RISK-INFORMED INSPECTION NOTEBOOK FOR

GENERIC PWR NUCLEAR POWER PLANT

Westinghouse PWR, Four-Loop Plant with Large Dry Containment

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Prepared for

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A-16

Table 1 - Categories of Initiating Events for Generic PWR Nuclear Power Plant

Row	Approximate Frequency	Example Event Type	Initiating Event Likelihood (IEL)		
I	> 1 per 1-10 yr	Loss of Power Conversion System (TPCS)	1	2	3
II	1 per 10-10^2 yr	Loss of offsite power (LOOP), Loss of Class 1E 125V DC Bus A or B (LODC)	2	3	4
III	1 per 10^2 - 10^3 yr	Steam Generator Tube Rupture (SGTR), Stuck open PORV/SRV (SORV), Small LOCA including RCP seal failures (SLOCA), Main Steam Line Break Outside Containment (MSLB)	3	4	5
IV	1 per 10^3 - 10^4 yr	Medium LOCA (MLOCA), LOOP with Loss of One Class 1E 4.16-kV Bus (LEAC)	4	5	6
V	1 per 10^4 - 10^5 yr	Large LOCA (LLOCA), Loss of Component Cooling Water (LCCW)	5	6	7
VI	less than 1 per 10^5 yr	ATWS(1)	6	7	8
			> 30 days	3-30 days	< 3 days
			Exposure Time for Degraded Condition		

Notes:

1. The SDP worksheets for ATWS core damage sequences assume that the ATWS is not recoverable by manual actuation of the reactor trip function. Thus, the ATWS frequency to be used by these worksheets must represent the ATWS condition that can only be mitigated by the systems shown in the worksheet (e.g., boration). Any inspection finding that represents a loss of capability for manual reactor trip for a postulated ATWS scenario should be evaluated by a risk analyst to consider the probability of a successful manual trip.

Table 2 Initiators and System Dependency for Generic PWR Nuclear Power Plant

Affected Systems	Major Components	Support Systems	Initiating Event Scenarios
Auxiliary Feedwater (AFW)	Three MDPs[1,2]	4.16-kV, DC, ESFAS, dedicated room cooling	All except MLOCA, LLOCA
	One TDP[2]	DC, ESFAS	All except MLOCA, LLOCA, SGTR, MSLB
	Feedwater isolation valves for MDPs	480V	SGTR, MSLB
	Feedwater isolation valve for TDP	DC	
Chemical and Volume Control System (CVCS)	Two centrifugal charging pumps (CCP)[3], 160 gpm @ 2575 psi	4.16-kV, 480V, DC, CCW, room cooling [3]	SGTR, ATWS
	Two boric acid transfer pumps[3]		ATWS
Component Cooling Water System (CCW)	Three trains, each with one pump	4.16-kV, DC, ECW, ESFAS	LCCW
Electric Power System	Three Class 1E 4.16-kV buses	EAB HVAC, DC	All
	Three Standby Diesel Generators [4]	DC, ESFAS, ECW	LOOP, LEAC
	Three trains of Class 1E 480V load centers and motor control centers	4.16kV, DC, EAB HVAC	All
	Class 1E vital 120V AC (4 trains)	DC, 480V, EAB HVAC	All

TABLE 2 PWR (cont)

Affected Systems	Major Components	Support Systems	Initiating Event Scenarios
	Four Class 1E 125V DC distribution buses, each supplied by two chargers and one battery. The duration of the batteries is 6 to 8 hours.	480V, EAB HVAC	All
Engineered Safeguards Features Actuation System (ESFAS)	Three actuation trains, each with a load sequencer	120V vital AC, DC	All
Essential Cooling Water System (ECWS)	Three trains, each with one pump	4.16-kV, 480V (for MOVs), DC, ESFAS	All
High Head Safety Injection (HHSI) System	Three pumps (800 gpm @1275 psi, shutoff head = 1650 psid)	4.16-kV, 480V, DC, ESFAS, SI pump room cooling[8]	All except LLOCA, ATWS, LODC
Instrument Air (IA)	Two IA compressors (per unit). Back up is two station air compressors	Offsite power, BOP diesel[5]	LOIA
Low Head Safety Injection (LHSI) System	Three pumps	4.16-kV, 480V, DC, ESFAS, SI pump room cooling[8]	All except ATWS, LCCW, LODC
Main Steam Isolation System	For each steam generator: one MSIV [FW isolation and Control Valves [10]]	Offsite power and IA, DC, ESFAS	SGTR, MSLB
	For each steam generator: one PORV	480V, DC, 120V vital AC	All except LLOCA, and MLOCA
	For each steam generator: five safety relief valves	None	TPCS, LOOP, ATWS, LEAC
Primary Relief System	Two PORVs	DC [9]	TPCS, SLOCA, SORV, LOOP, SGTR, ATWS, MSLB, LEAC
	Two block valves	480V [9]	SORV

