EXERCISE

SOLUTIONS

A-25

EXERCISE 1

Exercise 1

The Generic PWR Risk-Informed Inspection Notebook will be used for this example. Consider a hypothetical inspection finding that involves the failure of the licensee to identify a 180 degree circumferential crack on a weld on a 2 inch line connected to the reactor coolant system. Evidence of the crack remained unidentified for four months. The inspectors determined that a small loss of coolant accident would result if this weld failed. Assume that recovery credit is not appropriate for the circumstances surrounding this hypothetical finding.

Solution

The first step in performing a Phase 2 analysis of this finding is to determine which initiating event worksheets must be evaluated. (See IMC 0609, Appendix A, Attachment 1, Step 2.1)

- Since this finding only impacts the SLOCA initiating event frequency only the SLOCA worksheet needs to be solved. It is not necessary to enter Table 2.

The second step in performing a Phase 2 analysis of this finding is to determine the initiating event likelihood for each of the worksheets that must be evaluated. (See IMC 0609, Appendix A, Attachment 1, Step 2.2)

- Enter Table 1, "Categories of Initiating Events for Generic PWR Nuclear Power Plant." The exposure time associated with this finding is 120 days. Therefore, the column for an exposure time of greater than 30 days should be entered. Since this finding increases the likelihood of a SLOCA and does not involve a support system, then by usage rule 1.2, "Inspection Finding (Not Involving a Support System) that Increases the Likelihood of an Initiating Event," the initiating event frequency should be increase by one order of magnitude.
    - The small loss of coolant accident (SLOCA) initiating event is located in Row III. Therefore, an initiating event likelihood of 2 should be used when solving this initiating event worksheet.
- Table 1 is shown below.

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.

The third step in performing a Phase 2 analysis of this finding is to determine which safety functions are impacted on each of the worksheets for this finding. (See IMC 0609, Appendix A, Attachment 1, Step 2.3.1)

- For this finding no safety functions are impacted.

The fourth step in performing a Phase 2 analysis of this finding is to determine which sequences need to be solved on the SLOCA worksheet.

- Since this finding impacts the initiating event frequency, all sequences on the SLOCA worksheet need to be solved.

The fifth step in performing a Phase 2 analysis of this finding is to determine the remaining mitigation capability credit for each of these sequences. (See IMC 0609, Appendix A, Attachment 1, Step 2.3.3).

- Since for this finding no safety functions were impacted, full mitigation credit should be given to every function on the SLOCA worksheet.

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	3	0	5
2 **SLOCA** - **AFW - FB** (5)	9	2	4 + 2	0	8
3 **SLOCA** - **EIHP** (8) 3 + 3	6	2	3	0	5

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. 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.

The eighth step in performing a Phase 2 analysis of this finding is to determine the risk significance of the inspection finding due to internal initiating events. (See IMC 0609, Appendix A, Attachment 1, Step 2.4.2).

- Complete Table 6, "Counting Rule Worksheet." This worksheets contain 3 sequences that are required to be solved. All sequences are greater than 9, two have sequence results of 5, and one has a sequence result of 8. Therefore, the risk significance of the inspection finding due to internal initiating events is 5 or Yellow.

  The completed Table 6 is shown below.

Counting Rule Worksheet			
Step	**Instructions**		
(1)	Enter the number of sequences with a risk significance equal to 9.	(1)	0
(2)	Divide the result of Step (1) by 3 and round down.	(2)	**0**
(3)	Enter the number of sequences with a risk significance equal to 8.	(3)	**1**
(4)	Add the result of Step (3) to the result of Step (2).	(4)	**1**
(5)	Divide the result of Step (4) by 3 and round down.	(5)	**0**
(6)	Enter the number of sequences with a risk significance equal to 7.	(6)	**0**
(7)	Add the result of Step (6) to the result of Step (5).	(7)	**0**
(8)	Divide the result of Step (7) by 3 and round down.	(8)	**0**
(9)	Enter the number of sequences with a risk significance equal to 6.	(9)	0
(10)	Add the result of Step (9) to the result of Step (8).	(10)	**0**
(11)	Divide the result of Step (10) by 3 and round down.	(11)	**0**
(12)	Enter the number of sequences with a risk significance equal to 5.	(12)	**2**
(13)	Add the result of Step (12) to the result of Step (11).	(13)	**2**
(14)	Divide the result of Step (13) by 3 and round down.	(14)	**0**

(15)	Enter the number of sequences with a risk significance equal to 4.	(15)	**0**
(16)	Add the result of Step (15) to the result of Step (14).	(16)	**0**

- If the result of Step 16 is greater than zero, then the risk significance of the inspection finding is of high safety significance (RED).
- If the result of Step 13 is greater than zero, then the risk significance of the inspection finding is at least of substantial safety significance (YELLOW).
- If the result of Step 10 is greater than zero, then the risk significance of the inspection finding is at least of low to moderate safety significance (WHITE).
- If the result of Steps 10, 13, and 16 are zero, then the risk significance of the inspection finding is of very low safety significance (GREEN).

Phase 2 Result: ☐ GREEN ☐ WHITE ■ **YELLOW** ☐ **RED**

Table 6 - Counting Rule Worksheet

Exercise 2

Exercise 2

Scenario

Use the Generic PWR Risk-Informed Inspection Notebook for this exercise. While performing a complete system walkdown of the high head safety injection (HHSI) system in accordance with Inspection Procedure 71111.04, "Equipment Alignment," an inspector identified that a normally locked open manual valve in the discharge flow path of one train was closed. The valve position for this valve was not indicated in the control room. This valve was also not in the flow path during quarterly surveillance testing of the system. It was subsequently determined that the valve had been out of position since maintenance was last performed on the system ten months prior. The inspectors determined that the criteria for crediting operator recovery of the HHSI train were

satisfied and that credit for recovery of the train was appropriate

Solution

The first step in performing a Phase 2 analysis of this finding is to determine which initiating event worksheets must be evaluated. (See IMC 0609, Appendix A, Attachment 1, Step 2.1)

- Enter the row for the high head safety injection system on Table 2, "Initiators and System Dependency for Generic PWR Nuclear Power Plant."
- The Initiating Event Scenarios column of Table 2 for this row identifies that all of the worksheets except large loss of coolant accident (LLOCA), anticipated transients without scram (ATWS), and loss of class 1E 125V DC Bus A or B (LODC) as the worksheets that need to be evaluated. The appropriate page from Table 2 is shown below.

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

Affected Systems	Major Components	Support Systems	Initiating Event Scenarios
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[4]	**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[4]	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

The second step in performing a Phase 2 analysis of this finding is to determine the initiating event likelihood for each of the worksheets that must be evaluated. (See IMC 0609, Appendix A, Attachment 1, Step 2.2)

- Enter Table 1, "Categories of Initiating Events for Generic PWR Nuclear Power Plant." The exposure time associated with this finding is ten months. Therefore, the column for an exposure time of greater than 30 days should be entered. (Note: This finding does not increase the likelihood of any initiating events.)

    - The loss of power conversion system (TPCS) initiating event is located in Row I. Therefore, an initiating event likelihood of 1 should be used when solving this initiating event worksheet.

