

19K PRA-Based Reliability and Maintenance

The information in this Appendix of the reference ABWR DCD, including all subsections and tables, is incorporated by reference with the following departures and supplements.

STD DEP T1 2.4-3 (Table 19K-1, Table 19K-2, ~~Table 19K-3~~, Table 19K-4)

STD DEP T1 3.4-1 (Table 19K-1, Table 19K-2, ~~Table 19K-3~~, Table 19K-4)

STP DEP T1 5.0-1 (Table 19K-4)

STD DEP 8.3-1 (Table 19K-1, Table 19K-2, Table 19K-3, Table 19K-4)

STP DEP 10.4-2 (Table 19K-4)

STD DEP 19.3-1 (Table 19K-1, Table 19K-2, ~~Table 19K-3~~, Table 19K-4)

STP DEP 19R-1 (Table 19K-4)

19K.3 Determination of “Important Structures, Systems and Components” for Level 1 Analysis

STD DEP T1 2.4-3

STD DEP T1 3.4-1

STD DEP 8.3-1

STD DEP 19.3-1

To determine which plant structures, systems and components (SSCs) are the most important with respect to CDF, the Level 1 analysis results were analyzed. The SSCs were listed in order of Fussell-Vesely (FV) importance, or the percent of cutsets that contribute to the CDF, as calculated by the CAFTA code. A second criterion for selecting SSCs was to consider those SSCs with high “risk achievement worth”, or the increase in CDF if that SSC always fails. The ~~24~~ 34 ~~14~~ SSCs of greatest importance, in that they had modest FV importance are shown in Table 19K-1. ~~Nine additional SSCs with modest values of risk achievement worth were considered.~~ Not shown in Table 19K-1 are several post initiating event human error contributions. Significant human errors are addressed in Subsection 19D.7.

~~The 26~~ ~~23~~ ~~SSCs in Table 19K-1 were further evaluated to eliminate those with a combination of low values for both FV importance and risk achievement worth. The five SSCs meeting this criterion are so indicated. However, one of those five is retained because of its designation as a “critical task” in the human factors evaluation of Subsection 18E.2. The other four are not considered further in this subsection.~~

The remaining ~~22~~ designated SSCs of Table 19K-1 should be included with important SSCs being considered for periodic testing and/or preventive maintenance (PM) as part of the Reliability Assurance Program (RAP) of the plant owner/operator. The

reliability and maintenance actions suggested for the listed SSCs are identified in Subsection 19K.11.

A second table, Table 19K-2, was prepared to show those SSCs with small to moderate values of risk achievement worth. These SSCs all have very low Fussell-Vesely importance, indicating a low probability of failure. However, if they fail, the impact on CDF is not negligible. Most of these SSCs have ~~the same~~ similar risk achievement worths because their failure would result in failure of the RHR system or the RCIC system to perform ~~its function~~ their functions.

Initiating events that are significant contributors to CDF in the Level 1 analysis are listed in Table 19K-3. There are ~~five~~ seven ~~six~~ such events which are shown. The three most significant events, accounting ~~account~~ for more than one-half of the CDF, are all station blackout events. ~~The two most important events are isolation/loss of feedwater and unplanned manual reactor shutdown. Three station blackout events and turbine trip account for modest contributions to CDF.~~, The remainder of the ~~next two~~ events, contributing small fractions ~~of~~ to CDF are loss of offsite power for two to eight hours, unplanned manual reactor shutdown, medium break loss of coolant accident (LOCA), and isolation/loss of feedwater and manual reactor shutdown. All other initiating events contribute small amounts to CDF.

19K.7 Determination of “Important Structures, Systems and Components” for Flood Analysis

STP DEP T1 5.0-1

STP DEP 10.4-2

STP DEP 19R-1

The following site-specific supplement discusses the effects of the RSW pump house floods.

