ArevaEPRDCPEm Resource

From: BRYAN Martin (EXT) [Martin.Bryan.ext@areva.com]
Sent: Thursday, June 17, 2010 8:03 AM
To: Tesfaye, Getachew
Cc: KOWALSKI David J (AREVA NP INC)
Subject: FW: DRAFT RESPONSES FOR FSAR Chapter 9 Weekly NRC Telecon
Attachments: Blank Bkgrd.gif; DRAFT RESPONSE RAI 417 Q.09.02.02-119.pdf; DRAFT RESPONSE RAI 417 Q.09.02.02-116.pdf; DRAFT RESPONSE RAI 417 Q.09.02.02-117.pdf; DRAFT RESPONSE RAI 417 Q.09.02.02-118.pdf

Importance: High

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Sent: Thursday, June 17, 2010 6:21 AM
To: BRYAN Martin (EXT)
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Subject: DRAFT RESPONSES FOR FSAR Chapter 9 Weekly NRC Telecon
Importance: High

Marty:

Please transmit to Getachew Tesfaye the attached partial set of DRAFT responses to RAI 417 questions. These responses will be discussed at today's (6/17/10) FSAR Chapter 9 Weekly Telecon/GoToMeeting with the NRC.

Attached DRAFT responses include the following:

- Response to RAI 417 Question 09.02.02-116.
- Response to RAI 417 Question 09.02.02-117.
- Response to RAI 417 Question 09.02.02-118.
- Response to RAI 417 Question 09.02.02-119.

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

Please call me if you have any questions. Thanks.

David J. Kowalski, P.E.
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Email Number: 1573

Mail Envelope Properties (BC417D9255991046A37DD56CF597DB71068D193D)

Subject: FW: DRAFT RESPONSES FOR FSAR Chapter 9 Weekly NRC Telecon
Sent Date: 6/17/2010 8:03:11 AM
Received Date: 6/17/2010 8:05:01 AM
From: BRYAN Martin (EXT)

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Post Office: AUSLYNCMX02.adom.ad.corp

Files	Size	Date & Time
MESSAGE	1710	6/17/2010 8:05:01 AM
Blank Bkgrd.gif	210	
DRAFT RESPONSE RAI 417 Q.09.02.02-119.pdf	387577	
DRAFT RESPONSE RAI 417 Q.09.02.02-116.pdf	366900	
DRAFT RESPONSE RAI 417 Q.09.02.02-117.pdf	486403	
DRAFT RESPONSE RAI 417 Q.09.02.02-118.pdf	411577	

Options
Priority: High
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received:

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)

09.02.02-119

Follow-up to RAI 334, Question 9.2.2-70 and RAI 174, Question 9.2.2-22

Some of this RAI is editorial in nature.

Part (a)- In Part (a) of follow-up Question 9.2.2-70 the applicant was requested to clarify and state the basis for the Safety Injection (SI) sequences presented in U.S. EPR FSAR Tier 2 Sections 9.2.2.3.1 and 9.2.2.6. The staff's review found the applicant's response unacceptable and noted the following corrections (technical and editorial) are required in the FSAR markups submitted in RAI 334, Supplement 1:

1. Section 9.2.2.3.1 on page 9.2-36 of the mark-up under the heading for "Previously Running Pumps..." At the end of the first bulleted sentence; delete the phrase "of the train not initially in operation," since it does not belong under this heading. Also, "The initiation of each sequence is provided as a group command" should be removed. (editorial)

2. Section 9.2.2.6 on page 9.2-44 of the markup under the heading "CCWS Actuation from a Safety Injection Signal; this sequence needs to recognize that a "Safety Injection Signal" will also initiate a concurrent containment Isolation "Stage 1" signal to isolate CCWS HVAC and NIDVS users in the Reactor Building. Refer to FSAR Tier 2, Section 7.3.1.2.9 "Containment Isolation," and Figure 7.3-20, "Containment Isolation" for justification that stage 1 is initiated by a safety injection signal. (editorial)

3. Section 9.2.2.3.1 was not consistent with Section 9.2.2.6.1 related to SI signal and the opening of the LHSI pump seal cooler. (technical)

Response to Question 9.2.2-119:

1. A review of the CCWS confirmed the phrase “of the train not initially in operation” does not apply. The statement “The initiation of each sequence in provided as group command” will also be removed.
2. A statement related to a Safety Injection Signal also initiating a concurrent Containment Isolation Stage I signal will be added to FSAR Section 9.2.2.6.
3. A review of the CCWS confirmed the LHSI pump seal cooler discussion is missing from FSAR Section 9.2.2.3.1

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 9.2.2.3.1 and 9.2.2.6 will be revised as described in the response and indicated on the enclosed markup.

