ArevaEPRDCPEm Resource

From: BRYAN Martin (EXTERNAL AREVA) [Martin.Bryan.ext@areva.com]
Sent: Thursday, September 09, 2010 9:25 AM
To: Tesfaye, Getachew
Cc: Miernicki, Michael; KOWALSKI David (AREVA)
Subject: FW: DRAFT RESPONSES FOR FSAR Chapter 9 Weekly NRC Telecon
Attachments: Blank Bkgrd.gif; DRAFT RESPONSE RAI 397 Q.09.02.05-36.pdf; DRAFT RESPONSE RAI 417 Q.09.02.02-118.pdf

Importance: High

Mike,

Can you check to make sure this one gets to the Ch 9 folks this morning (Sam Lee, Larry Wheeler, etc.) for a phone call later? I think Peter Hearn is out this week and I am sure Getachew is cacthing up with 100s of emails.

Thanks,

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From: BRYAN Martin (External RS/NB)
Sent: Thursday, September 09, 2010 9:08 AM
To: Tesfaye, Getachew
Cc: Hearn, Peter; KOWALSKI David (RS/NB)
Subject: FW: DRAFT RESPONSES FOR FSAR Chapter 9 Weekly NRC Telecon
Importance: High

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From: KOWALSKI David (RS/NB)
Sent: Thursday, September 09, 2010 7:23 AM
To: BRYAN Martin (External RS/NB)
Cc: BALLARD Bob (EP/PE); CONNELL Kevin (EP/PP); HUDDLESTON Stephen (EP/PE); BROUGHTON Ronnie (EP/PE); BRYANT Chad (EP/PE); GARDNER Darrell (RS/NB); MCINTYRE Brian (RS/NB); SLOAN Sandra (RS/NB)
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 397 and 417 questions. These responses will be discussed at today's (9/9/10) FSAR Chapter 9 Weekly Telecon/GoToMeeting with the NRC.

Attached are the following DRAFT response(s):

- Response to RAI 397 - Question 09.02.05-36.
- Response to RAI 417 - Question 09.02.02-118.

Note that these DRAFT responses have not been through the final Licensing review/approval process; nor do they reflect technical editing.

Please call me if you have any questions. Thanks.

David J. Kowalski, P.E.
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Request for Additional Information No. 397(4644, 4680), Revision 0

6/16/2010

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 09.02.02 - Reactor Auxiliary Cooling Water Systems
SRP Section: 09.02.05 - Ultimate Heat Sink

Application Section: 9.2

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

09.02.05-36

Follow-up to RAI 277, Question 09.02.05-21:

Based on the staff's review of the RAI 277, Question 09.02.05-21 response dated September 16, 2009, the applicant did not address the 10 CFR 52.47(a)(24) and (a)(25) regulations for the ultimate heat sink (UHS) emergency make-up water system which state:

"(24) A representative conceptual design for those portions of the plant for which the application does not seek certification, to aid the NRC in its review of the Final Safety Analysis Report (FSAR) and to permit assessment of the adequacy of the interface requirements in paragraph (a)(25) of this section;

(25) The interface requirements to be met by those portions of the plant for which the application does not seek certification. These requirements must be sufficiently detailed to allow completion of the FSAR;"

a. Since the design of the raw water supply system (RWSS) submitted in the response is designated as "non-safety" and supplies only the normal make-up water supply to the UHS, the EPR design certification (DC) application still lacks a description of the safety-related emergency make-up water system to the UHS. Therefore, to comply with 10 CFR 52.47(a)(24), the applicant should revise the FSAR to include a certified or conceptual design for the UHS emergency make-up water system.

b. Also, to comply with 10 CFR 52.47(a)(25), the FSAR, including Chapter 4, "Interface Requirements," of Tier 1, needs to be revised to include sufficiently detailed interface requirements for this system that must be satisfied by combined license applicants when they provide their plant specific RWSS design. Currently, the staff could find only a 300 gpm interface requirement for the safety-related, UHS emergency make-up water system, which has no certified or conceptual design provided. The current interface requirement is not comprehensive in that it does not take into account the temperature and chemistry of potential make-up water sources and their impact on the UHS performing its intended safety function over a period of 30 days. The applicant should address the staff's concern on the comprehensiveness of the interface requirement for the UHS emergency make-up water system.