The flood analysis considers the potential for core damage from plant damage resulting from internal or external floods. The important SSCs identified by this analysis are the ECCS rooms, RCW rooms, Reactor Service Water (RSW) pump rooms and RSW electrical equipment rooms, and all control and reactor building external water tight doors, including the watertight barriers on the equipment access to the diesel generator rooms, which prevent water from flowing into rooms other than the one with the leak or from external flood sources to the safety-related buildings; redundant supply side isolation valves on the ~~Reactor Service Water~~ RSW System and anti-siphon capability, prevent gravity drainage of the UHS basin, which limits the amount of water spilled into the control building or RSW pump rooms; circuit breakers that will trip RSW pumps, which also limits the amount of water spilled into the control building; isolation valves in the Circulating Water System (CWS); circuit breakers that will trip CWS pumps; level switches in the turbine building condenser pit, the ~~and~~ control building RCW rooms and the RSW pump rooms; sump pump operation; overflow lines in reactor building sumps on floor BIF; and room drain lines.

19K.10 Identification of Important Capabilities Outside the Control Room

STP DEP T1 5.0-1

The identified activities outside the control room are:

- (8) ~~Closing the normally open watertight door to the control room~~ Verifying all watertight doors are closed on notification of a main cooling reservoir breach.

19K.11.1 Component Inspections and Maintenance

STD DEP T1 2.4-3

STD DEP T1 3.4-1

STP DEP T1 5.0-1

STD DEP 8.3-1

STD DEP 19.3-1

The two individual component types with the highest FV importances in the Level 1 analysis are the combustion turbine generator and the emergency diesel generators. Maintenance activities to assure high reliability of these components are discussed in 19K.11.10 and 19K.11.11.

The Reactor Building Cooling Water System and the Reactor Service Water System have high FV importance with respect to common cause failure impacts, as these systems support a number of front-line safety systems. Maintenance and testing tasks are provided for the key components in each division, including pumps, heat exchangers and the service water cooling tower fans

The systems of greatest FV importance with respect to outage time ~~is~~ are the RCIC System, which has been assigned a small unavailability for test and maintenance and the RHR Loops. The amount of time ~~the these systems are~~ RCIC System is unavailable because of test and maintenance should be monitored to assure that it remains within the specified assumptions annually. Sensitivity studies of increased SSC unavailabilities showed that an increase in RCIC unavailability would cause the greatest increase in estimated core damage frequency of any SSC. The RCIC System was also found to be the most sensitive system to increased outage time assumptions. The highest contributor to uncertainties in the CDF as well as the CDF estimate was RCIC test and maintenance.

STD DEP T1 3.4-1

The Remote Digital Logic Controller (RDLC) performs the Remote Input/output Function (RIF). Components that provide this function ~~Multiplexers which provide multiple signals to several systems~~ are identified by the Level 1 analysis as high importance components. Safety system RDLCs ~~multiplexers~~ have self-diagnostics ~~a built-in self test that detect failures during on-line operation~~ checks circuits frequently.

In addition, one division of RDLCs ~~four multiplexers~~ can be bypassed and tested during plant operation without loss of system function. Such tests provide a periodic verification ~~complete simulation~~ of the RDLC operability ~~multiplexer signals, more than included in the self test~~. During plant outages more detailed RDLC ~~multiplexer~~ tests are possible, including a complete system test and identification of signal errors. These tests will include verification that the remote RDLCs ~~multiplexing units~~ function properly. RDLC RIF ~~Multiplexer~~ tests that are suggested as part of the RAP are given in Table 19K-4.

STD DEP T1 2.4-3

The turbine of the RCIC System is an important component, as identified in Table 19K-1. Periodic startup and operation of the RCIC turbine is one way to monitor this turbine, and less frequent turbine inspection and refurbishment are also recommended. The RCIC pump is tested at the same time by measurement of speed, flow rate, differential pressure, and vibration. ~~The turbine lube oil pump operation and many~~ Many of the RCIC valves are also tested when the turbine testing is done. These RAP activities are included in Table 19K-4.

STD DEP T1 3.4-1

Trip logic ~~units~~ functions (TLUsTLFs) for the Reactor Protection System (RPS) represent another high importance component. Functional tests of these TLUsTLFs are performed at ~~frequent predetermined intervals by the online, self test feature of ABWR solid state logic~~. Additional offline, ~~semi-automatic~~, end-to-end (sensor input to trip actuator) testing of TLUsTLFs, which exercises the safety system logic and control logic processes, is important because it allows the detection of failures not sensed by the online system. ~~The~~TLUs TLF tests that are suggested as part of the RAP are given in Table 19K-4.