This may be necessary only during peak summer conditions, and an excessive throttling (bypassing) of the LHSI HX to limit the CCWS temperatures late in the cooldown process is an indication of the need to do so.

Accident Operating Conditions

Safeguard Building LOCA or LOCA Coupled With Unavailability of Two CCWS/SIS Trains

This accident condition postulates the unavailability of one CCWS train due to a single failure with another train in maintenance. Upon receipt of a safety injection and containment isolation stage 1 actuation, the reactor protection system (RPS) starts the CCWS trains not in operation by:

- Starting of the CCWS pumps not initially in operation.
- Opening the LHSI/RHR isolation valves of the train not initially in operation.
- Isolation of the non-safety-related common users outside the Reactor Building.
- Isolation of the containment ventilation and RCDT loads inside the Reactor Building on Common Header 1.b (containment isolation stage 1).

For previously running pumps, the following sequence applies:

- Opening the LHSI/RHR isolation valves of the train not initially in operation.
- Isolation of the non-safety-related common users outside the Reactor Building.
- Isolation of the containment ventilation and RCDT loads inside the Reactor Building on Common Header 1.b (containment isolation stage 1).

The initiation of each sequence is provided as a group command.

- ~~Opening the LHSI/RHR isolation valves of the train not initially in operation.~~
- ~~Isolation of the non-safety-related common users outside the RB.~~
- ~~Isolation of the containment ventilation and RCDT loads inside the RB (containment isolation stage 1).~~
- ~~Starting of the CCWS pumps not initially in operation.~~

Upon actuation of a containment isolation stage 2 signal issued from the RPS, the RCP and CVCS loads inside the RB are isolated (not including the RCP thermal barriers).

- The common user emergency and normal switchover sequence is inhibited to avoid the transfer of the faulted piping on the associated train. The non-safety-related branches are isolated by fast closing valves if there is a flow mismatch between the inlet and outlet of the users supply and return lines.

- If the surge tank level continues to decrease to less than the MIN3 setpoint, the common headers are isolated by closure of the switchover valves (KAA10/20/30/40 AA006/010/032/033) and the switchover sequence is prohibited.

- If the surge tank level continues to decrease to less than MIN4 set point, the common user sets switchover sequence function is unlocked to allow supplying of the common users by the associated train. The DWDS supply isolation valve (KAA10/20/30/40 AA027) is also closed in order to avoid DW water supply to a train with a leak.

The surge tank level is detected by two redundant analog level measurements.

CCWS Actuation from Safety Injection Signal

Upon receipt of a safety injection signal, the four CCWS trains are started, supplying all SIS pump coolers and the four LHSI heat exchangers. The non-safety-related users outside of the RB are also isolated.

The system response optimizes the CCWS to cool the SIS pumps and LHSI heat exchangers. The following CCWS actuations are automatically initiated:

- Start CCWS pumps (KAA10/20/30/40 AP001), if not previously running.

- Open LHSI HX isolation valves (KAA12/22/32/42 AA005).

- Open LHSI pump seal cooler isolation valves (KAA22/32 AA013).

- Close isolation valves for non-safety related users outside of RB (KAB50 AA001/ 004/006 & KAB80 AA015/016/019).

Simultaneous operation of LHSI heat exchanger isolation valves (opening) and non-safety-related user isolation valves (closing) maintains pump operation in a safe range.

CCWS Operation from Containment Isolation Stage 1

Upon receipt of a containment isolation stage 1 signal, CONT HVAC and NI DVS users in the RB are isolated via closure of KAB40 AA001/006/012.

This system response isolates these users, confirms the containment isolation function is met, and allows a maximum cooling flow rate through the LHSI heat exchanger in the event of a coincident safety injection signal.

