group is normally closed. These valves would NOT be cycled to test Containment Isolation operability during NPO because of the potential impact on operating RCPs. However, if the valves are cycled shut and immediately reopened, temporary interruption of CCW cooling to the RCP thermal barriers does not result in damage to the RCP seals. If CVCS seal flow to the RCPs is lost, RCS pressure will cause leakage out through the pump seals. If CCW cooling to the thermal barriers is also lost for more than two minutes, the high temperature of the leaking coolant will cause thermal expansion that will damage the seals and increase the leakage through them.	**47) Mission Success Criteria are met.** With one CCW train out for maintenance, failure of any one CCW Containment Isolation valve on either the supply or return line to the RCP thermal barriers would interrupt flow to the barriers. If RCP thermal barriers were aligned to the complementary CCW train, and one of the containment isolation valves closed during/after a DBA, then scenario is bounded by 2) above and leaves at minimum: 2 CCW trains operable on one side of the plant, 1 SFP Cooling HX operable 1 CVCS charging pump operable 1 CVCS letdown HP cooler operable, and CCW able to supply flow to all RCP thermal barriers – **but may require operator action to restore cooling flow.**	Check valves KAB30 AA050 and KAB30 AA054 provide second isolation valve on CCW Supply lines (Inner CIV) Loss of the operating CVCS pump automatically shifts CVCS operation to the standby CVCS pump, which should restore normal RCP seal water flow.
			Fails to Close	Mechanical, Electrical, I&C	These containment isolation valves are NOT actuated by SIS, CI-1, or CI-2 signals, so they REMAIN OPEN during and after a DBA. If any ONE of these containment isolation valves fails to CLOSE, the containment isolation function is fulfilled by the redundant containment isolation valve on the supply or return side.	**48) Mission Success Criteria are met**. Results bounded by 47) above.	

Component Name	Identifier	Component Function	Failure Mode	Failure Mechanism	Failure Effect	Mission Success	Comments / Actions
Non-Safety Related Common Operating Load (1/2)B Isolation Valves	KAB80 AA015 KAB50 AA001 (CCW Supply u/s isolation) KAB80 AA016 KAB50 AA006 (CCW Supply d/s isolation KAB80 AA019 KAB50 AA004 (CCW Return u/s isolation)	Normally open; automatically closed to shed non-safety-related heat loads on receipt of SIS signal.	Fails to Open	Mechanical, Electrical, I&C	If any ONE of these containment isolation valves fails to OPEN, then CCW cooling cannot be provided to the non-safety related components and systems on the affected side of the plant. Loss of a CCW flow path to the non-safety related loads supplied by the Common Operating Loads (1.B/2.B) has no deleterious effect on the ability of the CCW system to provide cooling to its safety-related loads.	**49) Mission Success Criteria are met.** With one CCW train out for maintenance, failure of one Containment Isolation valve in the supply or return lines to the non-safety related loads on the complementary CCW train does not further constrain any safety-related CCW cooling loads. This leaves at minimum: 3 CCW trains operable, including the affected train 2 SFP Cooling HX operable 2 CVCS charging pump operable 2 CVCS letdown HP cooler operable, and CCW supplying flow to all RCP thermal barriers.	Check valve KAB80 AA020 and KAB50 AA008 provide downstream isolation valve on CCW Return lines
			Fails to Close	Mechanical, Electrical, I&C	If any ONE of these containment isolation valves fails to CLOSE, the containment isolation function is fulfilled by the redundant containment isolation valve on the supply or return side.	**50) Mission Success Criteria are met**. Results bounded by 49) above.	
Safety Chilled Water System Condensers 2/3	QKA20 AC002 QKA30 AC002	Safety Chilled Water System (QKA) Divisions 2 and 3 cool Main Control Room ventilation and Safeguards Buildings 2 and 3 SCWS Divisions 2 and 3 each contain one 100% refrigerating chiller unit with a water cooled condenser. Circulating refrigerant vaporizes to remove heat from the SCWS (QKA) side in the chiller, and transports that heat to the condenser. CCW condenses the circulating refrigerant in the condenser, removing the heat from the SCWS. The circulating refrigerant returns to the chiller to repeat the cycle.	Tube Rupture: CCW leaks to SCWS water-cooled Condenser	Mechanical	Because the SCWS and CCW are separated by a closed refrigerant loop circulating between the condenser (QKA20/30 AC002) and chiller (QKA20/30 AC001), a tube rupture does not result in transfer of water inventory between the two systems. A tube rupture in condenser QKA20/30 AC002 results in CCW leakage to the circulating refrigerant loop, continuing until the pressure of that loop equalizes with CCW pressure. Dilution of the circulating refrigerant reduces its ability to transfer heat from the SCWS in the chiller to the CCW system in the condenser. There are no automatic isolation features on either the CCW side or the circulating refrigerant side of the SCWS condensers. There will be a reduction of CCW surge tank level on the affected train.	**51) Mission Success Criteria are met.** With one CCW train out for maintenance, a CCW leak to the circulating refrigerant in the SCWS water-cooled condenser removes one of the two 100% water-cooled SCWS divisions from service. If this occurs during/after a DBA, the impact on CCW capacity is bounded by 1) above, and leaves at minimum: 3 CCW trains operable, including affected train 2 SFP Cooling HX operable 2 CVCS charging pump operable 2 CVCS letdown HP cooler operable, and CCW supplying flow to all RCP thermal barriers.	Operator action may be required to align Main Control Room HVAC to the unaffected SCWS Division (2/3).