Common-cause miscalibration of RHR flow meters, and of Level 8 sensors, and common-cause failure (CCF) of digital trip ~~modules~~ (DTMs) function (DTFs), and of Level 2 sensors, will have acceptable probabilities if adequate administrative controls are exercised. Calibration procedures for RHR flow meters and for Level 8 sensors should include notes about the safety importance of these instruments. Historical trend analysis should be performed for Level 2 sensors at each calibration. The procedure for testing DTMs DTFs should include a warning about their importance to safety. Suggested RAP activities are given in Table 19K-4.

19K.11.13 Flood Protection

STP DEP T1 5.0-1

STP DEP 19R-1

The following site-specific supplement discusses the effects of the RSW pump house floods.

The important SSCs for flood protection are the water tight doors on external entrances to the control and reactor buildings, including the watertight barriers on the equipment access to the diesel generator rooms, and in ECCS, RSW pump house, and RCW rooms, the RSW and CWS isolation valves, ~~anti siphon capability~~, the circuit breakers that trip ~~the RSW and CWS~~ pumps and water level sensors in the turbine building condenser pit, RSW pump rooms, and control building RCW rooms; sump pump operation; overfill lines on reactor building sumps on floor BIF; and room drain lines (Subsection 19K.7). Periodically room water barriers should be inspected to assure that they will prevent the spread of flooding, room drain lines should be checked to ensure no blockage exists, RSW isolation valves (MOVs) should be stroke tested (normally accomplished by switching from one pump to the standby pump in a given loop), CWS isolation valves should be stroke tested, the ability of RSW ~~and CWS~~ pump circuit breakers to trip upon receipt of a trip signal should be demonstrated, as well as RSW System ~~anti siphon~~ isolation capability. These RAP activities are included in Table 19K-4.

Table 19K-1 ABWR SSCs of Greatest Importance for GDF, Level 1 Analysis

SSC	Fussell-Vesely Importance (%) [‡]	Risk Achievement Worth [‡]
Cooling Water Divisions A, B, & C (CCF)		
Multiplex Transmission Network (CCF)		
Essential Communication Function (CCF)		
Service Water Cooling Tower Fans (CCF)		
RHR Core Flood System Failure (CCF)		
Trip Logic Function (CCF)		
Remote I/O Function Module (CCF)		
Trip Logic Units		
Remote Multiplexing Units		
RCIC Turbine Lubrication System		
HPCF System (CCF)		
HPCF Pump†		
Single Offsite Power Line*		
RCIC Min-Flow Bypass Valve E51-F011 (NOFO)†		
RCIC Min-Flow Bypass Valve E51-F011 (NCFC)†		
RCIC Injection Valve E51-F004 (NCFC)†		
RCIC Steam Supply Valve E51-F037 (NCFC)†		
HPCF Maintenance Valve E22-F005B‡		
RCIC Isolation Signal Logic		
Both Offsite Power Sources		
HPCF Pump		
SRVs		
RHR Flow Transmitters (CCF Miscalibration)		
Cooling Water Divisions B & C (CCF)		
Cooling Water Divisions A & B (CCF)		
Cooling Water Divisions A & C (CCF)		
Level 8 Sensors (CCF Miscalibration)		
Digital Trip Modules (CCF)		
Digital Trip Function (CCF)		
SP Temp High (Loss of Pump Head)		
Suppression Pool Unavailable Due to Rupture		

* Not part of DCD (Refer to SSAR)

† SSCs with low FV importance and low risk achievement worth. Not considered further for RAP on the basis of Level-1 analysis.

‡ Valves that are closed during normal operation, and fail to open when required during a transient, are designated NCFC. Technically, they are "fail as is" conditions, which is closed. The minimum flow bypass valve is closed during normal operation, but during transients requiring RCIC operation, the bypass valve opens. Failure of this valve to open at that demand is shown as NCFC. Later in the transient this bypass valve, which is normally open at this time, should close on demand. If it fails to close, the shorthand description NOFO is used.

f SSC with low FV importance and low risk achievement worth, but retained because of human factor importance.