    - The loss of offsite power (LOOP) initiating event is located in Row II. Therefore, an initiating event likelihood of 2 should be used when solving this initiating event worksheet.

    - The steam generator tube rupture (SGTR), Stuck Open PORV/SRV (SORV), Small loss of coolant accident (SLOCA), and Main Steam Line Break Outside Containment (MSLB) initiating events are located in Row III. Therefore, an initiating event likelihood of 3 should be used when solving these initiating event worksheets.

    - The medium loss of coolant accident (MLOCA) and LOOP with loss of One Class 1E 4.16KV Bus (LEAC) initiating events are located in Row IV. Therefore, an initiating event likelihood of 4 should be used when solving these initiating event worksheets.

    - The loss of component cooling water (LCCW) initiating event is located in Row V. Therefore, an initiating event likelihood of 5 should be used when solving this initiating event worksheet.

- Table 1 is shown below.

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		

The third step in performing a Phase 2 analysis of this finding is to determine which safety functions are impacted on each of the worksheets for this finding. (See IMC 0609, Appendix A, Attachment 1, Step 2.3.1)

- The high head safety injection train is needed for the EIHP safety function on each of the worksheets that are required to be evaluated.

The fourth step in performing a Phase 2 analysis of this finding is to determine which sequences contain the affected safety functions on these worksheets. These sequences need to be solved. (See IMC 0609, Appendix A, Attachment 1, Step 2.3.2). Therefore, the following sequences need to be solved.

- Sequence 3 on the TPCS worksheet
- Sequence 3 on the SLOCA worksheet
- Sequence 3 on the SORV worksheet
- Sequence 3 on the MLOCA worksheet
- Sequences 3 and 5 on the LOOP worksheet
- Sequences 2, 3, 4, and 8 on the SGTR worksheet
- Sequences 4 and 5 on the MSLB worksheet
- Sequence 2 on the LCCW worksheet

- Sequences 3 and 5 on the LEAC worksheet

The fifth step in performing a Phase 2 analysis of this finding is to determine the remaining mitigation capability credit for each of these sequences. (See IMC 0609, Appendix A, Attachment 1, Step 2.3.3).

- The success criteria for the EIHP function on the TPCS, SLOCA, SORV, LOOP, SGTR, MSLB, and LCCW worksheets are: 1/3 HHSI trains (1 multi-train system). Therefore, the full credit mitigation capability for the EIHP function is 3. (See Table 5, "Remaining Mitigation Capability Credit.")

  Because one of the HHSI trains are not available, the remaining mitigation capability of the EIHP function on these worksheets is 1/2 remaining HHSI trains. Therefore, the remaining mitigation capability for the EIHP function is 3.

- The success criteria for the EIHP function on theMLOCA and LEAC worksheets are: 1/2 HHSI trains (1 multi-train system). Therefore, the full credit mitigation capability for the EIHP function is 3. (See Table 5, "Remaining Mitigation Capability Credit.")

  Because one of the HHSI trains are not available, the remaining mitigation capability of the EIHP function on these worksheets is 1/1 remaining HHSI trains. Therefore, the remaining mitigation capability for the EIHP function is 2.

- All of the other safety functions in these sequences are not impacted by this finding. Therefore, full mitigation credit is given for each of them.

The sixth step in performing a Phase 2 analysis of this finding is to determine if the nature of the degradation is such that an operator could recover the unavailable equipment or function in time to mitigate the assumed initiating event. (See IMC 0609, Appendix A, Attachment 1, Step 2.3.4). For this example, assume that recovery credit should be given.

The seventh step in performing a Phase 2 analysis of this finding is to determine the sequence risk significance for each of the affected sequences. (See IMC 0609, Appendix A, Attachment 1, Step 2.4.1). Each of the solved worksheets are shown below.

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) High Pressure Recirculation (LPR)	2/2 pressurizer PORVs open for Feed/Bleed (operator action = 2) [2] 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 of Failed Train	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	1	4 + 3	1	9

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

Operator open manual valve.

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 3.2 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) **Secondary Heat Removal (AFW)** **Primary Heat Removal, Feed/Bleed (FB)** **Low Pressure Injection (LPI)** **Low Pressure Recirculation (LPR)**	**1/3 HHSI pumps (1 multi-train system)** 1/3 MDAFW trains (1 multi-train system) or 1/1 TDAFW train (1 ASD train) 2/2 PORVs open for Feed/Bleed (operator action = 2) 1/3 LHSI pumps (1 multi-train system) 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 of Failed Train	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	3	3	1	7

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

Operator open manual valve

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 3.3 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) **Early Inventory, HP Injection (EIHP)** **Secondary Heat Removal (AFW)** **Primary Heat Removal, Feed/Bleed (FB)** **Low Pressure Injection (LPI)** **Low Pressure Recirculation (LPR)**	The closure of the block valve associated with stuck open PORV (operator action = 2) [2] **1/3 HHSI pumps (1 multi-train system)** 1/3 MDAFW trains (1 multi-train system) or 1/1 TDAFW train (1 ASD train) 1/1 remaining PORVs open for Feed/Bleed (operator action = 2) 1/3 LHSI pumps (1 multi-train system) 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 of Failed Train	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	3	2 + 3	1	9

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

Operator open manual valve

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 3.4 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 of Failed Train	Results
1 MLOCA - LPR (2) 4 + 3	7				
2 MLOCA - LPI (3) 4 + 3	7				
3 MLOCA - **EIHP** (4) 4 + 3	7	**4**	**2**	**1**	**7**

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

Operator open manual valve

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 3.6 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)	1/3 Standby Diesel Generators (1 multi-train system)
Secondary Heat Removal (TDAFW)	1/1 TDAFW pump (1 ASD train) with 1/ 5 safety relief valves per SG that is fed by AFW
Secondary Heat Removal (AFW)	1/3 MDAFW trains (1 multi-train system) or 1/1 TDAFW train (1 ASD train)
Recovery of AC Power in < 2 hrs (REC2)	Recovery of AC power (operator action = 1)[1]
Recovery of AC power in < 5 hrs (REC5)	Recovery of AC power (operator action = 2)[2,4]
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)
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)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery of Failed Train	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	**2**	**4 + 3**	**1**	**10**
4 LOOP - EAC - LPR (7, 11) 2 + 3 + 3 (AC Recovered)	8				
5 LOOP - EAC - **EIHP** (8, 13) 2 + 3 + 3	8	**2**	**3 + 3**	**1**	**9**
6 LOOP - EAC - REC5 (9) 2 + 3 + 2	7				
7 LOOP - EAC - TDAFW - FB (12) 2 + 3 + 1 + 2 (AC Recovered)	8				
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:

Operator open manual valve

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 3.7 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 of Failed Train	Results
1 SGTR - EQ - ISOL (3) 3 + 2 + 2	7				
2 SGTR - **EIHP** - SDC (5) 3 + 3 + 3	9	3	3 + 3	1	10
3 SGTR - **EIHP** - DEPR (6) 3 + 3 + 2	8	3	3 + 2	1	9
4 SGTR - **EIHP** - EQ (7) 3 + 3 + 2	8	3	3 + 2	1	9
5 SGTR - AFW - LPR (9) 3 + 3 + 3	9				
6 SGTR - AFW - ISOL (10) 3 + 3 + 2	8				
7 SGTR - AFW - FB (11) 3 + 3 + 2	8				
8 SGTR - AFW - **EIHP** (12) 3 + 3 + 3	9	3	3 + 3	1	10