TABLE 2 PWR (cont.)

Affected Systems	Major Components	Support Systems	Initiating Event Scenarios
	Pressurizer normal spray	DC (for valves). RCPs 1A and 1D for two spray valves, IA	SGTR
	Pressurizer auxiliary spray	DC (for valve), CVCS (CCP) flow, IA	
	Three safety relief valves	None	ATWS
Reactor Containment Fan Coolers (RCFCs)	Three trains, each with two cooler units	480V, DC, ESFAS, CCW	TPCS, SLOCA, SORV, MLOCA, LLOCA, LOOP, SGTR, MSLB, LEAC
Reactor Coolant Pump Seal Cooling (RCP)	Seals and thermal barriers of four Reactor Coolant Pumps (RCP)	CCW, CVCS. The success criteria is 1 / 3 CCW pumps to the RCP thermal barriers (1 multi-train system) or 1 / 2 centrifugal charging pumps for RCP seal injection (1 multi-train system)	SLOCA
Residual Heat Removal System (RHRS)	Three trains; pumps, valves, and heat exchangers	480V, DC, CCW	TPCS, SLOCA, SORV, MLOCA, LLOCA, LOOP, SGTR, MSLB, LEAC
SI Pump Room Cooling[8]	Supplemental coolers and three manual valves in the chilled water line	480V, ECW	TPCS, SLOCA, SORV, MLOCA, LLOCA, LOOP, SGTR, MSLB, LEAC

Table 2 PWR (cont.)

Notes:

1. The licensee indicated that no support system for room cooling is required for MDAFW pumps. It therefore referred to as dedicated room cooling.

2. The licensee indicated that no support system for cooling these components is required, e.g. turbine driven AFW pump room.

3. The CCPs need room cooling as indicated in the table. Emergency boration and use of the boric acid transfer pumps are not credited in the IPE. We consider that they are part of the CVCS.

4. Each of the three standby diesel generators per unit has individual fuel oil storage tanks with enough fuel for seven days. These tanks are mounted above the diesel generator bays. The fuel oil is gravity fed to the individual engine driven booster pump and to the standby booster pump.

5. The BOP diesel generator supplies power to instrument air compressor 12 and the auxiliary cooling water pump. On loss of offsite power, operator action is necessary to restore these components to operation.

6. MSIVs close on loss of instrument air after loss of offsite power.

7. The steam generator PORVs are hydraulically actuated. The hydraulic system stores energy in an accumulator which is pressurized by a pump powered from Class 1E 480V power. The PORVs are modeled by the licensee as failing to operate on loss of AC power.

8. Loss of pump room cooling is of concern if more than one train is running. Since in SI all trains will be actuated, room cooling is assumed to be needed.

9. PORV and the associated Block valve are fed from the same division of DC and AC respectively.

10. FW isolation and control valves fail closed on loss of power.

Table 3.1 SDP Worksheet for Generic PWR Nuclear Power Plant — Transients with Loss of PCS (TPCS) [1]

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Secondary Heat Removal (AFW)	1/3 MDAFW trains (1 multi-train system) or 1/1 TDAFW train (1 ASD train) with (1/1 SG PORV or 1/5 safety relief valves) per SG that is fed by AFW
High Pressure Injection for FB (EIHP)	1/3 HHSI pumps (1 multi-train system)
Primary Heat Removal, Feed/Bleed (FB)	2/2 pressurizer PORVs open for Feed/Bleed (operator action = 2) [2]
High Pressure Recirculation (LPR)	1/3 LHSI trains and with associated 1/3 RHR heat exchangers or 2/6 RCFCs with cooling flow aligned to CCW (1 multi-train system)

Circle Affected Functions		**IEL**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Recovery Credit**	**Results**
1 TPCS - AFW - LPR (3) **1 + 4 + 3**	**8**				
2 TPCS - AFW - FB (4) **1 + 4 + 2**	**7**				
3 TPCS - AFW - EIHP (5) **1 + 4 + 3**	**8**				

Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:

If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use.