c. The applicant's response included an FSAR markup including a conceptual design of a non-safety related RWSS in FSAR Section 9.2.9. The sentence "[[Connections to the UHS cooling tower basins are made at safety-related motor operated valves (MOV), identified in Section 9.2.5]]" is notated as "conceptual" design while these MOVs are shown to be part of the standard design in all of the corresponding figures. The applicant should clarify and maintain consistency regarding what portions are conceptual design, and what portions are part of the certified design in figures, tables, and text for FSAR Sections 9.2.1, 9.2.5, and 9.2.9. For figures and tables that include both conceptual design portions and certified design portions, a clear notation should be used to illustrate the distinctions. The applicant should address the apparent discrepancy in the example cited above as well as review the FSAR for other inconsistencies.

d. The opening sentence of FSAR Chapter 9.2.9 provided in the response states that the RWSS provides ultimate heat sink make-up. Figure 9.2.9-1 shows the RWSS supplies only "normal" make-up to the UHS. The applicant should add the word "normal" to the text portion so that there is clarity that the RWSS does not provide both normal and emergency make-up water to the UHS per the conceptual design provided.

Response to Question 09.02.05-36:

Item (a)

The safety related emergency makeup water system supplies only the emergency makeup water supply to the UHS. The certified portion of the emergency makeup water system is the supply piping and isolation valves downstream of the flange at the building interface as illustrated in Figure 9.2.5-1. The site-specific portion, conceptually shown in Figure 9.2.5-2 (revised in response to RAI 351 Question 9.2.5-33), is the responsibility of the COL applicant and is included in the COL information items Tier 2 Table 1.8-2 Item No. 2.3-10 and 9.2-1. In addition, Tier 1 Section 2.7.11-8.0 will be revised to include interface requirements for supply temperature, SSC classifications, and water chemistry as described in the response to Item (b).

The emergency makeup water system components piping and isolation valves included within the scope of the design certification are classified as listed in Tier 2 Table 3.2.2-1. The supply piping and isolation valves are ASME Section III, Class 3 safety related and seismic category 1.

The safety functions of the emergency makeup water system are described in Tier 1 Section 2.7.11-1.0 and Tier 2 Section 9.2.5.5. Tier 2 Section 9.2.5.5 paragraph five will be revised to include the word ‘emergency’ to clarify the makeup system being referred to as shown in the enclosed markup.

Item (b)

Tier 1 Section 2.7.11-8.0 will be revised to include the following interface requirements:

8.2 The site specific emergency makeup water system provides water to each ESW cooling tower basin at a temperature below the maximum ESWS supply temperature of 95° F.

8.3 The site specific emergency makeup water system is designed in accordance with ASME Section III, Class 3 safety related systems, structures and components and seismic category I requirements.

8.4 The site specific emergency makeup water system provides a means to limit corrosion, scaling, and biological contaminants in order to minimize component fouling.

These revisions are reflected in Insert 1

Item (c)

The safety related emergency makeup water system isolation valves are included within the scope of the certified design. Tier 2 Section 9.2.9 paragraph four will be revised per the following and as indicated in the enclosed markup:

[[Non-safety-related normal makeup water is provided to the UHS cooling tower basins as clean (desalinated) water.]] The certified portion of the normal makeup water system is the supply piping downstream of the flange at the building interface as illustrated in Figure 9.2.5-1. The site-specific portion, conceptually shown in Figure 9.2.5-2, is the responsibility of the COL applicant and is included in the COL information items Tier 2 Table 1.8-2 Item No. 9.2-1. The non-safety related connections to the UHS cooling tower basins are made at safety-related motor operated valves (MOV), identified in Section 9.2.5. These valves close during a DBA on receipt of an accident signal, thereby maintaining UHS cooling tower basin integrity under accident conditions.

Item (d)

Tier 2 Section 9.2.9 paragraph one will be revised to include the word ‘normal’ to clarify the makeup system being referred to as shown in the enclosed markup.

FSAR Impact:

U.S. EPR FSAR, Tier 2, Sections 9.2.5 and 9.2.9 and Tier 1, Section 2.7.11 will be revised as described in the response and indicated on the enclosed markup.