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

Operator open manual valve

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 3.9 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 of Failed Train	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	3	3 + 2	1	9
5 MSLB - **EIHP** - AFW (9) 3 + 3 + 3	9	3	3 + 3	1	10
6 MSLB - MSIV (10) 3 + 3	6				

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

Operator open manual valve

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 3.10 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) Seal Injection using PDP (PDP) **High Pressure Injection (EIHP)** Secondary Heat Removal (AFW)	Operator trips the RCPs to prevent a seal LOCA (operator action = 2) [2] Operator starts PDP for seal injection (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 of Failed Train	Results
1 LCCW - AFW (2) 5 + 4	9				
2 LCCW -- **EIHP** (3) 5 + 3	8	5	3	1	9
3 LCCW - RCP (4) 5 + 2	7				

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

Operator open manual valve

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 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) **Secondary Heat Removal (AFW)** **High Pressure Injection for FB (EIHP)** **Primary Heat Removal, Feed/Bleed (FB)** **Low Pressure Recirculation (LPR)**	2/2 Pressurizer PORVs reclose after opening during transient (1 train) 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 **½ HHSI pumps (1 multi-train system)** 2/2 pressurizer PORVs open for Feed/Bleed (operator action = 2) 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 of Failed Train	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	4 + 2	1	11
4 LEAC - PORV - LPR (7) 4 + 2 + 3	9				
5 LEAC - PORV - **EIHP** (8) 4 + 2 + 3	9	4	2 + 2	1	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:

Operator open manual valve

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.

The eighth step in performing a Phase 2 analysis of this finding is to determine the risk significance of the inspection finding due to internal initiating events. (See IMC 0609, Appendix A, Attachment 1, Step 2.4.2).

- Complete Table 6, "Counting Rule Worksheet." These worksheets contain 15 sequences that are required to be solved. Five have sequence results greater than 9, eight have sequence results of 9, and two have sequence results of 7. Therefore, the risk significance of the inspection finding due to internal initiating events is 7 or Green.

  The completed Table 6 is shown below.

Counting Rule Worksheet			
Step	**Instructions**		
(1)	Enter the number of sequences with a risk significance equal to 9.	(1)	8
(2)	Divide the result of Step (1) by 3 and round down.	(2)	2
(3)	Enter the number of sequences with a risk significance equal to 8.	(3)	0
(4)	Add the result of Step (3) to the result of Step (2).	(4)	2
(5)	Divide the result of Step (4) by 3 and round down.	(5)	0
(6)	Enter the number of sequences with a risk significance equal to 7.	(6)	2
(7)	Add the result of Step (6) to the result of Step (5).	(7)	2
(8)	Divide the result of Step (7) by 3 and round down.	(8)	0
(9)	Enter the number of sequences with a risk significance equal to 6.	(9)	0
(10)	Add the result of Step (9) to the result of Step (8).	(10)	0
(11)	Divide the result of Step (10) by 3 and round down.	(11)	0
(12)	Enter the number of sequences with a risk significance equal to 5.	(12)	0
(13)	Add the result of Step (12) to the result of Step (11).	(13)	0
(14)	Divide the result of Step (13) by 3 and round down.	(14)	0
(15)	Enter the number of sequences with a risk significance equal to 4.	(15)	0
(16)	Add the result of Step (15) to the result of Step (14).	(16)	0

- If the result of Step 16 is greater than zero, then the risk significance of the inspection finding is of high safety significance (RED).
- If the result of Step 13 is greater than zero, then the risk significance of the inspection finding is at least of substantial safety significance (YELLOW).
- If the result of Step 10 is greater than zero, then the risk significance of the inspection finding is at least of low to moderate safety significance (WHITE).
- If the result of Steps 10, 13, and 16 are zero, then the risk significance of the inspection finding is of very low safety significance (GREEN).

Phase 2 Result: ■ **GREEN** ☐ **WHITE** ☐ **YELLOW** ☐ **RED**

Table 6 - Counting Rule Worksheet

EXERCISE 3

Exercise 3

Scenario

Use the Generic BWR Risk-Informed Inspection Notebook for this exercise. The "A" instrument air (IA) compressor seized shortly after it was started for periodic rotation of the operating equipment. It was subsequently determined that the compressor seized because of improperly performed preventive maintenance which had been conducted two days prior. The IA system is a normally cross-tied support system. The inspectors determined that the criteria for crediting operator recovery of the IA compressor were not satisfied and that credit for recovery of the compressor was not appropriate.

Solution

The first step in performing a Phase 2 analysis of this finding is to determine which initiating event worksheets must be evaluated. (See IMC 0609, Appendix A, Attachment 1, Step 2.1)

- Enter the row for the instrument air system on Table 2, "Initiators and System Dependency for Generic BWR Nuclear Power Plant."
- The Initiating Event Scenarios column of Table 2 for this row identifies the loss of instrument air worksheet as the only worksheet that needs to be evaluated. The appropriate page from Table 2 is shown below.

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

Affected System		Major Components	Support Systems	Initiating Event Scenarios
Code	Name			
DGCW	Diesel generator Cooling Water	Pumps	480 V-AC	All
SW	Service water	5 pumps in Unit 1/ 2 Crib house; shared system supplying a common header	4160 V-AC, 125 V-DC, IA	LOSW
TBCCW	Turbine Building Closed Cooling Water System	2 pumps, 2 HXs, an expansion tank	SW, IA, 4160 V-AC	TRAN, TPCS, SLOCA, IORV, LOOP, ATWS
HPCI	High Pressure Coolant Injection	1 TDP, MOV	125 V-DC, 250 V-DC, Room HVAC	All except LLOCA, LOSW
LPCS	Low Pressure Core Spray	2 Trains or Loops; 1 LPCS pump per train	4160 V-AC, 480 V-AC, 125 V-DC, SW, Pump Room HVAC	All except LOSW
RCIC	Reactor Core Isolation Cooling	1 TDP, MOV	125 V-DC, Room HVAC	All except LLOCA, MLOCA
FPS	Fire Protection System	2 diesel fire pumps, MOV	120V AC, SW, 24V Nickel-cadmium batteries	LOSW, LOIA
CRD	Control Rod Drive Hydraulic System	2 MDP, MOV	Non-emergency ESF AC Buses, TBCCW	TRAN, TPCS, SLOCA, IORV, LOOP, ATWS
IA	**Instrument Air**	2 compressors for each unit plus a shared compressor supplying both units	SW, 480V AC	**LOIA**
SLC	Standby Liquid Control	2 MDP, 2 explosive valves	480 V-AC, 125 V-DC	ATWS
Room HVAC			DGCW	All

The second step in performing a Phase 2 analysis of this finding is to determine the initiating event likelihood for each of the worksheets that must be evaluated. (See IMC 0609, Appendix A, Attachment 1, Step 2.2)

- Enter Table 1, "Categories of Initiating Events for Generic BWR Nuclear Power Plant." The LOIA initiating event is located in Row II. The exposure time associated with this finding is two days. Therefore, the column for an exposure time of less than 3days should be entered. As a result, an initiating event likelihood of 4 would normally be assigned; but, because the finding

increases the likelihood of a LOIA event, an initiating event likelihood of 3 should be used. (See IMC 0609, Appendix A, Attachment 2, Rule 1.3)

- Table 1 is shown below.