Component Name	Identifier	Component Function	Failure Mode	Failure Mechanism	Failure Effect	Mission Success	Comments / Actions
Safety Chilled Water System Condenser 2/3 CCW Recirculation Flow Control Valves	KAA22 AA101 KAA32 AA101	Position varies based on SCWS chiller internal temperature. For high SCWS temperature, valve moves to increase CCW return flow and reduce CCW recirculation to cooler inlet, thus reducing CCW temperature at cooler inlet. For low SCWS temperature, valve moves to reduce CCW return flow and increase CCW recirculation to cooler inlet, thus raising CCW temperature at cooler inlet.	Fails to move towards increased CCW return flow (Open)	Mechanical, Electrical, I&C	Failure to increase CCW return flow maintains recirculation of a portion of CCW outlet flow back to the inlet side of the SCWS water-cooled condenser in spite of increasing heat load on the QKA side. The result is a loss of cooling to the QKA system, and rising ambient temperatures in the MCR and safeguard building cooled by the affected QKA train. This event has no impact on the CCW capability to cool other safety-related loads.	**52) Mission Success Criteria are met.** With one CCW train out for maintenance, a failure of the CCW recirculation control valve reduces the cooling capacity for one of two 100% water-cooled SCWS divisions. If this occurs during/after a DBA, the impact on CCW capacity is bounded by 1) above, and leaves at minimum: 3 CCW trains operable, including affected train 2 SFP Cooling HX operable 2 CVCS charging pump operable 2 CVCS letdown HP cooler operable, and CCW supplying flow to all RCP thermal barriers.	
			Fails to move towards reduced CCW return flow (Closed)	Mechanical, Electrical, I&C	Failure to reduce CCW return flow maintains recirculation of a portion of CCW outlet flow back to the inlet side of the SCWS water-cooled condenser in spite of decreasing heat load on the QKA side. The result is overcooling of the QKA system, and decreasing ambient temperatures in the MCR and safeguard building cooled by the affected QKA train. This event has no impact on the CCW capability to cool other safety-related loads.	**53) Mission Success Criteria are met**. Results bounded by 52) above.	.