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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)

09.02.02-116

Follow-up to RAI 334, Question 9.2.2-61 and RAI 174, Question 9.2.2-12:

During the staff's review of the FSAR markup provided for RAI 334 Supplement 1 and RAI 9.2.2-61, it was noted on page 9.2-44 of Tier 2 Section 9.2.2.6.1, "Control Features and Interlocks" that the CCWS pump trip interlock was omitted from the discussion of the response to MIN4 surge tank level. The staff also found that the corresponding FSAR Tier 1 ITAAC Commitment Item 4.6 had been deleted. While not specifically addressed in RAI 334, the staff was informed that this change was made by the applicant in response to RAI 182 Supplement 4 and guidance from SRP 14.3 was cited as the basis for deletion of the ITAAC for MIN4 CCWS pump trip interlock in FSAR Tier 1 Section 2.7.1. However, staff review of this change found that the MIN4 interlock provides other functions (described below) and therefore questions the applicability of the SRP 14.3 definition "provided solely for equipment protection." The applicant is therefore requested to determine if removal of the Tier 1 ITAAC for MIN4 was appropriate with consideration to the other functions identified below.

a. Since the comment of RAI 182 and the SRP 14.3 guidance appear to apply only to Tier 1 ITAAC, describe the basis in this RAI response for the CCWS pump trip interlock being omitted from the discussion of the response to MIN4 surge tank level on page 9.2-44 of the Tier 2 Section 9.2.2 markup for RAI 334. Furthermore, based on the FSAR markup of the Emergency Backup Switchover Sequence from RAI 9.2.2-61), the tripping of the CCWS pump will automatically start the opposite CCWS train. Therefore, the tripping of a CCWS pump based on MIN4, is not solely for equipment protection but does automatically start the opposite CCWS pump.
b. The description of the MIN4 interlock on page 9.2-44 of the markup indicates that the common header switchover function is unlocked to allow restoration of flow to the common users, which were isolated at MIN3. Since restoration of flow to users on the common header can be important (e.g. RCP thermal barrier coolers), describe the basis for deleting the Tier 1 MIN4 Interlock from the CCWS ITAAC.

Response to Question 9.2.2-116:

a. A review of the CCWS confirmed the automatic pump trip on MIN4 level. In addition, an automatic pump trip automatically starts the opposite train associated with the common header. At a MIN4 surge tank level, the train switchover function is unlocked to allow restoration of flow to the common users.

b. Refer to the Response to Question 9.2.2-116 Part (a).

FSAR Impact:

U.S. EPR FSAR, Tier 1, Section 2.7.1 and Table 2.7.1-3 will be revised as described in the response and indicated on the enclosed markup.

4.0 I&C Design Features, Displays and Controls

4.1 Displays listed in Table 2.7.1-2—Component Cooling Water System Equipment I&C and Electrical Design are retrievable in the main control room (MCR) and the remote shutdown station (RSS) as listed in Table 2.7.1-2.

4.2 The CCWS equipment controls are provided in the MCR and the RSS as listed in Table 2.7.1-2.

4.3 Equipment listed as being controlled by a priority and actuator control system (PACS) module in Table 2.7.1-2 responds to the state requested by a test signal.

4.4 A CCWS low flow condition automatically opens the low head safety injection (LHSI)/residual heat removal (RHR) heat exchanger (HX) inlet valve.

4.5 A surge tank level of MIN3 automatically isolates the associated train common header switchover valves.

4.6 ~~A surge tank level of MIN4 automatically trips the associated CCWS pump~~Deleted.

4.7 A flowrate difference between the supply and return from the Nuclear Auxiliary Building (NAB) and the Radioactive Waste Building (RWB) automatically isolates the non-safety-related branch.

4.8 Loss of one CCWS train initiates an automatic switchover to allow cooling of the common 'a' and/or 'b' headers.

4.9 Deleted.

4.10 CCWS train separation to RCP thermal barriers is maintained by interlocks provided on the supply and return thermal barrier containment isolation valves. The interlocks require that CIVs associated with one common header be closed before the other common header CIVs can be opened.

5.0 Electrical Power Design Features

5.1 The components designated as Class 1E in Table 2.7.1-2 are powered from the Class 1E division as listed in Table 2.7.1-2 in a normal or alternate feed condition.