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

Row	Approximate Frequency	Example Event Type	Initiating Event Likelihood (IEL)		
I	> 1 per 1-10 yr	Transient (Reactor Trip) (TRAN), Loss of Power Conversion System (Loss of condenser, Closure of MSIVs, Loss of feedwater) (TPCS)	1	2	3
II	1 per 10-10^2 yr	Loss of offsite power (LOOP), Inadvertent or stuck open SRVs (IORV), **Loss of Instrument Air (LOIA)**	2	3	**4**
III	1 per 10^2 - 10^3 yr	Loss of Service Water (LOSW), Loss of an AC Bus (LOAC)	3	4	5
IV	1 per 10^3 - 10^4 yr	Small LOCA (RCS rupture) (SLOCA), Medium LOCA (RCS rupture) (MLOCA)	4	5	6
V	1 per 10^4 - 10^5 yr	Large LOCA (RCS rupture) (LLOCA), ATWS	5	6	7
VI	less than 1 per 10^5 yr	ISLOCA, Vessel rupture	6	7	8
			> 30 days	**3-30 days**	**< 3 days**
			Exposure Time for Degraded Condition		

The third step in performing a Phase 2 analysis of this finding is to determine which safety functions are impacted on each of the worksheets for this finding. (See IMC 0609, Appendix A, Attachment 1, Step 2.3.1)

- The LOIA worksheet assumes that a total loss of instrument air initiating event occurred; therefore, the safety functions needed to mitigate the event do not rely on instrument air.

The fourth step in performing a Phase 2 analysis of this finding is to determine which sequences contain the affected safety functions on these worksheets. These sequences need to be solved. (See IMC 0609, Appendix A, Attachment 1, Step 2.3.2).

- Because the finding increases the likelihood that a LOIA event will occur and the LOIA event frequency is a component in each of these sequences, all of the sequences on the LOIA worksheet need to be solved.

The fifth step in performing a Phase 2 analysis of this finding is to determine the remaining mitigation capability credit for each of these sequences. (See IMC 0609, Appendix A, Attachment 1, Step 2.3.3).

- Because the LOIA worksheet assumes that a total loss of instrument air initiating event occurred, the safety funcitons needed to mitigate the event do not rely on instrument air. Therefore, full mitigation capability credit should be given.

The sixth step in performing a Phase 2 analysis of this finding is to determine if the nature of the degradation is such that an operator could recover the unavailable equipment or function in time to mitigate the assumed initiating event. (See IMC 0609, Appendix A, Attachment 1, Step 2.3.4). For this example, no recovery credit should be given.

The seventh step in performing a Phase 2 analysis of this finding is to determine the sequence risk significance for each of the affected sequences. (See IMC 0609, Appendix A, Attachment 1, Step 2.4.1). Each of the solved worksheets are shown below.

Table 3.4 SDP Worksheet for Generic BWR — Loss of Instrument Air (LOIA)[1,2]

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
High Pressure Injection (HPI)	HPCI (1 ASD train) or RCIC (1 ASD train)
Depressurization (DEP)	1/5 ADS valves (RVs) manually opened (operator action = 2)
Low Pressure Injection (LPI)	1/4 RHR pumps in 1/2 trains in LPCI Mode (1 multi-train system) or 1/2 LPCS trains (1 multi-train system)
Containment Heat Removal (CHR)	1/4 RHR pumps in 1/2 trains with heat exchangers and 1/4 RHRSW pumps in SPC (1 multi-train system)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery of Failed Train	Results
1 **LOIA** - CHR (2,4) 2 + 3	5	3	3	0	6
2 **LOIA** - HPI - LPI (5) 2 + 2 + 6	10	3	2 + 6	0	11
3 **LOIA** - HPI - DEP (6) 2 + 2 + 2	6	3	2 + 2	0	7

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

None

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 available and ready for use.

The eighth step in performing a Phase 2 analysis of this finding is to determine the risk significance of the inspection finding due to internal initiating events. (See IMC 0609, Appendix A, Attachment 1, Step 2.4.2).

- Complete Table 6, "Counting Rule Worksheet." These worksheets contain 3 sequences that are required to be solved. One has a sequence result greater than 9, one has a sequence result of 7, and one has a sequence result of 6. Therefore, the risk significance of the inspection finding due to internal initiating events is 6 or White.

  The completed Table 6 is shown below.

Counting Rule Worksheet			
Step	**Instructions**		
(1)	Enter the number of sequences with a risk significance equal to 9.	(1)	0
(2)	Divide the result of Step (1) by 3 and round down.	(2)	0
(3)	Enter the number of sequences with a risk significance equal to 8.	(3)	0
(4)	Add the result of Step (3) to the result of Step (2).	(4)	0
(5)	Divide the result of Step (4) by 3 and round down.	(5)	0
(6)	Enter the number of sequences with a risk significance equal to 7.	(6)	1
(7)	Add the result of Step (6) to the result of Step (5).	(7)	1
(8)	Divide the result of Step (7) by 3 and round down.	(8)	0
(9)	Enter the number of sequences with a risk significance equal to 6.	(9)	1
(10)	Add the result of Step (9) to the result of Step (8).	(10)	1
(11)	Divide the result of Step (10) by 3 and round down.	(11)	0
(12)	Enter the number of sequences with a risk significance equal to 5.	(12)	0
(13)	Add the result of Step (12) to the result of Step (11).	(13)	0
(14)	Divide the result of Step (13) by 3 and round down.	(14)	0
(15)	Enter the number of sequences with a risk significance equal to 4.	(15)	0
(16)	Add the result of Step (15) to the result of Step (14).	(16)	0

- If the result of Step 16 is greater than zero, then the risk significance of the inspection finding is of high safety significance (RED).
- If the result of Step 13 is greater than zero, then the risk significance of the inspection finding is at least of substantial safety significance (YELLOW).
- If the result of Step 10 is greater than zero, then the risk significance of the inspection finding is at least of low to moderate safety significance (WHITE).
- If the result of Steps 10, 13, and 16 are zero, then the risk significance of the inspection finding is of very low safety significance (GREEN).

Phase 2 Result: ☐ **GREEN** ■ **WHITE** ☐ **YELLOW** ☐ **RED**

Table 6 - Counting Rule Worksheet

EXERCISE 4

Exercise 4

The Saint Lucie Nuclear Power Plant Unit 1 Risk-Informed Inspection Notebook will be used for this example. Consider a hypothetical inspection finding that involves the unavailability of the "B" component cooling water (CCW) pump for 2 days. At Saint Lucie, the CCW system is a split train support system. Assume that recovery credit is appropriate for the circumstances surrounding this hypothetical finding.