Response to

Request for Additional Information No. 361, Supplement 1

3/04/2010

U.S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 09.02.02 - Reactor Auxiliary Cooling Water Systems
Application Section: 09.02.08

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

Question 09.02.02-94:

Follow-up to RAI 174, Question 09.02.02-53

Based on the staff's review of the applicant's response to RAI 174, Question 9.2.2-53, Supplement 5 and information provided in the associated markup of the Final Safety Analysis Report (FSAR), Section 9.2.8, "Safety Chilled Water System" the staff found a significant design change to the system. The safety chilled water system (SCWS) design now utilizes "cross-ties" between Trains 1 and 2 and between Trains 3 and 4, instead of the independent four-train system structure utilized in the original design.

a. Describe the reason for making this change since it is a departure from the independent four train system structure utilized in the original design.

b. In the applicant's response, the word "division" is replaced with the word "train" when referring to the SWCS, but not in all instances. Add a note clarifying the differences, if any, between the words used throughout this section and provide consistency in their usage. For example, FSAR Section 9.2.8.1 says "Each SCWS train…" and 9.2.8.2.2 says "Each SCWS division…"

Response to Question 09.02.02-94:

a. The change from independent four train system structure to the cross-tied structure provides improved reliability and additional operational and maintenance flexibility. The change allows more favorable technical specifications for SCWS.

b. The word "division" as used for US EPR™ project means redundant safety systems (one per Safeguard Building) strictly separated within the Safeguard Buildings into four divisions. The word "division" is used in Section 9.2.8 to describe global systems such as a SCWS train and its associated Safeguard Building or its associated Emergency Diesel Generator.

The word "train" is now more appropriate due to the change from SCWS independent four train system structure to the cross-tied structure described in RAI 174. As indicated in response to RAI 174 Supplement 5, Question 09.02.02-53, markup of FSAR section 9.2.8.2.1, a SCWS train consists of a refrigeration chiller unit, two pumps, expansion tank, user loads, and the associated piping and controls.

U.S. EPR FSAR, Tier 2, Section 9.2.8 will be revised to provide consistent wording.

FSAR Impact:

U.S. EPR FSAR, Tier 2, Section 9.2.8 will be revised as described in the response and indicated in the attached markup.

Question 09.02.02-95:

Follow-up to RAI 174, Question 09.02.02-53

Standard Review Plan (SRP) Section 9.2.2, which is being utilized as guidance for the review of the safety chilled water system (SCWS), specifies in Section III confirmation of the overall arrangement of the component cooling system (CCWS) in the Final Safety Analysis Report (FSAR). Based on the staff's review of the applicant's response to RAI 174, Question 9.2.2-53, Supplement 5 and information provided in the associated markup of the Final Safety Analysis Report (FSAR), Section 9.2.8, "Safety Chilled Water System" the staff found a significant design change to the system. The safety chilled water system (SCWS) design now utilizes "cross-ties" between Trains 1 and 2 and between Trains 3 and 4, instead of the independent four-train system structure utilized in the original design.

a. The staff noted that Tier 1 Table 2.7.2-2, "Safety Chilled Water System Equipment I&C and Electrical Design," identifies normal and alternate power supplies for the motor-operated SCWS cross-tie valves, but the valve power supplies are not described anywhere in the proposed Tier 2 FSAR sections provided in the response.
b. Provide a description of these power supplies in the Tier 2 portion of the FSAR.
c. Update FSAR Table 3.9.6-2, "In-service Valve Testing Program Requirements" to include the motor-operated cross-tie valves.
d. Add the SCWS flow direction arrows to the Figure 9.2.8-1 (Sheets 1 through 4), "Safety Chilled Water Diagram," to confirm the directional flows in various sections of pipe under both independent and cross-tie alignments.

Response to Question 09.02.02-95:

a. The last paragraph in U.S. EPR FSAR Tier 2, Section 9.2.8.3.2 will be revised to describe the alternate power supplies to the motor operated valves in more detail.