Insert 1

8.2 The site specific emergency makeup water system provides water to each ESW cooling tower basin at a temperature below the maximum ESWS supply temperature of 95° F.

8.3 The site specific emergency makeup water system is designed in accordance with ASME Section III, Class 3 safety related systems, structures and components and seismic category I requirements.

8.4 The site specific emergency makeup water system provides a means to limit corrosion, scaling, and biological contaminants in order to minimize component fouling.

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

9.2.5.5 Safety Evaluation

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

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

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

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

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

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

6.0 Environmental Qualifications

6.1 Deleted.

7.0 Equipment and System Performance

7.1 The ESWS UHS as listed in Table 2.7.11-1 has the capacity to remove the design heat load from the CCWS.

7.2 The pumps listed in Table 2.7.11-1 have net positive suction head available (NPSHA) that is greater than net positive suction head required (NPSHR) at system run-out flow.

7.3 Class 1E valves listed in Table 2.7.11-2 can perform the function listed in Table 2.7.11-1 under system operating conditions.

7.4 The ESWS provides for flow testing of the ESWS pumps during plant operation.

7.5 Deleted.

7.6 The ESWS delivers water to the CCWS and EDG heat exchangers and the ESWPBVS room coolers.

8.0 Interface Requirements

8.1 The site specific emergency makeup water system provides 300 gpm makeup water to each ESW cooling tower basin to maintain the minimum basin water level.

9.0 Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.7.11-3 lists the ESWS ITAAC.

9.2.9 Raw Water Supply System

The raw water supply system (RWSS) provides the initial source of water supplied to the plant demineralized water, potable and sanitary water, ultimate heat sink makeup, and fire protection systems. The RWSS and the design requirements of the RWSS are site-specific and will be addressed by the COL applicant.

[[The RWSS contains water received from a site-specific natural source and supplies it directly to the points of use where it may be further processed by the receiving plant systems. The raw water for demineralized water, potable water, fire protection, and ultimate heat sink (UHS) normal makeup is preprocessed as required by filtration, reverse osmosis, chemical treatment, and desalinization of brackish raw water sources prior to use.]] The conceptual design of the RWSS is shown in Figure 9.2.9-1—[[Conceptual Site-Specific Raw Water Supply System]].

[[The RWSS does not provide any safety-related function. There is no connection between raw water and the components of other systems that have the potential to contain radiological contamination.]]

[[Normal non-safety-related makeup water is provided to the UHS cooling tower basins as clean (desalinated) water. Connections to the UHS cooling tower basins are made at safety-related motor operated valves (MOV), identified in Section 9.2.5. These valves close during a DBA on receipt of an accident signal, thereby maintaining UHS cooling tower basin integrity under accident conditions.]]

Testing is conducted during post-construction, pre-commissioning, and startup as necessary to confirm system integrity and proper operation of individual components and the total system. Portions of the system are leak tested to demonstrate proper operation.

Instrumentation is provided for local and remote system monitoring, including alarms for flows, temperatures and pressures, tank level and temperature, UHS makeup flow, demineralized water system feed flow, potable water system feed flow, valve position indication for selected valves, and pump power on/off indication.

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. Refer to the Response to RAI 406 Question 9.2.2-114 for information related to the RCP thermal barrier Containment Isolation Valve interlock function. 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.

For the CCWS FMEA, the failure of a common header switchover valve to completely close during a routine switchover is analyzed. With one CCWS train out of service the failure of one common header switchover valve very near the seat would prevent the permissive that opens the isolation valves for the other train from being achieved. In this case, with one of the first valves being nearly closed, there would be very low flow to the common header. This would leave three CCWS trains operable, but only one CCWS common header operable. The two CCWS trains that supply the inoperable common header would each remain operable and available for safety injection system cooling. The loss of cooling to one common header will result in a loss of cooling for the oil bearing coolers and motor air coolers of two Reactor Coolant Pumps. The loss of flow to these pumps will result in a reactor trip and a trip of each RCP. In this scenario, this is the safe condition for the plant. The reactor trip will allow the plant to be shut down to determine why the common header switchover valve failed and allow time for repairs to the valve. In this scenario, there is no quick operator action that could be achieved to restore full flow to the common header if the valve in stuck in a nearly closed position. It is likely the oil bearing temperature rise will occur in a time of less than one minute.