Notes:

1. The IPE's general transient event tree does not model main feedwater recovery. Thus, this worksheet covers both Transients (Reactor Trip) and Transients with loss of PCS.

2. As a part of feed and bleed operation the operator would depressurize the RCS to initiate the low pressure recirculation.

Table 3.2 SDP Worksheet for Generic PWR Nuclear Power Plant — Small LOCA (SLOCA)

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Early Inventory, HP Injection (EIHP)	1/3 HHSI pumps (1 multi-train system)
Secondary Heat Removal (AFW)	1/3 MDAFW trains (1 multi-train system) or 1/1 TDAFW train (1 ASD train)
Primary Heat Removal, Feed/Bleed (FB)	2/2 PORVs open for Feed/Bleed (operator action = 2)
Low Pressure Injection (LPI)	1/3 LHSI pumps (1 multi-train system)
Low Pressure Recirculation (LPR)	1/3 LHSI pumps with associated 1/3 RHR heat exchangers or 2/6 RCFCs with cooling flow from CCW (1 multi-train system)

Circle Affected Functions		**IEL**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Recovery Credit**	**Results**
1 SLOCA - LPR (2,4,7) **3 + 3**	**6**				
2 SLOCA - AFW - FB (5) **3 + 4 + 2**	**9**				
3 SLOCA - EIHP (8) **3 + 3**	**6**				

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Note:

1. The licensee considers that when at least one train of auxiliary feedwater and high pressure injection is available, one steam generator PORV and the associated operating auxiliary feedwater train are sufficient for depressurization and removal of decay heat.

Table 3.3 SDP Worksheet for Generic PWR Nuclear Power Plant — Stuck Open PORV (SORV)[1]

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Isolation of Small LOCA (BLK)	The closure of the block valve associated with stuck open PORV (operator action = 2) [2]
Early Inventory, HP Injection (EIHP)	1/3 HHSI pumps (1 multi-train system)
Secondary Heat Removal (AFW)	1/3 MDAFW trains (1 multi-train system) or 1/1 TDAFW train (1 ASD train)
Primary Heat Removal, Feed/Bleed (FB)	1/1 remaining PORVs open for Feed/Bleed (operator action = 2)
Low Pressure Injection (LPI)	1/3 LHSI pumps (1 multi-train system)
Low Pressure Recirculation (LPR)	1/3 LHSI pumps with associated 1/3 RHR heat exchangers or 2/6 RCFCs with cooling flow from CCW (1 multi-train system)

Circle Affected Functions		**IEL**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Recovery Credit**	**Results**
1 SORV - BLK - LPR (2, 4, 7) **3 + 2 + 3**	**8**				
2 SORV - BLK - AFW - FB (5) **3 + 2 + 4 + 2**	**11**				
3 SORV - BLK - EIHP (8) **3 + 2 + 3**	**8**				

Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:

If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use.

Notes:

1. The sequences of the SDP SORV worksheet are the same as those of the SDP small LOCA event tree with the addition of the failure of the safety function "Isolation of Small LOCA (BLK)" after the initiating event, SORV.

2. The IPE models this action as "Operator Closes PORV Block Valve To Isolate the LOCA Path" with a HEP = 9.52E-3.

3. The licensee considers that when at least one train of auxiliary feedwater and high pressure injection is available, one steam generator PORV and the associated operating auxiliary feedwater train are sufficient for depressurization and removal of decay heat.