The N+2 concept described in U.S. EPR FSAR Tier 2, Section 9.2.8.4 does not apply due to the change to cross-tie design; therefore, the sentence will be deleted.

b. See above response.

c. Refer to response to RAI 356, Question 09.02.02-91 concerning the addition of cross-tie valves to FSAR Table 3.9.6-2.

d. Refer to response to RAI 174 Supplement 5, Question 09.02.02-53, markup Figure 9.2.8-1 (Sheets 1 through 4). Flow direction arrows will be added where needed. The sheet-to-sheet continuation arrows provide an indication of flow direction. On sheets 1 through 4, the supply side is on the right and the return side is on the left. For cross-tie operation, flow can be in either direction in the cross-tie lines depending on which SCWS train is in operation. For example if SCWS Train 1 is the operating train in divisional pair 1 & 2, starting on sheet 1, approximately half the total flow is through Train 1 cross-tie supply valve 30QKA10AA102 (continuation to sheet 2) then through Train 2 cross-tie supply valve 30QKA20AA102, and then to Division 2 user heat exchangers. Similarly, on the return side, starting on Sheet 2, return flow is from the Division 2 user heat exchangers through the Train 2 cross-tie return valve 30QKA20AA103 (continuation to sheet 1) then through Train 1 cross-tie return valve 30QKA10AA103 and then to the suction side of the Train 1 pumps. As shown on sheet 1, on the supply side, the other approximate half of the total flow goes to the Division 1 user heat exchangers and returns to the suction side of the Train 1 pumps.

FSAR Impact:

a. U.S. EPR FSAR Tier 2, Section 9.2.8.3.2 will be revised as described in the response and indicated in the attached markup.

b. See a. above.

c. Refer to response to RAI 356, Question 09.02.02-91.

d. U.S. EPR FSAR Tier 2, Figure 9.2.8-1 (Sheet 2) will be revised as described in the response and indicated in the attached markup.

Question 09.02.02-96:

Follow-up to RAI 174, Question 09.02.02-53

The safety chilled water system (SCWS) must be able to withstand natural phenomena such as hurricanes, tornadoes, floods, and earthquakes without the loss of function in accordance with General Design Criteria (GDC) 2 requirements. Based on the staff's review of the applicant's response to RAI 174, Question 9.2.2-53, Supplement 5 and information provided in the associated markup of the Final Safety Analysis Report (FSAR), Section 9.2.8, "Safety Chilled Water System" the staff found a significant design change to the system. The safety chilled water system (SCWS) design now utilizes "cross-ties" between Trains 1 and 2 and between Trains 3 and 4, instead of the independent four-train system structure utilized in the original design. While the SCWS cross-tie valves are properly classified as Seismic Category I and located inside Seismic Category I structures, it lacks a description of the capability of the cross-tie piping that runs between safeguards building meeting the GDC 2 requirements. The staff requests the applicant describe the capability of the cross-tie piping to meet GDC 2 requirements.

Response to Question 09.02.02-96:

The cross-tie piping will be routed through the stair tower structures between Safeguard Building 1 and Safeguard Building 2 and between Safeguard Building 3 and Safeguard Building 4. The stair tower structures are Seismic Category I and designed to withstand natural phenomena the same as Safeguard Building 1 and Safeguard Building 4. The stair towers are shown on U.S. EPR FSAR Figures 3.8-64 through 3.8-69.

U.S. EPR FSAR Tier 2, Section 9.2.8.1 will be revised to indicate that GDC 2 is met.

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 9.2.8.1 will be revised as described in the response and indicated in the attached markup.

Question 09.02.02-98:

Follow-up to RAI 174, Question 09.02.02-53

General Design Criteria (GDC) 4 requires safety systems be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents. These structures, systems, and components shall be appropriately protected against dynamic effects of flow instabilities and attendant loads (i.e. water hammer). Based on the staff's review of the applicant's response to RAI 174, Question 9.2.2-53 (ID1810/6769), Supplement 5 and information provided in the associated markup of the Final Safety Analysis Report (FSAR), Section 9.2.8, "Safety Chilled Water System" the staff found a significant design change to the system. The safety chilled water system (SCWS) design now utilizes "cross-ties" between Trains 1 and 2 and between Trains 3 and 4, instead of the independent four-train system structure utilized in the original design.

a. The staff requests that the applicant describe the capability of the safety chilled water system (SCWS) cross-tie piping connecting the two divisions meeting GDC 4 requirements.
b. Depending on which division is in operation, SCWS flow could occur in either direction of the cross-tie piping. Upon a loss of one safety chilled water train, the other train would start and flow would reverse in cross-tie piping. Address how the SCWS design will mitigate the effects of water-hammer and flow instabilities with a particular focus on the cross-tie piping.
c. Address the evaluation of any intra-building impacts, such as internal flooding, for the safeguard buildings (SB) in view of the cross-ties that remove the independent nature of four SBs with four separate systems.