Solution

The first step in performing a Phase 2 analysis of this finding is to determine which initiating event worksheets must be evaluated. (See IMC 0609, Appendix A, Attachment 1, Step 2.1)

- Enter the row for the CCW system on Table 2, "Initiators and System Dependency St. Lucie Nuclear Power Plant, Unit 1."
- The Initiating Event Scenarios column of Table 2 for this row identifies that all of the worksheets except LICW need to be evaluated. Also identify all the trains that will also be rendered unavailable when train "B" of CCW is also unavailable. Table 2 is shown below.

  From Table 2 the following trains of front line systems are also unavailable.

  1. Train "B" of Containment Cooling System (CCS)
  2. Train "B" of Containment Spray System (CSS)
  3. Train "B" of High Pressure Injection System (HPSI)
  4. Train "B" of control room air conditioning system
  5. Train "B" of Low Pressure Safety Injection/Shutdown Cooling System (LPSI/SDC)

Table 2 Initiators and System Dependency St. Lucie Nuclear Power Plant, Unit 1 [1,2]

Affected Systems	Major Components	Support Systems	Initiating Event Scenarios
AC Power System (AC)	AC Power Distribution (two safety related buses), AC Instrument Power, and fast transfer	DC, HVAC[3]	All
Auxiliary Feedwater (AFW)	Two MDPs (one per SG) with normally closed cross-connections, Unit 1 condensate storage tank (UICST)	AC, ESFAS, DC	All except MLOCA and LLOCA
	One TDP to both SGs, UICST	ESFAS, DC, Main Steam	
Long Term AFW Make up	Automatic CST make up from demineralized water through an air operated valve LCV-12-9	IA backed by EDG	
	AFW cross tie to Unit 2 CST through a manual valve	None	
	CST make up from Treated Water Storage Tank (TWST) through TWST pumps and manual valves	Non safety related AC	
CCW	Three pumps in two trains with one CCW heat exchanger in each train and the third pump as a swing pump	AC, ESFAS, ICW, DC	**All except LICW**
Condensate / MFW	Three Condensate pumps	AC, DC, TCW	TRANS, LCCW, SLOCA
	Two MFW pumps	AC, DC, IA, TCW	
Containment Cooling System (CCS)	Four fan coolers	AC, ESFAS, *CCW*	All except LCCW and LICW
Containment Spray System (CSS)	Two trains with normally closed cross-connections, each with one pump and one shutdown cooling (SDC) heat exchanger	AC, DC, ESFAS, HVAC[3], *CCW*	All except LCCW and LICW
HPSI	Two HPSI trains, pumps shutoff at 1083 psi	AC, DC, ESFAS, *CCW*, HVAC[3]	All except LCCW and LICW

Affected Systems	Major Components	Support Systems	Initiating Event Scenarios
Charging Pumps (CHG)	Three Pumps	AC, DC, ESFAS	TRANS, TPCS, SLOCA, SORV, LDCBUS, SGTR, ATWS, MSLB, LIA
DC Power System	Buses, Battery Chargers[4] and Batteries	AC Dist. (without AC, battery capacity is 6 hrs.), HVAC	All
EDG	Two EDGs, fuel transfer pumps and storage tanks[5]	DC, ESFAS	LOOP
HVAC	Supply and Exhaust Fans	AC, ESFAS, DC, *CCW* (control room air conditioning)	All except LCCW and LICW
Instrument Air (IA)	Two Inside Air Compressors and Four Outside Compressors	AC, TCW (backed by alternate cooling fans)	LIA
Intake Cooling Water (ICW)	Three Pumps in two trains with normally closed cross-connections	AC, ESFAS	All
Turbine Cooling Water (TCW)	2 pumps, 2 heat exchangers	AC, DC, ICW	TRANS, LCCW, SLOCA
Main Steam[6]	Two SGs, each with one ARV (can be manually operated on loss of IA), eight safety valves, and one MSIV, Five turbine bypass valves with 45% capacity	DC, IA, AC	All except MLOCA and LLOCA
Pressurizer Pressure Relief[6]	Three Safety valves open at 2500 psia, 2 PORVs with block valves open at 2335 psia	DC, AC (block valves)	All except MLOCA, LLOCA, LCCW and LICW
RCP	Seals	*CCW* to thermal barrier heat exchanger (loss on ESFAS), IA for CCW supply and return valves	SLOCA
Safety Injection Tank (SIT)	Four SITs	None	LLOCA
LPSI/SDC[6]	Two LPSI pumps and two shutdown cooling (SDC) heat exchangers	AC, DC, ESFAS, *CCW*, HVAC[3]	All except MLOCA, LOOP, LCCW and LICW
Long Term RCS Makeup Sources	Charging pumps from Boric Acid Makeup (BAM) Tanks (5400 gallons each), Alignment of SITs (8183 gallons each) to VCT for CVCS pump operation	AC, DC	SLOCA, SORV, LDCBUS, SGTR

Notes:

1. This table was built using the dependency table of the IPE and subsequent input from licensee during benchmarking. It is assumed that AFW pumps, CCW pumps, LPSI and HPSI pumps require DC power to start.
2. Plant internal event CDF (including internal floods) = 1.99E-5/yr.
3. No cooling medium is needed for HVAC systems for ECCS pump room and switchgear room cooling. HVAC is air cooled.
4. Battery charger capacity is not adequate to carry the SI loads. Inspection finding on the batteries should be treated similar to the loss of the associated DC bus.
5. Each diesel generator set is served by two diesel day oil tanks each of which has a usable capacity of 159 gallons that is sufficient to allow 1.25 hours of full post-accident load condition.

6. Benchmarking identified the following under and overestimation by the notebook. One LPSI train including the associated H'S is estimated to be conservative by one order-of-magnitude in the notebook compared to the plant PSA. No underestimation was noted.
   In addition, difference in assumption between the notebook and the plant P.A. results was noted to affect the results. PSIA credits once-through cooling when both MSIVs fail. This results in lower color for MSIV failures and the operator failure to isolate the affected SG, but higher color for PORVs and the operator failure to conduct feed and bleed.

The second step in performing a Phase 2 analysis of this finding is to determine the initiating event likelihood for each of the worksheets that must be evaluated. (See IMC 0609, Appendix A, Attachment 1, Step 2.2)

- Enter Table 1, "Categories of Initiating Events for St. Lucie Nuclear Power Plant." The exposure time associated with this finding is 2 days. Therefore, the column for an exposure time between less than 3 days should be entered. Since the unavailability of the "B" CCW pump increases the likelihood of a total loss of CCW, then by usage rule 1.4 the initiating event likelihood for loss of CCW should be increased by one order of magnitude.

  - The transient (TRAN) and loss of power conversion system (TPCS) initiating events are located in Row I. Therefore, an initiating event likelihood of 3 should be used when solving these initiating event worksheets.

  - The loss of offsite power (LOOP) and loss of instrument air (LOIA) initiating events are located in Row II. Therefore, an initiating event likelihood of 4 should be used when solving these initiating event worksheets.