5.2 Valves listed in Table 2.7.1-2 fail as-is on loss of power.

6.0 Environmental Qualifications

6.1 Components in Table 2.7.1-2, that are designated as harsh environment, will perform the function listed in Table 2.7.1-1 in the environments that exist during and following design basis events.~~Electrical drivers for equipment listed in Table 2.7.1-2 for harsh environment can perform the safety function in Table 2.7.1-1 following exposure to the design basis environments for the time required.~~

Table 2.7.1-3—Component Cooling Water System ITAAC (7 Sheets)

	Commitment Wording	Inspections, Tests, Analyses	Acceptance Criteria
4.6	Deleted.~~A surge tank level of MIN4 automatically trips the associated CCWS pump.~~	~~Tests will be performed using test signals to verify the interlock.~~Deleted.	Deleted.~~The following interlock responds as specified below when activated by a test signal:~~ ~~Surge tank level of MIN4 automatically trips the associated CCWS pump.~~
4.7	A flow rate difference between the supply and return from NAB and RWB automatically isolates the non-safety related branch.	Tests will be performed using test signals to verify the interlock.	The following interlock responds as specified below when activated by a test signal: Flow rate difference between the supply and return from NAB and RWB automatically isolates the non-safety related branch.
4.8	Loss of one CCWS train initiates an automatic switchover to allow cooling of the common “a” and/or “b” headers.	Tests will be performed using test signals to verify the interlock.	The following interlock responds as specified below when activated by a test signal: Loss of one CCWS train automatically initiates a switchover to allow cooling of the common “a” and/or “b” headers.
4.9	Deleted.	Deleted.	Deleted.
4.10	CCWS train separation to RCP thermal barriers is maintained by interlocks provided on the supply and return thermal barrier containment isolation valves. The interlocks require that CIVs associated with one common header be closed before the other common header CIVs can be opened.	Tests will be performed using test signals to verify the interlocks.	The following interlock responds as specified below when activated by a test signal: Thermal barrier CIVs associated with common header 1 fail to open while CIVs associated with common header 2 are opened and vice versa. Thermal barrier CIVs associated with common header 1 open when CIVs associated with common header 2 are closed and vice versa.

RAI 417, Q 9.2.2-116

Insert ‘A’

4.6 A surge tank level of MIN4 automatically trips the associated CCWS pump and unlocks the common header switchover function to allow restoration of flow to the common users.

Insert ‘B’

Commitment Wording		Inspections, Tests, Analysis	Acceptance Criteria
4.6	A surge tank level of MIN4 automatically trips the associated CCWS pump and unlocks the common header switchover function to allow restoration of flow to the common users.	Tests will be performed using test signals to verify the interlock.	The following interlocks respond as specified below when activated by a test signal: Surge tank level MIN4 automatically trips the associated CCWS pump. Surge tank level MIN4 unlocks the switchover sequence

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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)

09.02.02-117

Follow-up to RAI 334, Question 9.2.2-63 and RAI 174, Question 9.2.2-14:

The applicant should explain in the RAI response the application of the pump head and flow margins (calculated to be approximate 15-16%) to the pump parameters identified in FSAR Tier 2 Table 9.2.2-1. For example, Table 9.2.2-1 states that the design parameter for the pump is 17,768 gpm and the pump head is 199.7 ft.

The information that was added as part of RAI 9.2.2-63 FSAR mark-up related to the details of the pump head and pump flow margin, including new Table 9.2.2-5, should be removed and more of a high level summary added in its place.

Response to Question 09.02.02-117:

The largest total required flow for the CCWS pumps results from Train 3 aligned to Common 2 header in addition to the train specific SIS users. This alignment results in a total required pump flow of 15,407 gpm. The pump design flow of 17,768 gpm in Table 9.2.2-1 is calculated by including a 15.33% margin on the calculated maximum required flow of 15,407 gpm.

The required total developed head for the CCWS pumps results from Train 3 aligned to Common 2 header in addition to the train specific SIS users. This alignment results in a required total developed head of 172.6 ft. The pump head of 199.7 ft in Table 9.2.2-1 is calculated by including a 15.72% margin on the calculated maximum required flow of 172.6 ft.

FSAR Impact:

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

RWPB. This non-seismic portion of piping is isolated from the Seismic I piping on the supply to the users by two Seismic I isolation valves, and one Seismic I isolation valve and one Seismic I check valve on the return from the users. A failure of this non-seismic portion of the CCWS does not result in excessive radiological release because there is no potential for radioactive in-leakage to the CCWS from these users. The CCWS is at a higher pressure than each of these systems, so the only potential for in-leakage is from CCWS into these systems. The control room is not adversely affected by a failure of the non-seismic CCWS piping in the NAB or the RWPB because the control room is located in the Seismic I SB 2.