Response to Question 09.02.02-98:

a. The cross-tie feature does not change the ability of the SCWS to meet GDC 4 as indicated in U.S. EPR FSAR Tier 2, Section 9.2.8.1.

b. Refer to information concerning mitigation of waterhammer in the response to RAI 356, Question 09.02.02-90.

   The cross-tie piping design and piping support design are designed to withstand the effects of flow in either direction.

c. The addition of the SCWS cross-ties between Trains 1 and 2 and between Trains 3 and 4 does not have a significant impact on the internal flooding analysis for the safeguard buildings (SB). The SCWS is a closed system with manual make up and therefore contains a limited volume of water. In the lower levels of the safeguard buildings the entire system contents is conservatively assumed to be released in the event of a pipe failure and directed within the division to the lowest building level through large openings and staircases. At higher building elevations (e.g. elevation +69 feet in SB-2 and SB-3) the released water volume from a pipe failure is further limited to the contents of two cross-tied SCWS trains. A common loss of the main control room air conditioning system (CRACS) in SB-2 or SB-3 is prevented by placing equipment sensitive to flooding above the expected flood water height resulting from the water released remaining in the area of the CRACS equipment rooms and adjoining service corridor.

FSAR Impact:

a. The U.S. EPR FSAR will not be changed as a result of this question.

b. The U.S. EPR FSAR will not be changed as a result of this question.

c. U.S. FSAR Tier 2 Section 3.4.3.4 will be revised as described in the response and indicated on the enclosed markup.

Question 09.02.02-99:

Follow-up to RAI 174, Question 09.02.02-53

The safety chilled water system (SCWS) must be capable of removing heat from structures, system and components (SSCs) important to safety during normal operating and accident conditions over the life of the plant in accordance with general design criteria (GDC) 44 requirements. Based on the staff's review of the applicant's response to RAI 174, Question 9.2.2-53, Supplement 5 and information provided in the associated markup of the Final Safety Analysis Report (FSAR), Section 9.2.8, "Safety Chilled Water System" the staff found a significant design change to the system. The safety chilled water system (SCWS) design now utilizes "cross-ties" between Trains 1 and 2 and between Trains 3 and 4, instead of the independent four-train system structure utilized in the original design. In order for the staff to confirm that the SCWS has been adequately sized, the applicant needs to clarify the FSAR and Technical Specifications (TS) with regards to sizing of the pumps, compressors, and chillers.

a. With regards to percent capacity for the SCWS pumps, chillers, and compressors, identify whether the percent capacity references supplying two divisions or just one division considering the "normal" alignment is cross-tied. For example, TS Bases B3.7.9 states each chiller contains three 50% compressors. It is unclear whether this value is based on maximum cross-connected loadings. If so, the total chiller capacity would be capable of 150% of the accident heat loads from two safeguards buildings and therefore, 300% of heat loads from a single building.

b. Describe the chiller capacities in tons of refrigeration. In addition, no changes were proposed for FSAR Table 9.2.8-1, "Safety Chilled Water Design Parameters," in the applicant's response. Address whether the stated evaporator capacities (275 ton air-cooled/250 ton water-cooled) are single train capacities or need to be modified for cross-tie (2-train) capacity and update Table 9.2.8-1, "Safety Chilled Water Design Parameters," as necessary.

c. Address the removal of the 100% values (for both pumps and chillers) from Section 9.2.8.2.2 but maintaining them in TS Bases B3.7.9. Also, TS Bases B3.7.9 states the four trains are independent. The staff requests the applicant address if the word "independent" still applies.