Table 19K-2 ~~ABWR SSCs With Moderate Risk Achievement Worth, Level 1 Analysis*~~

SSC	Fussell-Vesely-Importance (%)†	Risk-Achievement-Worth†
RCIC Min Flow Bypass Valve E51-F011 (NOFO)		
RCIC Injection Valve E51-F004 (NCFC)		
RCIC Min Flow Bypass Valve E510F011 (NCFC)		
RCIC Steam Supply Valve E51-F037 (NCFC)		
Both Offsite Power Sources		
RCIC Isolation Signal Logic		
RHR Suppression Pool Cooling Failure (CCF)		
Div 1 ECF-EMS Transmission Ntwk Failure-		
RCIC Steam Supply Bypass Valve F045 Limit Switch Fails		
1st ESF RIF-RMU Div 1 Fails		
2nd ESF RIF-RMU Div 1 Fails		
1st ESF SLF Channel Div 1 Fails		
2nd ESF SLF Channel Div 1 Fails		
Failure of SP Temp Signal T53-TRS-601A & B		
RCIC Pres Sensor PIS-Z605 Miscalibrated		
RCIC Flow Sensor FT-007-2 Miscalibrated		
Diode SID-Open		
SP Temp High (Loss of Pump Head)		
SLF/ECF-SLU/EMS Link for Div 1 SLF 1 Fails (RCIC Fails)		
SLF/ECF-SLU/EMS Link for Div 1 SLF 2 Fails (RCIC Fails)		

* ECF = Essential Communication Function
 ESF = Essential Safety Feature
 RIF = Remote Input/Output Function
 SLF = Safety System Logic Function

† Not part of DGD (refer to SSAR)

Table 19K-3 ~~ABWR Initiating Event Contribution to CDF, Level 1 Analysis~~

Initiating Event	Events per Year	Total CDF x 10⁸*	Percent CDF Contribution*
Turbine Trip			

* ~~Not part of DCD (Refer to SSAR)~~

Table 19K-1 ABWR SSCs of Greatest Importance for CDF, Level 1 Analysis

<u>SSC</u>	<u>Fussell-Vesely Importance (%)*</u>	<u>Risk Achievement Worth*</u>
<i>Combustion Turbine Generator</i>		
<i>Emergency Diesel Generator CCF</i>		
<u>SRV CCF (Open and reseal)</u>		
<u>RHR Loop Maintenance</u>		
<u>RBCW CCF</u>		
<u>RSW CCF</u>		
<u>RHR Pump (individual pumps)</u>		
<u>Control Rod Drive Injection (Level Control)</u>		
<i>RCIC Unavailable Due To Testing Or Maintenance</i>		
<u>RHR Pump Room AC</u>		
<u>Div II Power Cable</u>		
<i>Multiplex Transmission Network (ECF) CCF</i>		
<i>RCIC Turbine</i>		
<u>RHR Core Flooding CCF</u>		
<u>Minimum Flow Valve E11-F021A (B, C) (NOFO) ±</u>		
<i>RCIC Pump</i>		
<u>RHR Heat Exchanger Inlet Valve P21-F013A (B,C) (NCFC) ±</u>		
<u>RHR Strainer E11-D001A (B, C)</u>		
<u>Suppression Pool Discharge Valve E11-F008A (B, C) (NCFC) ±</u>		
<u>Trip System Logic Unit CCF</u>		
<i>Remote Multiplexing Units CCF</i>		
<i>RCIC Turbine Lubrication System</i>		
<i>HPCF-B (Unavailable, Test or Maintenance)</i>		
<u>HPCF CCF</u>		
<u>RCIC Pump Room AC Unit</u>		
<i>Station Batteries CCF</i>		
<i>Single Offsite Power Line ±</i>		
<i>RCIC Min Flow Bypass Valve E51-F011 (NOFO) ±</i>		
<i>RCIC Injection Valve F004 (NCFC) ±</i>		
<i>RCIC Min Flow Bypass Valve E51-F011 (NCFC) ±</i>		
<i>RCIC Steam Supply Valve E51-F037 (NCFC) ±</i>		

Table 19K-1 ABWR SSCs of Greatest Importance for CDF, Level 1 Analysis (Continued)