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

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.

9.2.2.6.1.5 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.~~

- Manual or automatic actuation of a CCWS pump automatically actuates the corresponding ESWS pump.

9.2.2.6.1.6 RCP Thermal Barrier Temperature Monitoring

The return temperature from each RCP thermal barrier is continuously monitored in the MCR using temperature elements in the outlet of each thermal barrier as indicated in Figure 9.2.2-2, Sheets 3, and 4 and Figure 9.2.2-3, Sheets 3 and 4. High temperature indication initiates an alarm in the MCR.

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.

3. ASME Boiler and Pressure Vessel Code, Section VIII: "Rules for Construction of Pressure Vessels," The American Society of Mechanical Engineers, 2004.

RAI 417, Q 9.2.2-118

9.2.2.7 CCWS Failure Modes and Effects Analysis

A Failure Modes and Effects Analysis (FMEA) for the Component Cooling Water System is provided in Table 9.2.2-7.

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, Water Cooled Division of the Safety Chilled Water System) 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).

Operating procedures included in the FMEA table for the CCWS will be developed by the COL applicant.

RAI 417; Q 9.2.2-118 FSAR Insert

Table 9.2.2-7 – Component Cooling Water System - Failure Modes and Effects Analysis

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 2 SCWS Water Cooled Chillers 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 SCWS Water Cooled Chiller 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 with a LOOP, may result in a loss of CCW flow to the RCP thermal barriers AND a loss of CVCS flow to RCP seals. The loss of one common header may result in a plant shutdown due to loss of cooling for bearing lube oil and motor air coolers for two RCPs. **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.** 48) and 49) below discuss RCP thermal barrier cooling related to a LOOP with a single failure of an EDG or LOOP with a valve single failure.

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	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 (ABSS). 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 SCWS Water Cooled Chillers operable 2 CVCS Letdown HP Coolers operable CCW maintains flow to RCP thermal barriers	
			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 Demineralized Water Distribution System. 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. A tube rupture in the CCWS heat exchanger with CCWS and ESWS both in standby mode would lead to leakage from the CCWS into ESWS.
			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.

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.
		Maintains CCW temperature between minimum of 59.0ºF and maximum of 100.4ºF by opening and closing to increase or reduce bypass flow around the CCW heat exchanger.	Fails in Intermediate Position	Mechanical, Electrical, I&C	CCW heat exchanger bypass control valve failure in intermediate position is bounded by failure to OPEN or CLOSE on demand.	**10) Mission Success Criteria are met**. Results bounded by 8) above for valve failure to move more OPEN. Results bounded by 9) above for valve failure to move more CLOSED.	
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.	**11) 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.	

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.	**12) 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 SCWS Water Cooled Chiller 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.	**13) 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).
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.	**14) 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 SCWS Water Cooled Chiller 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.	**15) 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.	
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 seal water cooler will cause steady elevation of seal water 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.	**16) 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 SCWS Water Cooled Chiller 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.	**17) 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 15) above.	

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.	**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 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 SCWS Water cooled chillers 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.	**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. This leaves at minimum: 3 CCW trains operable, including the affected train 2 SFP Cooling HX operable 2 SCWS Water cooled chillers 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.	**20) 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 18) above.	

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.	**21) 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 SCWS Water cooled chillers 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.	**22) Mission Success Criteria are met.** Results bounded by 21) 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.	**23) 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 SCWS Water cooled chillers 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.	**24) Mission Success Criteria are met.** Results bounded by 22) above for valve failure to move more OPEN. Results bounded by 23) above for valve failure to move more CLOSED.	

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.	**25) 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 SCWS Water Cooled Chiller 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.	**26) Mission Success Criteria are met.** Results same as 25) 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.	**27) 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 SCWS Water Cooled Chillers 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.

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.**	**28) 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 SCWS Water Cooled Chillers 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) 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). 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) 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 SCWS Water Cooled Chiller 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 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 SCWS Water Cooled Chillers operable 2 CVCS letdown HP cooler operable, and CCW supplying flow to all RCP thermal barriers.	