Response to Question 09.02.02-99:

a. The capacity is based on maximum cross-connected loading. The capacity of each SCWS train is sufficient to provide the maximum demand of the user heat exchangers in two divisions. For example, if SCWS Train 1 is the operating train in divisional pair 1 & 2, Train 1 supplies chilled water to the user heat exchangers in Safeguard Building 1, Safeguard Building 2 and Division 1 of the Fuel Building Ventilation System. Likewise, if SCWS Train 3 is the operating train in divisional pair 3 & 4, Train 3 supplies chilled water to the user heat exchangers in Safeguard Building 3, Safeguard Building 4 and second of two divisions (Division 4) of the Fuel Building Ventilation System. There are three compressors in each train. Two compressors operate to supply the required capacity. Both pumps in the operating train operate to provide the required capacity.

   U.S. EPR FSAR Tier 2, Section 9.2.8.2.1 will be revised to include the above.

b. Refer to response to RAI 356, Question 09.02.02-88 concerning SCWS capacities.

c. TS Bases B 3.7.9 will be revised.

FSAR Impact:

a. U.S. EPR FSAR Tier 2, Section 9.2.8.2.1 will be revised as described in the response and indicated in the attached markup.

b. Refer to response to RAI 356, Question 09.02.02-88.

c. TS Bases B 3.7.9 will be revised as described in the response and indicated in the attached markup.

Question 09.02.02-100:

Follow-up to RAI 174, Question 09.02.02-53

The safety chilled water system (SCWS) must be capable of removing heat from structures, system and components (SSCs) important to safety during normal operating and accident conditions over the life of the plant in accordance with general design criteria (GDC) 44 requirements. Based on the staff's review of the applicant's response to RAI 174, Question 9.2.2-53, Supplement 5 and information provided in the associated markup of the Final Safety Analysis Report (FSAR), Section 9.2.8, "Safety Chilled Water System" the staff found a significant design change to the system. The safety chilled water system (SCWS) design now utilizes "cross-ties" between Trains 1 and 2 and between Trains 3 and 4, instead of the independent four-train system structure utilized in the original design. In order for the staff to confirm that the SCWS has been adequately sized, address the following:

a. Final Safety Analysis Report (FSAR) Section 9.2.8.2.2 states that SCWS pump head is based on dynamic pressure losses and head losses of the mechanical equipment of the associated SCWS at full load operation. The staff requests the applicant describe in the FSAR whether full load operation assumes a cross-connected configuration (i.e. loads from two safeguard buildings) or a single SCW train.

b. Based on the fact that now multiple SCWS pumps will be running simultaneously during normal and accident conditions, the staff requests that the applicant readdress and respond to the issue of "strong pump vs. weak pump" testing in ITAAC that was originally addressed in RAI 9.2.2-55 Areva #174 Supplement 4, Item (d).

Response to Question 09.02.02-100:

a. See response to Question 09.02.02-99 above.

b. The parallel pump operation in cross-tie operation involves two pumps in one SCWS train. The two pumps are the same size and have the same hydraulic design. A new ITAAC is not necessary because there is an existing ITAAC 7.3 for SCWS design flowrate. FSAR Chapter 14.2 will be revised to include parallel pump testing as part of the initial test program. Test #052 will be revised to include parallel pump testing.

   Refer to response to RAI 356, Question 09.02.02-86 that covers the change in design flow value in U.S. EPR FSAR Tier 1, Table 2.7.2-3, ITAAC 7.3.

FSAR Impact:

a. See response to Question 09.02.02-99 above.

b. FSAR Tier 2, Section 14.2.12.6.2 will be revised as shown on the enclosed markup.