  - The steam generator tube rupture (SGTR), stuck open PORV/SRV (SORV), small LOCA including RCP seal failures (SLOCA) and main steam line break (MSLB) initiating events are located in Row III. Therefore, an initiating event likelihood of 5 should be used when solving these initiating events worksheets.

  - The medium LOCA (MLOCA), loss of CCW (LCCW) and loss of a DC bus (LDCBUS) initiating events are located in Row IV. Therefore, except for LCCW, an initiating event likelihood of 6 should be used when solving these initiating event worksheets. For LCCW an event likelihood of 5 should be used as directed by usage rule 1.4.

  1. The large LOCA (LLOCA) initiating event is located in Row V. Therefore, an initiating event likelihood of 7 should be used when solving this worksheet.

  2. The anticipated transient without scram (ATWS) initiating event is located in Row VI. Therefore, an initiating event likelihood of 8 should be used when solving this worksheet.

- Table 1 is shown below.

Table 1 Categories of Initiating Events for St. Lucie Nuclear Power Plant, Unit 1

Row	Approximate Frequency	Example Event Type	Initiating Event Likelihood (IEL)		
I	> 1 per 1-10 yr	Reactor Trip (**TRANS**), Loss of Power Conversion System (**TPCS**)	1	2	**3**
II	1 per 10-10^2 yr	Loss of Offsite Power (**LOOP**), Loss of Instrument Air (**LIA**)	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 (**MSLB**)	3	4	**5**
IV	1 per 10^3 - 10^4 yr	Medium LOCA (**MLOCA**), Loss of CCW (**LCCW**), Loss of ICW (LICW), Loss of a DC Bus (**LDCBUS**)	4	5	**6**
V	1 per 10^4 - 10^5 yr	Large LOCA (**LLOCA**)	5	6	**7**
VI	less than 1 per 10^5 yr	**ATWS**, Interfacing System LOCA (ISLOCA)	6	7	**8**
			> 30 days	**3-30 days**	**< 3 days**
			Exposure Time for Degraded Condition		

Note:

(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 for consideration of the probability of a successful manual trip.

The third step in performing a Phase 2 analysis of this finding is to determine which safety functions are impacted on each of the worksheets for this finding. (See IMC 0609, Appendix A, Attachment 1, Step 2.3.1)

- The "B" train of CCW supports the "B" train of HPSI, so the high pressure safety injection and high pressure recirculation safety functions on each of the worksheets are required to be evaluated.
- The "B" train of CCW supports the "B" train of LPSI/SDC, so the low pressure safety injection and shutdown cooling safety functions on each of the worksheets are required to be evaluated.
- The "B" train of CCW supports the "B" train of CCS and the train "B" of CSS, so the containment heat removal safety function on each of the worksheets are required to be evaluated.

The fourth step in performing a Phase 2 analysis of this finding is to determine which sequences contain the affected safety functions on these worksheets. These sequences need to be solved. (See IMC 0609, Appendix A, Attachment 1, Step 2.3.2). Therefore, the following sequences need to be solved.

- Sequences 1 through 7 on the TRAN worksheet
- Sequences 1 through 7 on the TPCS worksheet
- Sequences 1 through 5 on the SLOCA worksheet
- Sequences 1 through 5 on the SORV worksheet
- Sequences 1 through 3 on the MLOCA worksheet

- Sequences 1 through 3 on the LLOCA worksheet
- Sequences 1, 2, 4, 6, 7 and sequence 9 on the LOOP worksheet
- Sequences 1 through 8 and sequence 10 on the SGTR worksheet
- Sequences 5 through 8 on the ATWS worksheet
- Sequences 1 through 6 and sequence 8 on the MSLB worksheet
- Sequence 1 and sequences 3 through 5 on the LDCBUS worksheet
- Sequences 1 through 7 on the LIA worksheet
- Sequences 1 through 3 on the LCCW worksheet

The fifth step in performing a Phase 2 analysis of this finding is to determine the remaining mitigation capability credit for each of these sequences. (See IMC 0609, Appendix A, Attachment 1, Step 2.3.3).

- The success criteria for the HPSI function on each of these worksheets is: ½ high pressure injection trains (1 multi train system). Therefore, the full credit mitigation capability for the HPSI function is 3 (See Table 5, "Remaining Mitigation Capability Credit"). Because train B of HPSI is not available, the remaining mitigation capability of the HPSI function is 1 train or credit of 2.
- The success criteria for the HPR function on each of these worksheets is: ½ high pressure injection trains in the recirculation mode (1 multi train system). Therefore, the full credit mitigation capability for the HPR function is 3 (See Table 5, "Remaining Mitigation Capability Credit"). Because train B of HPSI is not available the remaining mitigation capability of the HPR function is 1 train or credit of 2.
- The success criteria for the CHR function each of these worksheets is: 2/4 fan coolers or 1/ 2 high containment spray trains with SDC heat exchangers (1 multi train system). Therefore, the full credit mitigation capability for the CHRI function is 3 (See Table 5, "Remaining Mitigation Capability Credit.") Because train B of CSS and CCS are not available the remaining mitigation capability of the CHR function is 1 train or credit of 2.
- The success criteria for the LPSI on each of these worksheets is: ½ low pressure injection trains (1 multi train system). Therefore, the full credit mitigation capability for the LPSI function is 3 (See Table 5, "Remaining Mitigation Capability Credit.") Because train B of LPSI is not available the remaining mitigation capability of the LPSI function is 1 train or credit of 2.
- The success criteria for the SDC function on each of these worksheets is: 1/3 charging pumps and 1/ 2 LPSI trains with SDC heat exchangers (operator action = 2). Therefore, the full credit mitigation capability for the SDC safety function is 2. The remaining mitigation capability of the SDC safety function has not changed since the credit for the remaining train is not less than the credit for operator action.

The sixth step in performing a Phase 2 analysis of this finding is to determine if the nature of the degradation is such that an operator could recover the unavailable equipment or function in time to mitigate the assumed initiating event. (See IMC 0609, Appendix A, Attachment 1, Step 2.3.4). For this example, assume that recovery credit should be given and a value of 1 should be credited.

The seventh step in performing a Phase 2 analysis of this finding is to determine the sequence risk significance for each of the affected sequences. (See IMC 0609, Appendix A, Attachment 1, Step 2.4.1). Each of the solved worksheets are shown below.