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 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), 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 two trains supplying the opposite Common Header leaves at minimum: 3 CCW trains operable 1 SFP Cooling HX operable 1 SCWS Water Cooled Chiller 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.**	If RCP thermal barrier cooling flow is initially aligned to the common header with one CCWS train available, no operator action is required to transfer thermal barrier cooling to the other common header that has a failed switchover valve. If RCP thermal barrier cooling flow is initially aligned to the common header with two CCWS trains available and the common header switchover valve for one of these two trains fails, operator action will be required to transfer thermal barrier cooling to the other common header.
			Fails during routine train switchover near the seat but does not fully close resulting in very low flow to the common header	Mechanical, Electrical, I&C	Interlock prevents opening the on-coming switchover isolation valves until the off-going isolation valves are closed. Valve failure in a nearly closed position results in very low flow to the affected Common Operating Loads (1.B/2.B).	**32) Mission Success Criteria not 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 two trains supplying the opposite Common Header leaves at minimum: 3 CCW trains operable 1 CCW Common Header operable 1 SFP Cooling HX operable 1 SCWS Water Cooled Chiller 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 case of a failure of a switchover valve on the initial train or lack of opening of a switchover valve on the final train, another switchover is automatically performed to revert back to the initial configuration. This auto revert back feature is built into the switchover function. If a valve is mechanically stuck, and is unable to be closed or reopened, the associated CCWS train is not able to be aligned to the common header. Therefore, one common header has no cooling water supply even though the two trains that supply that common header are operable. The remaining configuration in this operating scenario would leave one CCWS train operable on one of the two common headers. The remaining two CCWS trains would be operable and available for Safety Injection system cooling. The loss of one common header may result in a plant shutdown due to loss of cooling for bearing lube oil and motor air coolers for two RCPs. The loss of CCWS cooling to the two RCPs on the affected common header will lead to an automatic trip of the RCPs and a reactor trip. This is covered in the FSAR Chapter 15 Safety Analysis.

Containment Isolation Valves in CCW Supply/Return 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.	**33) 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 SCWS Water Cooled Chillers 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).
			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.	**34) Mission Success Criteria are met**. Results bounded by 33) 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.	**35) 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 SCWS Water Cooled Chillers 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.	**36) Mission Success Criteria are met**. Results bounded by 35) 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.	**37) 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 SCWS Water Cooled Chillers 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.
			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.	**38) Mission Success Criteria are met.** Results bounded by 35) 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	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.	**39) 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 SCWS Water Cooled Chillers 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.

		KBA11/12 CT752	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.	**40) Mission Success Criteria are met**. Results bounded by 39) 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 SCWS Water Cooled Chillers 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	CCW temperature control valve failure in intermediate position is bounded by failure to OPEN on demand.	**41) Mission Success Criteria are met**. Results bounded by 39) 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.	**42) 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.	**43) 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 SCWS Water Cooled Chillers 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.	**44) 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 SCWS Water Cooled Chillers 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.**
			Spurious low flow signal	I&C	Spurious low flow signal could mask recognition of high flow condition associated with CVCS (RCS) to CCW leak.	**45) Mission Success Criteria are met**. Results bounded by 44) 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.	**46) Mission Success Criteria are met**. Results bounded by 44) 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.	**47) Mission Success Criteria are met**. Results bounded by 44) 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.**

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 AA050 KAB30 AA054 (CCW Supply Inner 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 one of the two supply valves and one of the two return valves 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.	**48) Mission Success Criteria are met.** With one CCW train out for maintenance, and the associated train for that common header supplying thermal barrier cooling when a thermal barrier cooling transfer is initiated to the other common header with two CCWS trains OPERABLE, failure of any one CCW Containment Isolation valve on either the supply or return line to the RCP thermal barriers would automatically revert the system back to the original configuration where thermal barrier cooling is supplied by the common header with only one CCWS train OPERABLE. This results in a 72 LCO per TS 3.7.7 Note A.1.	In Normal Power Operation (prior to securing a CCWS train for maintenance) with 4 CCWS trains operable, two CVCS trains are available for RCP seal injection. If a RCP thermal barrier CIV fails mid-position on the off-going header or mid-position on the on-coming header it is assumed that CCWS flow to each of the two common headers (including CVCS) is still available from any of the 4 CCWS trains. Two trains of CVCS normally supply RCP seal injection while CCWS flow to the thermal barriers is restored. The one out of two logic for the initial supply valves plus the one out of two logic for the initial return valves to close allowing the transfer to complete by opening the on-coming header valves confirms that CCWS flow will be restored to the thermal barriers in the event of a LOOP with a single failure of a diesel generator or a LOOP with a single failure of one of the off-going header valves in mid-position. There is an auto revert back feature built in the thermal barrier transfer that puts the thermal barrier cooling back in the initial configuration if the single failure is one of the valves on the on-coming header to fully open. Loss of the operating CVCS pump automatically shifts CVCS operation to the standby CVCS pump, which should restore normal RCP seal water flow.