Table 3.4 SDP Worksheet for Generic PWR Nuclear Power Plant — Medium LOCA (MLOCA)

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Early Inventory, HP Injection (EIHP) **Low Pressure Injection (LPI)** **Low Pressure Recirculation (LPR)**	½ remaining HHSI trains (1 multi-train system)[2] ½ remaining LHSI trains (1 multi-train system) ½ remaining LHSI trains with associated 1/3 RHR heat exchangers or 2/6 RCFCs with cooling flow from CCW (1 multi-train system)

Circle Affected Functions		**IEL**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Recovery Credit**	**Results**
1 MLOCA - LPR (2) **4 + 3**	**7**				
2 MLOCA - LPI (3) **4 + 3**	**7**				
3 MLOCA - EIHP (4) **4 + 3**	**7**				

Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:

If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use.

Note:

1. Major assumptions of the IPE: 1) Coolant flow through the break is sufficient to remove core decay heat without any additional cooling required through the steam generators, 2) IPE does not give mitigating credit to rapid depressurization of the RCS to LHSI cut-in conditions on loss of HHSI, 3) the location of the break would reduce the number of mitigation trains for injection by 1,and 4) IPE indicates that the accumulators are not needed in a medium LOCA.

2. One loop of the associated ECCS train is assumed not to be available due to location of the break.

Table 3.5 SDP Worksheet for Generic PWR Nuclear Power Plant — Large LOCA (LLOCA)

Safety Functions Needed:		**Full Creditable Mitigation Capability for Each Safety Function:**			
Early Inventory, LP Injection (EILP) **Low Pressure Recirculation (LPR)**		½ LHSI pumps (1 multi-train system) ½ LHSI pumps with associated 1/3 RHR heat exchangers or 2/6 RCFCs with cooling flow from CCW (1 multi-train system)			
Circle Affected Functions		**IEL**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Recovery Credit**	**Results**
1 LLOCA - LPR (2) **5 + 3**	**8**				
2 LLOCA - EILP (3) **5 + 3**	**8**				

Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:

If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use.

Note:

1. IPE indicates that mitigation of a large LOCA does not require accumulators. Furthermore, one loop and the associated ECCS injection is assumed not to be available due to the location of the break.

Table 3.6 SDP Worksheet for Generic PWR Nuclear Power Plant — Loss of Offsite Power (LOOP)

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Emergency AC Power (EAC) **Secondary Heat Removal (TDAFW)** **Secondary Heat Removal (AFW)** **Recovery of AC Power in < 2 hrs (REC2)** **Recovery of AC power in < 5 hrs (REC5)** **Early Inventory, HP Injection (EIHP)** **Primary Heat Removal, Feed/Bleed (FB)** **Low Pressure Recirculation (LPR)**	1/3 Standby Diesel Generators (1 multi-train system) 1/1 TDAFW pump (1 ASD train) with 1/ 5 safety relief valves per SG that is fed by AFW 1/3 MDAFW trains (1 multi-train system) or 1/1 TDAFW train (1 ASD train) Recovery of AC power (operator action = 1) [1] Recovery of AC power (operator action = 2) [3, 4] 1/3 HHSI pumps (1 multi-train system) 2/2 pressurizer PORVs open for Feed/Bleed (operator action = 2) 1/3 LHSI trains and with the associated 1/3 RHR heat exchangers or 2/6 RCFCs with cooling flow aligned to CCW (1 multi-train system)

Circle Affected Functions		**IEL**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Recovery Credit**	**Results**
1 LOOP - AFW - LPR (3) **2 + 4 + 3**	**9**				
2 LOOP - AFW - FB (4) **2 + 4 + 2**	**8**				
3 LOOP - AFW - EIHP (5) **2 + 4 + 3**	**9**				
4 LOOP - EAC - LPR (7, 11) **2 + 3 + 3** (AC Recovered)	**8**				
5 LOOP - EAC - EIHP (8, 13) **2 + 3 + 3** (AC Recovered)	**8**				
6 LOOP - EAC - REC5 (9) **2 + 3 + 2**	**7**				
7 LOOP - EAC - TDAFW - FB (12) **2 + 3 + 1 + 2** (AC Recovered)	**8**				

Table 3.6 PWR (cont)

8 LOOP - EAC - TDAFW - REC2 (14) 2 + 3 + 1 + 1	7				
Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event: If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use.					