<u>SSC</u>	<u>Fussell-Vesely Importance (%)*</u>	<u>Risk Achievement Worth*</u>
<u>HPCF Maintenance Valve E22-F005Bf</u>		
<u>Suppression Pool Temperature</u>		
<u>Division 1 Transmission Network (ECF)</u>		
<u>RCIC Isolation Signal Logic</u>		
<u>Both Offsite Power Sources</u>		
<u>HPCF Pump ‡</u>		
<u>SRVs ‡</u>		
<u>RHR Flow Transmitters (GCF Miscalibration)</u>		
<u>Level 2 Sensors (GCF)</u>		
<u>Level 8 Sensors (GCF Miscalibration)</u>		
<u>Digital Trip Modules (GCF)</u>		

*-Not part of DCD (Refer to SSAR). (contained in plant-specific PRA documentation)

‡ SSCs with low FV importance and low risk achievement worth. Not considered further for RAP on the basis of Level 1 analysis.

Table 19K-2 ABWR SSCs With Moderate Risk Achievement Worth For CDF, Level 1 Analysis*

<u>SSC</u>	<u>Fussell-Vesely Importance % †</u>	<u>Risk Achievement Worth ‡</u>
<u>Suppression Pool Water Level (Pool Rupture)</u>		
<u>Digital Trip Units CCF</u>		
<u>SRV CCF [ADS]</u>		
<u>Water Level 8 Sensors Miscalibrated (CCF)</u>		
<u>AC Distribution Power Cables</u>		
<u>1st ESF RIF RMU Div 4 (3 Divisions) Fails</u>		
<u>2nd ESF RIF RMU Div 4 (3 Divisions) Fails</u>		
<u>Div 1(2, 3) ECF EMS Transmission Network Failure</u>		
<u>Class 1E 4160V/480V Transformers</u>		
<u>RBCW Temperature Control Valve P21-F006A (B, C) (NOFC)</u>		
<u>RHR -Flow Transmitter FT008A (B, C)</u>		
<u>RHR Pump A (B, C)</u>		
<u>RHR Heat Exchanger Tube Side Bypass E11-F013A (B, C) (NCFO)</u>		
<u>RHR Wetwell Spray Valve E11-F019A (B, C) (NCFO)</u>		
<u>RHR Injection Valve E11-F005A (B, C) (NCFO)</u>		
<u>RPV Suction Line Isolation Valve E11-F012A (B, C) (NCFO)</u>		
<u>RHR Pump Suction Valve E11-F001A (B, C) (NOFC)</u>		
<u>RHR Valve E11-F004A (B, C) (NOFC)</u>		
<u>RHR Pump Discharge Check Valve E11-F002A (B, C)</u>		
<u>RHR Manual Valve E11-F003A (B, C)</u>		
<u>RHR Heat Exchanger A (B, C)</u>		
<u>RHR Pump Motor Bearing Cooler A (B, C)</u>		
<u>RHR Pump Mechanical Seal Cooler A (B, C)</u>		
<u>RHR Suppression Pool Temp Signal T53-TRS-601A & B</u>		
<u>RHR Loop Flow Transmitters FT008A,B,C Miscalibration</u>		
<u>Class 1E 4160V Switchgear</u>		
<u>Class 1E 480V Switchgear</u>		
<u>Class 1E 480V MCCs</u>		
<u>Class 1E DC Power Distribution Panels</u>		
<u>RBCW Temperature Control Valve P21-F006A (B, C) (NOFC)</u>		
<u>HPCF Flow Transmitters (CCF Miscalibration)</u>		

Table 19K-2 ABWR SSCs With Moderate Risk Achievement Worth For CDF, Level 1 Analysis*