Containment Isolation Valves in CCW Supply/Return lines to RCP 1/2/3/4 Thermal Barriers (Continued)	KAB30 AA049 KAB30 AA053 (CCW Supply Outer CIV) KAB30 AA050 KAB30 AA054 (CCW Supply Inner 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 one of the two supply valves and one of the two return valves 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 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.	**49) Mission Success Criteria are met**. Results bounded by 48) above.	In Normal Power Operation (prior to securing a CCWS train for maintenance) with 4 CCWS trains operable, two CVCS trains are operable for RCP seal injection. If a RCP thermal barrier CIV fails mid-position on the off-going header or mid-position on the on-coming header it is assumed that CCWS flow to each of the two common headers (including CVCS) is still available from any of the 4 CCWS trains. Two trains of CVCS normally supply RCP seal injection while CCWS flow to the thermal barriers is restored. The one out of two logic for the initial supply valves plus the one out of two logic for the initial return valves to close allowing the transfer to complete by opening the on-coming header valves confirms that CCWS flow will be restored to the thermal barriers in the event of a LOOP with a single failure of a diesel generator or a LOOP with a single failure of one of the off-going header valves in mid-position.
Non-Safety Related Common Operating Load (1/2)B Isolation Valves	KAB80 AA015 KAB50 AA001 (CCW Supply first isolation) KAB80 AA016 KAB50 AA006 (CCW Supply second isolation) KAB80 AA019 KAB50 AA004 (CCW Return 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 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.	**50) Mission Success Criteria are met.** With one CCW train out for maintenance, failure of one 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 SCWS Water Cooled Chillers 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. The Non-Safety user isolation valves (KAB80 AA015/016/019 and KAB50 AA001/004/006) are designed to fail closed on loss of power to the hydraulic actuation circuit. Each Non-Safety user isolation valve has multiple solenoid operated pilot valves and hydraulic fluid pumps. The solenoid operated pilot valves and hydraulic fluid pumps are each powered from different Class 1E divisions to provide redundancy.
			Fails to Close	Mechanical, Electrical, I&C	If any ONE of these isolation valves fails to CLOSE, the isolation function is fulfilled by the redundant isolation valve on the supply or return side.	**51) Mission Success Criteria are met**. Results bounded by 50) 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.	**52) 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 SCWS Water Cooled Chillers 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).

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.	**53) 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.	**54) Mission Success Criteria are met.** Results bounded by 53) above.	.
			Fails in Intermediate Position	Mechanical, Electrical, I&C	Failure of the SCWS condenser CCW recirculation flow control valves in the intermediate position is bounded by failure to move toward increased CCW return flow (open) and failure to move toward reduced CCW return flow (closed).	**55) Mission Success Criteria are met.** Results bounded by 53) and 54) above.	