Question 09.02.02-101:

Follow-up to RAI 174, Question 09.02.02-53

The safety chilled water system (SCWS) must be capable of removing heat from structures, systems and components (SSCs) important to safety during normal operating and accident conditions over the life of the plant in accordance with general design criteria (GDC) 44 requirements. Based on the staff's review of the applicant's response to RAI 174, Question 9.2.2-53, Supplement 5 and information provided in the associated markup of the Final Safety Analysis Report (FSAR), Section 9.2.8, "Safety Chilled Water System" the staff found a significant design change to the system. The safety chilled water system (SCWS) design now utilizes "cross-ties" between Trains 1 and 2 and between Trains 3 and 4, instead of the independent four-train system structure utilized in the original design. In order to satisfy the above requirements, address the following regarding instrumentation and controls (I&C):

a. Clarify the difference between a single pump tripping/failing and multiple pumps tripping/failing along with the logic for maintaining the proper flow to ensure adequate cooling for both trains.
    1. Table 2.7.2-3, "Safety Chilled Water ITAAC," Item 4.4 states that the standby chiller and its pump(s) start on a trip of the running chiller or its pump(s). Describe the SCWS response (i.e. how many pumps start) on a loss of a single pump in the operating train. Also describe the SCWS response to a loss of both pumps in the operating train.
    2. Final Safety Analysis Report (FSAR) Section 9.2.8.6 states that the affected chilled water system train is deactivated by "pump" failure. Clarify if this is deactivation occurs for the loss of a single pump or requires loss of both pumps.
b. FSAR Section 9.2.8.6 indicates the cross-tied loops isolate on low-low system pressure. The staff requests that the applicant address if there is a similar isolation based on low expansion tank level. If not, describe the SCWS would response to a slow leak of the inventory lost but no activation of the low-low pressure trip.
c. Technical Specification (TS) Bases B3.7.9 states that the chiller standby units start on trip of the running chiller. Address the SCWS response to increasing temperatures if the running chiller is overloaded or degraded but not tripped.
d. Address any I&C logic associated with the motor-operated cross-tie valves (auto-close or auto-open) if applicable.

Response to Question 09.02.02-101:

a. For full load, cross-tie operation of SCWS, two pumps in the operating train are required to operate. If one pump fails, the standby train is started and the operating train is stopped.

b. SCWS pressure is maintained by the nitrogen pressure in the tank. There is no permanently connected nitrogen source, so the effect of a nitrogen leak would be the same as a slow water leak. There is no similar isolation based on low expansion tank level. A slow leak of the inventory would activate a low pressure alarm. The operator would check nitrogen charge, check for water leaks and provide makeup water.

Refer to response to RAI 356 Question 09.02.02-86b for additional information on SCWS instrumentation.

c. The chiller evaporator outlet temperature is monitored. An alarm occurs if temperature reaches high set point. An automatic switchover to the standby train occurs if temperature reaches high–high set point.

d. The cross-tie valves are normally open. The cross-tie valves are closed manually from the control system in the event the trains are required to operate independently as single divisions.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 09.02.02-102:

Follow-up to RAI 174, Question 09.02.02-53

The safety chilled water system (SCWS) must be capable of removing heat from structures, systems and components (SSCs) important to safety during normal operating and accident conditions over the life of the plant in accordance with general design criteria (GDC) 44 requirements. Under seismic or post-accident conditions with the demineralized water unavailable for safety chilled water system (SCWS) makeup, the expansion tanks should contain sufficient water volume to assure reliable system operation without makeup for at least seven days. Based on the staff's review of the applicant's response to RAI 174, Question 9.2.2-53, Supplement 5 and information provided in the associated markup of the Final Safety Analysis Report (FSAR), Section 9.2.8, "Safety Chilled Water System" the staff found a significant design change to the system. The safety chilled water system (SCWS) design now utilizes "cross-ties" between Trains 1 and 2 and between Trains 3 and 4, instead of the independent four-train system structure utilized in the original design. In the cross-tied configuration, the staff requests the applicant describe whether the expansion tank in the non-operating train is isolated from the system. If not, address precluding of the SCWS design from the sluicing of water between the two expansion-tanks as system loads cycle (or on trip of a chiller and start of the standby unit) and describe the tanks volume requirements to account for sluicing. If isolated, describe the operation of the expansion tank isolation valves during operation and accident conditions.

Response to Question 09.02.02-102:

In cross-tie operation, the expansion tank in the standby train is not mechanically isolated.