<u>SSC</u>	<u>Fussell-Vesely Importance % †</u>	<u>Risk Achievement Worth†</u>
<u>HPCF Pressure Transmitters (CCF Miscalibration)</u>		
<u>Water Level 2 Sensors [CCF Miscalibration]</u>		
<u>Both Offsite Power Sources [CCF]</u>		
<u>Pipe Rupture [RBCW Loop]</u>		
<u>Pipe Rupture [RSW Loop]</u>		
<u>NBS Isolation Check Valve B21-F003B (FW Isolation) Fails Closed</u>		
<u>NBS Isolation Check Valve B21-F004B (FW Isolation) Fails Closed</u>		
<u>RCIC Check Valve E51-F003 Fails to Open</u>		
<u>RCIC Outboard Check Valve F005 Fails to Open</u>		
<u>RCIC Check Valve F038 Fails to Open</u>		
<u>NBS Manual Valve B21-F005B (NOFC) Fails Closed</u>		
<u>RCIC Valve E51-F011 (NOFO) Fails</u>		
<u>RCIC Valve E51-F004 (NCFC) Fails</u>		
<u>RCIC Valve E51-F011 (NCFC) Fails</u>		
<u>RCIC Valve E51-F037 (NCFC) Fails</u>		
<u>RCIC Isolation Valve F035 Fails (NOFC)</u>		
<u>RCIC Isolation Valve F036 Fails (NOFC)</u>		
<u>RCIC Isolation Valve F039 Fails (NOFC)</u>		
<u>RCIC Turbine Exhaust Isolation Valve F039 Limit Switch Fails</u>		
<u>RCIC Steam Supply Bypass Valve F045 Limit Switch Fails</u>		
<u>RCIC Flow Sensor FT-007-2 Miscalibrated</u>		
<u>RCIC Pressure Sensor PIS-Z605 Miscalibrated</u>		
<u>RCIC Flow Sensor E51-FT007-2 Fails</u>		
<u>RCIC Pressure Sensor PIS-Z605 Fails</u>		
<u>Diode SID Open</u>		
<u>SLF/ECF SLU/EMS Link for Div 1 SLU 1 Fails (RCIC Fails)</u>		
<u>SLF/ECF SLU/EMS Link for Div 1 SLU 2 Fails (RCIC Fails)</u>		

† Not part of DCD (Refer to SSAR); (contained in plant-specific PRA documentation)

Table 19K-3 ABWR Initiating Event Contribution to CDF, Level 1 Analysis

<u>Initiating Event</u>	<u>Events Per Year*</u>	<u>Total CDF *</u>	<u>Percent CDF Contribution*</u>
<u>Station Blackout for Less Than Two Hours</u>			
<u>Station Blackout for Two to Eight Hours</u>			
<u>Loss of Offsite Power for Two to Eight Hours</u>			
<u>Unplanned Manual Reactor Shutdown</u>			
<u>Station Blackout for More Than Eight Hours</u>			
<u>Medium Break LOCA</u>			
<u>Isolation/Loss of Feedwater</u>			

* Not part of DCD ~~(Refer to SSAR)~~ (contained in plant-specific PRA documentation)

Table 19K-4 Failure Modes and RAP Activities

Component	Failure Mode/Cause	Recommended Maintenance	Test or Maintenance Interval	Basis	Unavailability, Failure Rate
Multiplexers	Common cause failure of all MUX to give proper signals	System functional test Complete system test, error check	3 months 2 years	Experience Experience	*
ECF	Common cause failure of all ECF to give proper signals	System functional test	3 months	Experience	*
		Complete system test, error check	2 years	Experience	*
One ESF RIF SMU for Div 1 or one SLF/ECF SLU/EMS Link for SLF SLU Div 1	Failure of RIF or link between RIF and SLF Failure of remote-multiplex unit or link between RMU and safety system logic unit	System functional test	3 months	Experience	*
		Complete system test, error check	2 years	Experience	*
RPS TLFs Trip Logic Units	Failure to trip upon demand	System functional test	3 months	Experience	*
		Complete system test, error check	R/M outage	Experience	*
RCIC Turbine Lube System	Lube oil pump failure	Lube oil pump operation and oil pressure check	3 months	Experience	*
Limit Switches on RCIC Turbine Exhaust Isolation and Valve Steam Supply Bypass Valve	Failure of switch to change position when valve movement occurs	Observation of limit switch actuation during valve stroke test	3 months	Experience ‡	†
DTFs Digital Trip Modules	Common cause failure to trip	Review trip unit test procedure to assure note about potential safety considerations	Annual	Judgment	*

Table 19K-4 Failure Modes and RAP Activities (Continued)