Solenoid Operated Pilot Valves for Hydraulic Operated vales		Controls flow of hydraulic fluid to actuator for hydraulically actuated valves to open / close.	Fails on demand	Mechanical, Electrical, I&C	Hydraulic circuits fail on demand to provide or stop flow to actuators as required for hydraulically actuated valve to open / close.	**56) Mission Success Criteria are met**. Results bounded by 18), 19) and 20) above for SFP switchover isolation valves.	The common header switchover valves (KAA10/20/30/40 AA006/010/032/033) are designed to fail as-is on loss of power to the hydraulic power circuit. Each common header switchover valve has multiple solenoid operated pilot valves and hydraulic fluid pumps. The solenoid operated pilot valves and hydraulic fluid pumps are each powered from different Class 1E divisions to provide reliability of the switchover function.
						57) Mission Success Criteria are met. Results bounded by 29), 30) and 31) above for Common 1.B / 2.B switchover isolation valves.	
						58) Mission Success Criteria are met. Results bounded by 50) and 51) above for Non-Safety related CCWS user isolation valves.	The Non-Safety user isolation valves (KAB80 AA015/016/019 and KAB50 AA001/004/006) are designed to fail closed on loss of power to the hydraulic power circuit. Each Non-Safety user isolation valve has multiple solenoid operated pilot valves and hydraulic fluid pumps. The solenoid operated pilot valves and hydraulic fluid pumps are each powered from different Class 1E divisions to provide redundancy.
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 while running	Air Intrusion	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 (ABSS). 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.	**59) Mission Success Criteria are met.** Results bounded by 3) above.	The CCWS system has no connection with compressed air systems inside the plant therefore the potential for air intrusion in the CCWS system piping from compressed air systems does not exist. To prevent air intrusion from the surge tank through the pump suction line, the minimum water level in any CCWS surge tank is calculated per ANSI/HI 9.8 (1998). This minimum water level will be set as MIN4 level in each tank. MIN4 is the level that trips the operating CCWS pump.

CCWS Surge Tank Level Instrumentation	KAA10/20/30/40 CL094 KAA10/20/30/40 CL099	Monitors CCW surge tank level; Monitor system leakage per TS SR 3.7.7.2; MAX1 level signal automatically isolates makeup from Demin Water system via closure of KAA10/20/30/40 AA027; MIN1 level signal automatically opens the Demin Water system makeup valve (KAA10/20/30/40 AA027); MIN2 level signal concurrent with high inlet / outlet flow differential in the Non-safety related user branch automatically isolates the non-safety related users outside the reactor building via closure of valves KAB80 AA015/016/019 and KAB50 AA001/004/006; a MIN2 level also inhibits the common header valve switchover sequence (automatic and normal); MIN3 level signal automatically isolates the common headers via closure of valves KAA10/20/30/40 AA006/010/032/033 and the switchover sequence is prohibited; MIN4 level signal trips the operating CCWS pump which automatically starts the associated train pump for that common header and unlocks the switchover sequence function.	Fails to properly automatically actuate on various surge tank level indications or transmit surge tank level	Mechanical, Electrical, I&C	Failure of the surge tank instrumentation to properly automatically actuate on a MAX1 level (which isolates demin water makeup) could lead to a high-high level in the surge tank with tank inventory being lost into the drain system via the tank overflow line. Failure of the surge tank instrumentation to properly automatically actuate on a MIN1 level (which initiates makeup from demin water) could lead to a MIN2 level at which time the non-safety users are isolated. Failure of the surge tank instrumentation to properly automatically actuate on a MIN2 level (which isolates non-safety related users with a concurrent high inlet / outlet flow differential) could lead to a MIN3 level at which time the common header is isolated. Failure of the surge tank instrumentation to properly automatically actuate on a MIN3 level (which isolates the common header) could lead to a MIN4 level at which time the operating pump is tripped and the associated train pump for the common header is automatically started. Failure of the surge tank instrumentation to properly automatically actuate on a MIN4 level could lead to the operating pump running without adequate NPSH and prevent the associated train pump for the common header from starting.	**60) Mission Success Criteria are met.** Failure to properly automatically actuate on a MAX1 level does not prevent a CCWS pump from operating. This would leave 4 of 4 CCWS train operable. Failure of the instrumentation to properly automatically actuate on MIN1, MIN2, MIN3 and MIN4 levels could ultimately lead to a failure of two CCWS trains. This would potentially be due to the fact that one train could have insufficient surge tank capacity to operate the pump and the associated train pump for that common header may not have started. 2 CCWS trains inoperable leaves at minimum 2 CCW trains operable on one side of the plant, 1 SFP Cooling HX operable 1 SCWS Water Cooled Chiller 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. Results bounded by 2) above.**	Failure of level instrumentation to properly automatically actuate on any surge tank level indication will lead to manual operator actions. Operating procedures will direct the automatic actions to be manually backed up. If an automatic action is to occur and does not properly function, operators are to take manual actions to complete that action.