Notes:

1. For the function "Recovery of AC Power in < 2 hrs (REC2)", generic value was used.
2. The HEP value provided by the licensee for this action is 0.3.
3. For the function "Recovery of AC Power in < 5 hrs (REC5)", no human error probability was found in the IPE. We used the generic value for this human action.
4. In an SBO situation, an RCP seal LOCA may occur, with subsequent core damage at about 5 hours.

Table 3.7 SDP Worksheet for Generic PWR Nuclear Power Plant — Steam Generator Tube Rupture (SGTR) [1]

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Secondary Heat Removal (AFW)	1/3 MDAFW trains (1 multi-train system) [2]
Early Inventory, HP Injection (EIHP)	1/3 HHSI pumps (1 multi-train system)
Primary Heat Removal, Feed/Bleed (FB)	2/2 pressurizer PORVs open for Feed/Bleed (operator action = 2)
Pressure Equalization (EQ)	Operator depressurizes RCS to less than setpoint of relief valve of SG using 1/3 pressurizer spray valves or 2/2 pressurizer PORVs (operator action = 2)
Isolation of Faulted SG (ISOL)	Operator isolates the faulted SG by closing 1/1 MSIV and associated Feedwater Isolation Valve (operator action = 2)
Cooldown and depressurization (DEPR)	Operator cools down and depressurizes the RCS using 1/4 SG PORVs or ½ pressurizer PORVs (operator action = 2)
Low Pressure Recirculation (LPR)	1/3 LHSI trains and with the associated 1/3 RHR heat exchangers or 2/6 RCFCs with cooling flow aligned to CCW (1 multi-train system)
Low Pressure Injection (SDC)	1/3 RHR trains (pumps & HXs) and ½ charging pumps (operator action = 3) [3]

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 SGTR - EQ - ISOL (3) **3 + 2 + 2**	**7**				
2 SGTR - EIHP - SDC (5) **3 + 3 + 3**	**9**				
3 SGTR - EIHP - DEPR (6) **3 + 3 + 2**	**8**				
4 SGTR - EIHP - EQ (7) **3 + 3 + 2**	**8**				
5 SGTR - AFW - LPR (9) **3 + 3 + 3**	**9**				
6 SGTR - AFW - ISOL (10) **3 + 3 + 2**	**8**				

3.7 PWR

7 SGTR - AFW - FB (11) **3 + 3 +2**	**8**				
8 SGTR - AFW - EIHP (12) **3 + 3 + 3**	**9**				

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Notes:

1. The IPE states that long-term RWST makeup and AFWST makeup are not addressed in current plant procedures or training. The licensee also stated that such long-term makeup is not required or modeled in the licensee's event trees. If both pressure equalization and isolation of faulted SG failed, the loss of primary inventory through the faulted SG will increase. Hence, we assumed that the RWST would be eventually depleted, with subsequent core damage.

2. If the SGTR is in SG D, the TDP of AFW is not available. The licensee uses a likelihood of 0.25 for the availability of this pump (1 in 4 SGs). We conservatively assume that this pump is not available in a SGTR.

3. The HEP value for SDC in updated PSA is 2.3E-3. A credit of 3 is given consistent with the HEP value in the PSA.

Table 3.8 SDP Worksheet for Generic PWR Nuclear Power Plant — Anticipated Transients without Scram (ATWS)

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Turbine trip (TTP)	½ ESFAS trains trip the turbine (1 multi-train system)
Safety Relief Valves (SRV)	3/3 pressurizer safety relief valves with 2/2 pressurizer PORVs (1 train)
Secondary Heat Removal (AFW)	2/4 AFW trains (1 multi-train system) with (1/1 SG PORV or 1/5 safety relief valves) per SG that is fed by AFW
Emergency Boration (EMBO)	Operators carry out emergency boration using ½ CCPs with ½ boric acid transfer pumps (operator action = 2) [1]

Circle Affected Functions		**IEL**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Recovery Credit**	**Results**
1 ATWS - EMBO (2) **6 + 2**	**8**				
2 ATWS - AFW (3) **6 + 3**	**9**				
3 ATWS - SRV (4) **6 + 2**	**8**				
4 ATWS - TTP (5) **6 + 3**	**9**				

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Table 3.9 SDP Worksheet for Generic PWR Nuclear Power Plant — Main Steam Line Break Outside Containment (MSLB)