Component	Failure Mode/Cause	Recommended Maintenance	Test or Maintenance Interval	Basis	Unavailability, Failure Rate
Non-ADS SRVs	Common mode failure of SRVs to open on demand or remain open	Inspect and replace degradable parts and test for correct operation	5 years (max)	Environmental qualification	*
		Remove valve, test for setpoint pressure, adjust setpoint as necessary, test for seat leakage, repair. Stagger testing of valves, 50% at one outage	3 years	Experience, ANSI/ASME OM1	*

Table 19K-4 Failure Modes and RAP Activities (Continued)

Component	Failure Mode/Cause	Recommended Maintenance	Test or Maintenance Interval	Basis	Unavailability, Failure Rate
DC Div 1 Distribution Panel (including Diode S1D)	Panel or diode failure	Panel function is demonstrated by system test	3 months	Experience	*
Div 1 EMS ECF Transmission Network	Network failure Failure	System functional test	3 months	Experience	*
		Complete system test, error check	2 years	Experience	*
RBCW Pumps	Failure to provide adequate flow at desired pressure	Discharge pressure test Inlet pressure test Flow test Vibration test	3 months	Table 3.9-8	*
		Monitor pump parameters on the normally running pump to detect abnormalities	Weekly	Judgment	*
RBSW Pumps	Failure to provide adequate flow at desired pressure	Discharge pressure test Inlet pressure test Flow test Vibration test	3 months	Table 3.9-8	*
		Monitor pump parameters on the normally running pump to detect abnormalities	Weekly	Judgment	*

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Table 19K-4 Failure Modes and RAP Activities (Continued)

Component	Failure Mode/Cause	Recommended Maintenance	Test or Maintenance Interval	Basis	Unavailability, Failure Rate
RBCW Heat Exchangers	Plugging/fouling	Monitor heat exchanger flow and delta temperature/pressure to detect existence of fouling	Weekly	Experience	*
		Internal inspection of heat exchangers for plugging and fouling	R/M Outage	Experience	*
RBSW Strainers	Plugging	Monitor RBSW flow rate and strainer delta pressure for indications of plugging	Weekly	Experience	*
RBSW Cooling Tower UHS Fans	Failure to provide adequate fan flow through tower	Flow test Vibration Test	3 months	Experience	*
		Inspection and cleaning/lubrication	R/M Outage	Experience	*
Control and Reactor Building, RSW pump House, and ECCS Room Watertight Doors	Failure to retain integrity	Inspection of watertight doors, including penetrations	1 year & after major maintenance	Judgment	*
RSW and CWS Pump Circuit Breakers	Failure to trip pump on demand	Breaker trip test to assure trip on Demand	6 months	Judgment	*
HPCF Pumps	Failure to provide adequate flow at desired pressure	Discharge pressure test Inlet pressure test Flow test Vibration test	3 months	Table 3.9-8	†††

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Table 19K-4 Failure Modes and RAP Activities (Continued)

Component	Failure Mode/Cause	Recommended Maintenance	Test or Maintenance Interval	Basis	Unavailability, Failure Rate
HPCF Injection Valves F003 and F005	Failure to open because of mechanical problems	Stroke test	3 months	Experience; ASME Code ISI	†††
		Visual and penetrant inspection of stem, ultrasonic inspection of stem; replace if necessary.	10 years	Low failure rate; ASME Code ISI.	*
	Failure to open because of electrical problems	Electrical circuit test	3 months	Experience	*

Table 19K-4 Failure Modes and RAP Activities (Continued)

Component	Failure Mode/Cause	Recommended Maintenance	Test or Maintenance Interval	Basis	Unavailability, Failure Rate
RHR Injection Valves F001, F003, F005, F006	Failure to open because of mechanical problems	Stroke test	3 months	Experience; ASME Code ISI	††
		Visual and penetrant inspection of stem, ultrasonic inspection of stem; replace if necessary.	10 years	Low failure rate; ASME Code ISI.	*
	Failure to open because of electrical problems	Electrical circuit test	3 months	Experience	*
RHR Heat Exchangers	Fouling	Monitor and trend delta-temperature across heat exchanger during RHR testing and operation	R/M Outage	Judgment	††
ESF SLF Divisions	Failure to operate; failure to properly generate initiation signals	System functional test	3 months	Experience	*
		Complete system test, error check	2 years	Experience	*
Suppression Pool	Loss of structural integrity; leakage	Periodic inspection of suppression pool structural elements to detect degradation, incipient leakage or corrosion	R/M Outage	Experience	*