The dedicated CCWS is a non-safety-related system located in SB 4 whose piping and components are non-seismic. This system is used in beyond design basis accidents to transfer heat from the severe accident heat removal system (SAHRS). A failure of this non-seismic portion of the CCWS does not result in excessive radiological release since the pressurized tank in the dedicated CCWS keeps the system at a higher pressure than that of the SAHRS to prevent possible in-leakage of contaminated fluids in the SAHRS. The control room is not adversely affected by a failure of the non-seismic dedicated CCWS piping located in SB 4 because the control room is located in the Seismic I SB 2.

A fault in CCWS piping is recognized by redundant level indications on each CCWS surge tank. In the event that tank levels drop to MIN 2, the non-safety-related branches automatically isolate if there is a flow mismatch in inlet and outlet of the supply and return lines for the users. The CCWS is a closed-loop cooling water system with the only potential for radioactive in-leakage coming from the high pressure CVCS and RCS.

9.2.2.2.2 Component Description

Refer to Section 3.2 for details of the seismic and system quality group classification of the CCWS, CCW structures, and CCW components.

CCWS Pumps

CCWS pumps are sized to provide the capacity to support system flow requirements during penalizing conditions. To accomplish this, design margins are added to the limiting flow requirements (volumetric flow and head). The required design margins of the CCWS pumps are given in Table 9.2.2-5—Design Margins of CCWS Pumps.

Margin is combined using the square root of the sum of the squares method to prevent system over design which challenges system operation during normal operation. Considering that margin must be available for system flow balancing, the margin provided for this purpose is added using a straight summation to that combined using the square root of the sum of the squares (e.g., wear, testing uncertainty, grid frequency deviations). The margin (penalties) to be applied to the pump design conditions are as follows:

Pump head design margin:	$\sqrt{(10\%)^2 + (2\%)^2 + (3.31\%)^2} + 5\% = 15.72\%$
Pump flow design margin:	$\sqrt{(10\%)^2 + (2\%)^2 + (1.67\%)^2} + 5\% = 15.33\%$

The CCWS pumps are part of the safety-related cooling trains.

The four pumps are centrifugal type. The pump motor is cooled by an air-water cooler supplied by CCWS itself. The pump and motor are horizontally mounted on a common base plate. The pump and motor bearings are oil lubricated and are air cooled.

Motor heaters are provided on the motors and are energized when the pump is not in operation to prevent the formation of condensation.

During normal operating conditions, two of the four pumps are operating.

Dedicated CCWS Pump

The dedicated CCWS pump is non-safety-related and is in standby during normal plant operation.

The pump is centrifugal type. The pump motor is cooled by an air-water cooler supplied by the CCWS itself. The pump and motor are horizontally mounted on a common base plate. The pump and motor bearings are oil lubricated and are air cooled.

A motor heater is provided on the motor and is energized when the pump is not in operation to prevent the formation of condensation.

Dedicated CCWS Makeup Pump

The water supply pump is a positive displacement piston type to increase the head of the demineralized water distribution system (DWDS) supply to adjust the level of the pressurized surge tanks. To prevent flow pulses and to limit system vibration a pulsation damper is installed just downstream of the piston pump.

CCWS Heat Exchangers

The CCWS HXs are horizontal tube and shell type HXs. The CCW is circulated on the shell side and the ESWS supplies cooling water on the tube side.

Dedicated CCWS Heat Exchanger

The dedicated CCWS HX is a horizontal tube and shell type HX. CCWS circulates on the shell side and the ESWS supplies cooling water on the tube side.