Table 3.1 SDP Worksheet for St. Lucie, Unit 1 — Transients (Reactor Trip) (TRANS)

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Power Conversion System (PCS)	1/ 2 Main Feedwater trains and 1/3 condensate pumps (operator action = 3) [1]
Auxiliary Feedwater System (AFW)	1/ 2 MD AFW trains (1 multi-train system) or 1/1 TD AFW train (1 ASD train)
Feed and Bleed with 1 PORV (FB1)	1/ 2 PORVs (operator action=2)
Feed and Bleed (FB)	2/2 PORVs (operator action = 2) [2]
High Pressure Safety Injection (HPSI)	1/ 2 high pressure injection trains (1 multi-train system)
Long Term AFW Makeup (LTAFWMU)	Automatic makeup from demineralized water (1 train) or operator aligns AFW to take suction from Unit 2 CST or makeup to CST from treated water tank (operator action = 3) [3]
Shutdown Cooling (SDC)	1/3 charging pumps and 1/ 2 LPSI trains with SDC heat exchangers (operator action = 2) [4]
High Pressure Recirculation (HPR)	1/ 2 high pressure safety injection trains in recirculation mode (1 multi-train system)
Containment Heat Removal (CHR)	2/4 fan coolers or 1/ 2 containment spray trains with SDC heat exchangers (1 multi-train system)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 TRANS - PCS - LTAFWMU - SDC - CHR(5) 1 + 3 + 5 + 2 + 3	14	3	3 + 5 + 2 + 2	1	16
2 TRANS - PCS - LTAFWMU - SDC - HPR (6) 1 + 3 + 5 + 2 + 3	14	3	3 + 5 + 2 + 2	1	16
3 TRANS - PCS - LTAFWMU - SDC - HPSI (7) 1 + 3 + 5 + 2 + 3	14	3	3 + 5 + 3 + 2	1	17
4 TRANS - PCS - LTAFWMU - SDC - FB1 (8) 1 + 3 + 5 + 2 + 2	13	3	3 + 5 + 2 + 2	1	16
5 TRANS - PCS - AFW - CHR (10) 1 + 3 + 4 + 3	11	3	3 + 4 + 2	1	13
6 TRANS - PCS - AFW - HPR (11) 1 + 3 + 4 + 3	11	3	3 + 4 + 2	1	13
7 TRANS - PCS -AFW - HPSI (12) 1 + 3 + 4 + 3	11	3	3 + 4 + 2	1	13
8 TRANS - PCS - AFW - FB (13) 1 + 3 + 4 + 2	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.

Notes:

1. The HEP used in the IPE for operator failure to recover main feedwater is 1.21E-3.
2. The HEP for operator failure to initiate once through cooling in a transient is 7.5E-3.
3. The HEP for operator failure to provide makeup to CST is 1.55E-5 . The HEP for failure to cross tie to U2CST is 3.15 E-4. In this worksheet, a credit of 3 is assigned considering the hardware failures.
4. The HEP for operator failure to initiate shutdown cooling is 1.22E-3. A credit of 2 is assigned based on a survey of the CE plants.

Table 3.2 SDP Worksheet for St. Lucie, Unit 1 — Transients without PCS (TPCS)

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Auxiliary Feedwater System (AFW)	1/ 2 MD AFW trains (1 multi-train system) or 1/1 TD AFW train (1 ASD train) and steam relief through 1/ 2 ARVs or 1/16 safety valves
Feed and Bleed with 1 PORV (FB1)	1/ 2 PORVs (operator action=2)
Feed and Bleed (FB)	2/2 PORVs (operator action = 2) [1]
High Pressure Safety Injection (HPSI)	1/ 2 high pressure injection trains (1 multi-train system)
Long Term AFW Makeup (LTAFWMU)	Automatic makeup from demineralized water (1 train) or operator aligns AFW to take suction from trains Unit 2 CST or makeup to CST from treated water tank (operator action = 3) [2]
Shutdown Cooling (SDC)	1/3 charging pumps and 1/ 2 SDC trains with shutdown heat exchangers (operator action = 2) [3]
High Pressure Recirculation (HPR)	1/ 2 high pressure safety injection trains in recirculation mode (1 multi-train system)
Containment Heat Removal (CHR)	2/4 fan coolers or 1/ 2 containment spray trains with SDC heat exchangers (1 multi-train system)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 TPCS - LTAFWMU - SDC - CHR (4) 1 + 5 + 2 + 3	11	3	5 + 2 + 2	1	13
2 TPCS - LTAFWMU - SDC - HPR (5) 1 + 5 + 2 + 3	11	3	5 + 2 + 2	1	13
3 TPCS - LTAFWMU - SDC - HPSI (6) 1 + 5 + 2 + 3	11	3	5 + 2 + 2	1	13
4 TPCS - LTAFWMU - SDC - FB1 (7) 1 + 5 + 2 + 2	10	3	5 + 2 + 2	1	13

5 TPCS - AFW - CHR (9) 1 + 4 + 3	8	3	4 + 2	1	10
6 TPCS - AFW - HPR (10) 1 + 4 + 3	8	3	4 + 2	1	10
7 TPCS -AFW -HPSI (11) 1 + 4 + 3	8	3	4 + 2	1	10
8 TPCS - AFW - FB (12) 1 + 4 + 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) The HEP for operator failure to initiate once through cooling in a transient is 7.5E-3.

(2) The HEP for operator failure to provide makeup to CST is 1.55E-5 The HEP for failure to cross tie to U2CST is 3.15 E-4. In this worksheet, a credit of 3 is assigned considering the hardware failures.

(3) The HEP for operator failure to initiate shutdown cooling is 1.22 E-3. A credit of 2 is assigned based on a survey of the CE plants.

Table 3.3 SDP Worksheet for St. Lucie, Unit 1 — Small LOCA (SLOCA) (1/ 2"<D<3") [1]

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Secondary Heat Removal (SHR)	1/ 2 Main Feedwater trains and 1/3 condensate pumps (operator action = 1) [2] or 1/ 2 MD AFW trains (1 multi-train system) or 1/1 TD AFW train (1 ASD train) and steam relief through 1/ 2 ARVs or 1/16 safety valves
High Pressure Safety Injection (HPSI)	1/ 2 high pressure injection trains (1 multi-train system)
Feed and Bleed (FB)	2/2 PORV (operator action = 2) [3]
Shutdown Cooling (SDC)	1/3 charging pumps and 1/ 2 SDC trains with shutdown heat exchangers with long term AFW makeup and RCS makeup from BAM tanks and SITs (operator action = 2) [4]
High Pressure Recirculation (HPR)	1/ 2 high pressure safety injection trains in recirculation modes (1 multi-train system)
Containment Heat Removal (CHR)	2/4 fan coolers or 1/ 2 containment spray trains with SDC heat exchangers (1 multi-train system)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 SLOCA - SDC - HPR (3) 3 + 2 + 3	8	5	2 + 2	1	10
2 SLOCA - SDC - CHR (4) 3 + 2 + 3	8	5	2 + 2	1	10
3 SLOCA - HPSI (5, 10) 3 + 3	6	5	2	1	8
4 SLOCA - SHR - HPR (7) 3 + 5 + 3	11	5	5 + 2	1	13
5 SLOCA - SHR - CHR (8) 3 + 5 + 3	11	5	5 + 2	1	13
6 SLOCA - SHR - FB (9) 3 + 5 + 2	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.

Notes:

(1) The IPE calls this LOCA a small-small LOCA.

(2) The HEP for PCS recovery in the PRA is 0.35. An operator action credit of 1 is assigned.

(3) The HEP for operator failure to initiate once through cooling in a small-small LOCA is 7.5E-3.

(4) The HEP for operator failure to initiate shutdown cooling is 1.22 E-3. A credit of 2 is assigned based on a survey of the CE plants.