<u>Common Cause Failures</u>					
<u>RHR System (Shutdown Cooling & LPFL Modes)</u>	<u>Common mode failure</u>	<u>System walkdown to identify CCF type problems</u>	<u>R/M outage</u>	<u>Judgment</u>	<u>***</u>
<ul style="list-style-type: none"> ■ <u>Pumps</u> ■ <u>Room Air Conditioners</u> ■ <u>Injection MOVs</u> 	<ul style="list-style-type: none"> ■ <u>Start and Run</u> ■ <u>Start and Run</u> ■ <u>Open</u> 				<u>***</u>

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Table 19K-4 Failure Modes and RAP Activities (Continued)

Component	Failure Mode/Cause	Recommended Maintenance	Test or Maintenance Interval	Basis	Unavailability, Failure Rate
<u>HPCF System</u>	<u>Common mode failure</u>	<u>System walkdown to identify CCF type problems</u>	<u>R/M outage</u>	<u>Judgment</u>	<u>***</u> <u>-</u>
<ul style="list-style-type: none"> ▪ <u>Pumps</u> ▪ <u>Injection MOVs</u> ▪ <u>F005</u> 	<ul style="list-style-type: none"> ▪ <u>Start and Run</u> ▪ <u>Open</u> ▪ <u>Mispositioning</u> 	<u>Position check</u>	<u>Quarterly</u>		
<u>RBCW System</u>	<u>Common mode failure</u>	<u>System walkdown to identify CCF type problems</u>	<u>R/M outage</u>	<u>Judgment</u>	<u>***</u> <u>-</u>
<ul style="list-style-type: none"> ▪ <u>Pumps</u> 	<ul style="list-style-type: none"> ▪ <u>Run</u> 				
<u>RSW System</u>	<u>Common mode failure</u>	<u>System walkdown to identify CCF type problems</u>	<u>R/M outage</u>	<u>Judgment</u>	<u>***</u> <u>-</u>
<ul style="list-style-type: none"> ▪ <u>Pumps</u> ▪ <u>Strainers</u> 	<ul style="list-style-type: none"> ▪ <u>Run</u> ▪ <u>Plug</u> 	<u>Operation verification</u>	<u>Quarterly</u>		
<u>UHS System</u>	<u>Common mode failure</u>	<u>System walkdown to identify CCF type problems</u>	<u>R/M outage</u>	<u>Judgment</u>	<u>***</u> <u>-</u>
<ul style="list-style-type: none"> ▪ <u>Fans</u> 	<ul style="list-style-type: none"> ▪ <u>Run</u> 				
<u>Emergency Diesel Generators</u>	<u>Common mode failure</u>	<u>Start up to full load</u>	<u>1 month</u>	<u>Tech Spec</u>	<u>***</u> <u>-</u>
	<ul style="list-style-type: none"> ▪ <u>Start and run</u> 				

Table 19K-4 Failure Modes and RAP Activities (Continued)

Component	Failure Mode/Cause	Recommended Maintenance	Test or Maintenance Interval	Basis	Unavailability, Failure Rate
Suppression Pool Temperature sensors T53-TRS-601A and B	Sensor fails	Calibration of sensor	R/M outage	Experience	*
	Common mode failure	Analyze Level 2 calibration data for trends of drifting or other CCF indications	R/M Outage	Judgment	*
Containment Penetrations	Leakage	Periodic inspection of penetrations to detect indications of degradation	R/M Outage	Experience	N/A
		Local leak rate testing	R/M Outage (based on Tech Spec requirements)	Tech Spec	*
<i>RSW Anti-siphon Capability</i>	<i>Isolation valves don't close after pumps trip</i>	<i>Open RSW motor breakers with isolation valves open and monitor system flow rate</i>	<i>6 months</i>	<i>Judgment</i>	<i>‡</i>

* Contained in the plant-specific PRA documentation ~~Not part of DGD (refer to SSAR)~~

** ~~Contained in the plant-specific PRA documentation~~

‡‡ RHR component failure rates are included within the system unavailability.

‡‡‡ HPCF component failure rates are included within the system unavailability