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
MSLB Isolated (MSIV)[1]	3/4 MSIVs close [failure means at least 2 MSIVs failed] (1 multi-train)
High Pressure Injection (EIHP)	1/3 HHSI pumps (1 multi-train system)
Secondary Heat Removal (AFW)	1/3 MDAFW trains (1 multi-train system)
Feedwater valves close (FWVC)	Isolation of the feed to the SG whose MSIV did not close by auto trip of MFW pumps or isolation of MFW line, and operators close the valves feeding the SG from AFW, or trip of the AFW pump (operator action =2) [2]
Stop Injection (STIN)	Operators stop high pressure injection (operator action = 1) [3]
Primary Heat Removal, Feed/Bleed (FB)	2/2 pressurizer PORVs open for Feed/Bleed (operator action = 2)
High Pressure Recirculation (LPR)	1/3 LHSI pumps and with the associated 1/3 RHR heat exchangers or 2/6 RCFCs with cooling flow aligned to CCW (1 multi-train system)

Circle Affected Functions		**IEL**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Recovery Credit**	**Results**
1 MSLB - FWVC - STIN (3) **3 + 2 + 1**	**6**				
2 MSLB - AFW - LPR (5) **3 + 3 + 3**	**9**				
3 MSLB - AFW - FB (6) **3 + 3 + 2**	**8**				
4 MSLB - EIHP - FWVC (8) **3 + 3 + 2**	**8**				
5 MSLB - EIHP - AFW (9) **3 + 3 + 3**	**9**				
6 MSLB - MSIV (10) **3 + 3**	**6**				

3.9 PWR

Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:
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Notes:

1. When safety function MSIV fails, a major concern is pressurized thermal shock (PTS). We assumed if two MSIVs fail to close it leads to core damage. If one MSIV fail to close, the sequences provides mitigation capabilities. If all MSIVs close then the event is covered under TPCS.

2. Generic PWR is equipped with automatic trip of main feedwater and isolation of main feedwater flow. A generic HEP credit of 2 is assigned for assuring no feed to the affected SG.

3. Operators stop high pressure injection to prevent pressurized thermal shock. Since this action would be carried out under time and stress conditions, we assigned a mitigating credit = 1.

Table 3.10 SDP Worksheet for Generic PWR Nuclear Power Plant — Loss of Component Cooling Water (LCCW) [1]

Safety Functions Needed:		**Full Creditable Mitigation Capability for Each Safety Function:**			
RCP Trip (RCP) **High Pressure Injection (EIHP)** **Secondary Heat Removal (AFW)**		Operator trips the RCPs to prevent a seal LOCA (operator action = 2) [2] 1/3 HHSI trains (1 multi-train system) 1/3 MDAFW trains (1 multi-train system) or 1/1 TDAFW train (1 ASD train)			
Circle Affected Functions		**IEL**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Recovery Credit**	**Results**
1 LCCW - AFW (2) **5 + 4**	**9**				
2 LCCW - EIHP (3) **5 + 3**	**8**				
3 LCCW - RCP (4) **5 + 2**	**7**				
Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:					
If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use.					

Notes:

1. Loss of CCW causes loss of cooling to RHR heat exchanger (needed for recirculation), containment fan coolers, RCP thermal barrier, and centrifugal charging pumps. Operators are required to trip the RCPs to prevent a seal LOCA. If these actions fail, there is an unprotected LOCA that leads to core damage. If they are successful, secondary heat removal can only be achieved using AFW because high pressure recirculation (required after feed and bleed) is not available. The frequency of loss of CCW is 1.79E-5 per year .

2. The HEP for operator failure to start PD pump and manually trip RCP is 2.54E-2. In this case EIHP would be available to handle seal leakage of 120 gpm without the need for recirculation for more than 24 hours.

Table 3.11 SDP Worksheet for Generic PWR Nuclear Power Plant — Loss of Class 1E 125V DC Bus A or B (LODC) [1]

Safety Functions Needed: Secondary Heat Removal (AFW)		**Full Creditable Mitigation Capability for Each Safety Function:** ½ MDAFW train (1 multi-train system) or 1/1 TDAFW train (1 ASD train)			
Circle Affected Functions		**IEL**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Recovery Credit**	**Results**
1 LODC - AFW (2) **2 + 4**	**6**				
Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:					
If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use.					