Table 9.2.2-5—Design Margins of CCWS Pumps

	Parameter	Margin	Basis
Pump Wear (In-Service Testing) Tolerances	Required Pump TDH	-10%	(1)
	Required Design Flow		
Plant Testing Instrument Uncertainty	Required Pump TDH	±2%	(1)
	Required Design Flow		
Frequency Variations	Required Pump TDH	±3.31%	(2)
	Required Design Flow	±1.67%	
Pump Manufacturing Tolerances and Testing	Required Pump TDH	+3%	(3)
	Required Design Flow		
System Flow Balancing	Required Pump TDH	5%	(4)
	Required Design Flow		

Notes:

1. ASME OM Code – 2004, Subsection ISTB-3400
2. Northeast Power Coordinating Council (NPCC) Document A-03, "Emergency Operation Criteria," defines a reduced grid frequency transient of 57 Hz (5 percent) for three seconds that ramps to 59 Hz over five minutes. New generating plants are expected to be designed to stay on line during this transient. This transient is bounded by National Electrical Manufacturers Association requirements so that the motors continue to operate successfully. However, a corresponding reduction in speed would result in a reduction in pump performance. Based on the preliminary nature of the requirement and the short duration of the transient, a +/- 1 Hz variation will be used.
3. Manufacturing tolerance (+) need only to be considered for the determination of design pressure or run-out flow by specifying a guaranteed minimum pump curve, including shop performance test instrument uncertainty.
4. Margin is applied to the system flow requirements to accommodate system flow balancing. For the controlling user, it is expected that the head loss associated with this increased flow could vary by four percent.

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

09.02.02-118

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

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

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

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

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

Response to Question 09.02.02-118:

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

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

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

FSAR Impact:

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

9.2.2.6.1.4 CCWS Pump Control, Protection and Monitoring

High Bearings Temperatures

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

High Windings Temperatures

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

9.2.2.6.1.5 Additional Control Features and Interlocks

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

9.2.2.7 References

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

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9.2.7 CCWS Failure Modes and Effects Analysis

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

Mission Success Criteria for the Component Cooling Water System:

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

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

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

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

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

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

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

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

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

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

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

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

Component Name	Identifier	Component Function	Failure Mode	Failure Mechanism	Failure Effect	Mission Success	Comments / Actions
Common Operating Load Cooling Switchover Isolation Valves (Continued)	KAA10 AA006 KAA20 AA006 KAA30 AA006 KAA40 AA006 (Supply) KAA10 AA010 KAA20 AA010 KAA30 AA010 KAA40 AA010 (Return)	Open to provide CCW cooling flow to Common (1.B/2.B) operating loads. Closed to prevent CCW cooling flow to Common (1.B/2.B) operating loads. Interlocked to prevent both CCW trains from providing flow to Common (1.B/2.B) operating loads at the same time. Fast-acting (<10 seconds) to minimize interruption of cooling flow to Common (1.B/2.B) during switchover.	Fails to Close	Mechanical, Electrical, I&C	Failure of ONE Common Operating Load (1.B/2.B) switchover isolation valve (Supply or Return) to CLOSE on demand prevents transfer of cooling supply to the complementary CCW train. IF the affected CCW train is otherwise operable, that train may continue to supply cooling flow to Common Operating Loads (1.B/2.B).	**30) Mission Success Criteria are met.** With one CCW train out for maintenance, failure of one Common Operating Load (1.B/2.B) supply or return switchover isolation valve in the complementary train to CLOSE does not prevent that train from providing cooling flow to those loads. This leaves at minimum: 3 CCW trains operable, including affected train 2 SFP Cooling HX operable 2 CVCS charging pump operable 2 CVCS letdown HP cooler operable, and CCW supplying flow to all RCP thermal barriers.	
			Fails in Intermediate Position	Mechanical, Electrical, I&C	Interlock prevents opening the oncoming switchover isolation valves until the off-going isolation valves are closed. Valve failure in an intermediate position may reduce CCW flow to the affected Common Operating Loads (1.B/2.B) loads, but still allows some flow from the affected CCW train.	**31) Mission Success Criteria are met.** With one CCW train out for maintenance, failure of one Common Operating Load (1.B/2.B) supply or return switchover isolation valve in the complementary train to CLOSE does not prevent that train from providing cooling flow to those loads. Bounded by 28) above.	
Containment Isolation Valves in CCW Supply/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.	**32) Mission Success Criteria are met.** With one CCW train out for maintenance, failure of one Containment Isolation valve in the supply or return lines to the Containment Ventilation coolers and the RCS drain cooler does not further constrain any safety-related cooling loads. This leaves at minimum: 3 CCW trains operable, including affected train 2 SFP Cooling HX operable 2 CVCS charging pump operable 2 CVCS letdown HP cooler operable, and CCW supplying flow to all RCP thermal barriers.	Check valve KAB40 AA002 provides second isolation valve on CCW Supply line (Inner CIV)

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

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

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

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

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

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

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