Sluicing is not significant because the two cross-tied expansion tanks are not close together. One tank is in one Safeguard Building and the other tank in the pair is in another Safeguard Building. The cross-tied expansion tanks are not at the same elevation. Train 2 tank is several floor elevations lower than Train 1 tank. Train 3 tank is several floor elevations lower than Train 4 tank. The pipe size (2 inches) connecting each tank to the system is small relative the system pipe size.

Refer to information concerning sizing of expansion tank in the response to RAI 356, Question 09.02.02-91.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 09.02.02-103:

Follow-up to RAI 174, Question 09.02.02-53

The safety chilled water system (SCWS) must be capable of removing heat from structures, systems and components (SSCs) important to safety during normal operating and accident conditions over the life of the plant in accordance with general design criteria (GDC) 44 requirements. Based on the staff's review of the applicant's response to RAI 174, Question 9.2.2-53, Supplement 5 and information provided in the associated markup of the Final Safety Analysis Report (FSAR), Section 9.2.8, "Safety Chilled Water System" the staff found a significant design change to the system. The safety chilled water system (SCWS) design now utilizes "cross-ties" between Trains 1 and 2 and between Trains 3 and 4, instead of the independent four-train system structure utilized in the original design. In Final Safety Analysis Report (FSAR) section 9.2.8.3.2, the applicant states "At or before the end of 24 hours post DBA, the cross-tie isolation valves are manually isolated to protect against a passive failure." The staff requests the applicant address the basis for the 24-hour period and the tracking or controlling of this time post accident (i.e. valve timing logic, COL applicant action item for procedures, etc.)

Response to Question 09.02.02-103:

The basis for the 24-hour period is the limiting single failures indicated in U.S. EPR FSAR Tier 2, Section 15.0.0.3.8.

Unless there is a failure that affects SCWS, post-LOCA operator action is dependent upon the condition of the RCS and ECCS; not on the condition of the SCWS.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 09.02.02-104:

Follow-up to RAI 174, Question 09.02.02-53

Based on the staff's review of the applicant's response to RAI 174, Question 9.2.2-53, Supplement 5 and information provided in the associated markup of the Final Safety Analysis Report (FSAR), Section 9.2.8, "Safety Chilled Water System" the staff found a significant design change to the system. The safety chilled water system (SCWS) design now utilizes "cross-ties" between Trains 1 and 2 and between Trains 3 and 4, instead of the independent four-train system structure utilized in the original design. In reviewing the modified Technical Specifications (TS) for the safety chilled water system (SCWS), the staff requests that the applicant address the following:

a. The staff noticed that the limiting-condition-for-operation (LCO) for TS 3.7.9 states that "Four SCW trains shall be OPERABLE and in operation." Provide the definition of "in operation" for the cross-tie alignment. In addition, if 4 trains are OPERABLE and one train is not "in operation," the TS (as currently written) would require the applicant to enter LCO 3.0.3 because the associated action (one train not in operation) is no longer provided. Justify having one of four SCWS trains not in operation requiring entry into LCO 3.0.3 or remove the term "in operation" from the LCO.

b. The note under the "Actions" for TS 3.7.9 states to enter LCO 3.4.6 for any residual heat removal loops made inoperable by the SCWS. With the divisions cross-tied, explain the basis for this note in TS 3.7.9.

c. Surveillance Requirement (SR) 3.7.9.3 says to verify each SCW train has the capability to remove the design heat load every 24 months. Explain the basis for removing this surveillance from the TS.

Response to Question 09.02.02-104:

a. With the cross-tie alignment, all four SCW trains do not need to be in operation. LCO 3.9.7 will be revised to delete "and in operation."

b. With the cross-tie alignment, this Note is no longer needed and will be deleted.

c. The surveillance requirements for the SCW system were reviewed and SR 3.7.9.3 will be un-deleted.

FSAR Impact:

U.S. EPR FSAR Tier 2, Chapter 16, Technical Specifications Section 3.7.9 and Bases will be revised as described in the response and indicated on the enclosed markup.