Note:

1. There are 4 DC buses at the plant. Loss of 125V DC Class 1E channel I (bus E1A11) or channel III (bus E1B11) will result in the closure of all MSIVs. It will also cause the closure of all main feedwater isolation and control valves. For bus E1B11, no charging pumps are affected. The systems that are affected by bus E1A11 are: EDG 11, breakers on the 4.16-kV AC bus E1A are disabled (local, manual actions are required to open or close the breakers), train A of ECW (DC power required to start, but not to run), train A of essential chilled water(ECH) (DC power required to start, but not to run), train A of CCW (DC power required to start, but not to run), component cooling supply and return for the CCPs is split, all MSIVs close, turbine bypass is inoperable , MDAFW pump 11, charging pump 1B , HP SI pump 1A , pressurizer PORV PCV655A (fails closed), LPSI pump 1A , containment spray pump A, RHR pump A, and two fan coolers. Feed/Bleed cannot be implemented because 2 / 2 pressurizer PORVs are required to open, but one is closed. The frequency of loss of DC bus E1A11 is 5E-3per year, and of DC bus E1B11 is 5E-3 per year. Hence, the frequency of the loss of any of these two buses is 1.0E-2 per year.

Table 3.12 SDP Worksheet for Generic PWR Nuclear Power Plant — LOOP and Loss of One Class 1E 4.16-kV Bus (LEAC)[1]

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
PORV Recloses (PORV)	2/2 Pressurizer PORVs reclose after opening during transient (1 train)
Secondary Heat Removal (AFW)	½ MDAFW trains (1 multi-train system) or 1/1 TDAFW train (1 ASD train) with 1/5 safety relief valve per SG that is fed by AFW
High Pressure Injection for FB (EIHP)	½ HHSI pumps (1 multi-train system)
Primary Heat Removal, Feed/Bleed (FB)	2/2 pressurizer PORVs open for Feed/Bleed (operator action = 2)
Low Pressure Recirculation (LPR)	½ LHSI pumps with (associated ½ RHR heat exchangers or 2/4 RCFCs with cooling flow aligned to CCW) (1 multi-train system)

Circle Affected Functions		**IEL**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Recovery Credit**	**Results**
1 LEAC - AFW - LPR (3) **4 + 4 + 3**	**11**				
2 LEAC - AFW - FB (4) **4 + 4 + 2**	**10**				
3 LEAC - AFW - EIHP (5) **4 + 4 + 3**	**11**				
4 LEAC - PORV - LPR (7) **4 + 2 + 3**	**9**				
5 LEAC - PORV - EIHP (8) **4 + 2 + 3**	**9**				
6 LEAC - PORV - AFW (9) **4 + 2 + 4**	**10**				

Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:

If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use.

TABLE 3.12 PWR

Notes:

1. The plant has three Class 1E 4.16-kV buses. The dominant impact is the loss of Class 1E 4.16-kV bus E1A because bus E1B does not support a charging pump, and bus E1C does not support a pressurizer PORV. Loss of Class 1E 4.16-kV bus E1A has the following impact: EDG11 lost; the battery charger of the Class 1E 125V DC buses E1A11 and E1D11 lose power, and the batteries will eventually fail due to depletion; channels I and II of Class 1E Vital 120V AC fail and as a result, SSPS train R is lost (reactor is tripped) and ESFAS train A is lost; MDAFW pump 11 is lost; SG PORVs SGA and SGD are modeled by the licensee as failing to operate on loss of AC power; charging pump 1B is lost; HP SI pump 1A is lost; block valve of pressurizer PORV PCV655A loses power; LP SI pump 1A; containment spray pump A is lost; SI recirculation pump A is lost; it appears that each RHR pump can be powered from two Class 1E 4.16-kV buses, and hence no RHR pump is lost; and reactor coolant fan coolers 11A and 12A are lost. We assume that one train of ECW and CCW will also be unavailable. When Vital 4.16 kV AC Bus E1A is lost, there is not motive power available to close the block valve of a stuck open PORV.