Table 3.4 SDP Worksheet for St. Lucie, Unit 1 — Stuck Open Relief Valve (SORV)

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Isolation (BLK)	Operator closes the block valve (1 train) [1]
Auxiliary Feedwater System (AFW)	1/ 2 MD AFW trains (1 multi-train system) or 1/1 TD AFW train (1 ASD train) and steam relief through 1/ 2 ARVs or 1/16 safety valves
High Pressure Safety Injection (HPSI)	1/ 2 high pressure injection trains (1 multi-train system)
Feed and Bleed (FB)	Operator conducts FB using the remaining 1/1 PORV (operator action = 2) [2]
Shutdown Cooling (SDC)	1/3 charging pumps and 1/ 2 SDC trains with shutdown heat exchangers and long term AFW makeup and RCS makeup from BAM tanks and SITs (operator action = 2) [3]
High Pressure Recirculation (HPR)	1/ 2 high pressure safety injection trains in recirculation mode (1 multi-train system)
Containment Heat Removal (CHR)	2/4 fan coolers or 1/ 2 containment spray trains with SDC heat exchangers (1 multi-train system)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 SORV - BLK - SDC - HPR (4) 3 + 2 + 2 + 3	10	5	2 + 2 + 2	1	12
2 SORV - BLK - SDC - CHR (5) 3 + 2 + 2 + 3	10	5	2 + 2 + 2	1	12
3 SORV - BLK - HPSI (6,11) 3 + 2 + 3	8	5	2 + 2	1	10
4 SORV - BLK - AFW - HPR (8) 3 + 2 + 4 + 3	12	5	2 + 4 + 2	1	14
5 SORV - BLK - AFW - CHR (9) 3 + 2 + 4 + 3	12	5	2 + 4 + 2	1	14
6 SORV - BLK - AFW - FB (10) 3 + 2 + 4 + 2	11				

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 HEP for operator failure to isolate the PORV path is 3.E-3. The credit for this function is limited by hardware failure.

(2) The HEP for operator failure to initiate once through cooling in a small-small LOCA is 7.5E-3.

(3) The HEP for operator failure to initiate shutdown cooling is 1.22 E-3. A credit of 2 is assigned based on a survey of the CE plants.

Table 3.5 SDP Worksheet for St. Lucie, Unit 1 — Medium LOCA (MLOCA) (3"<D<5") [1]

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
High Pressure Safety Injection (HPSI)	1/ 2 high pressure injection trains (1 multi-train system)
High Pressure Recirculation (HPR)	1/ 2 high pressure safety injection trains in recirculation mode [2] (1 multi-train system)
Containment Heat Removal (CHR)	2/4 fan coolers or 1/ 2 containment spray trains with SDC heat exchangers (1 multi-train system)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 MLOCA - CHR (2) 4 + 3	7	6	2	1	9
2 MLOCA - HPR (3) 4 + 3	7	6	2	1	9
3 MLOCA - HPSI (4) 4 + 3	7	6	2	1	9

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 plant P.A. calls this LOCA a small LOCA.

(2) In case of failure of HPSI pumps, LPSI pumps can be used for recirculation.

Table 3.6 SDP Worksheet for St. Lucie, Unit 1 — Large LOCA (LLOCA) (D > 5")

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Safety Injection Tank (SIT)	3/3 unaffected SITs (1 train)
Low Pressure Safety Injection (LPSI)	1/ 2 LPSI trains (1 multi-train system)
High Pressure Recirculation (HPR)	1/ 2 high pressure safety injection trains in recirculation mode[1] (1 multi-train system)
Containment Heat Removal (CHR)	2/4 fan coolers or 1/ 2 containment spray trains with SDC heat exchangers (1 multi-train system)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 LLOCA - CHR (2) 5 + 3	8	7	2	1	10
2 LLOCA - HPR (3) 5 + 3	8	7	2	1	10
3 LLOCA - LPSI (4) 5 + 3	8	7	2	1	10
4 LLOCA - SIT (5) 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.

Note:

(1) In case of failure of HPSI pumps, LPSI pumps can be used for recirculation.

Table 3.7 SDP Worksheet for St. Lucie, Unit 1 — Loss of Offsite Power (LOOP) [1]

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Emergency Diesel Generator (EDG)	1/ 2 Emergency Diesel Generators (1 multi-train system) or crosstie other unit EDG (operator action=1) [2]
Turbine-driven AFW pump (TDAFW)	1/1 TDP trains of AFW (1 ASD train) and steam relief through 1/ 2 ARVs or 1/16 safety valves
Recovery of AC Power in < 2 hrs (REC2)	(Operator action = 1) [3]
Auxiliary Feedwater (AFW)	[1/ 2 MDAFW trains (1 multi-train system) or 1/1 TDAFW train (1 ASD train) with steam relief through 1/ 2 ARVs or 1/16 safety valves] with [long term AFW make up from demineralized water or unit 2 CST [4]]
High Pressure Safety Injection (HPSI)	1/ 2 high pressure injection trains (1 multi-train system)
Recovery of AC Power in < 7 hrs (REC7)	Recovery of offsite power and establishment of long term AFW make up from demineralized water or unit 2 CST(Operator action = 2) [5]
Feed and Bleed (FB)	2/2 PORV (operator action = 2) [6]
High Pressure Recirculation (HPR)	1/ 2 high pressure safety injection trains in recirculation mode (1 multi-train system)
Containment Heat Removal (CHR)	2/4 fan coolers or ½ containment spray trains with SDC heat exchangers (1 multi-train system)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 LOOP - AFW - CHR (3) 2 + 4 + 3	9	4	4 + 2	1	11
2 LOOP - AFW - HPR (4) 2 + 4 + 3	9	4	4 + 2	1	11
3 LOOP - AFW - FB (5) 2 + 4 + 2	8				
4 LOOP - AFW - HPSI (6) 2 + 4 + 3	9	4	4 + 2	1	11
5 LOOP - EDG - REC7 (8) 2 + 4 + 2	8				
6. LOOP - EDG - TDAFW - CHR (10) 2 + 4 + 1 + 3	10	4	4 + 1 + 2	1	12
7 LOOP - EDG - TDAFW - HPR (11) 2 + 4 + 1 + 3	10	4	4 + 1 + 2	1	12
8 LOOP - EDG - TDAFW - FB (12) 2 + 4 + 1 + 2	9				
9 LOOP - EDG - TDAFW - HPSI (13) 2 + 4 + 1 + 3	10	4	4 + 1 + 2	1	12
10 LOOP - EDG - TDAFW - REC2 (14) 2 + 4 + 1 + 1	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 frequency of LOOP is 5.4E-2 per year.

(2) The operator action associated with crosstie has an HEP of 1.1E-02. The hardware contribution is 5.5E-02. Considering the combined unavailability, a credit of 1 is assigned.

(3) Upon loss of heat removal, in approximately 2 hours, core damage would result. The HEP for operator failure to restore offsite power is 0.184. A credit of 1 is assigned.

(4) The HEP for operator failure to provide makeup to CST is 1.55E-5. The HEP for failure to cross tie to U2CST is 3.15 E-4. In this worksheet, a credit of 3 is assigned considering the hardware failures.

(5) In a SBO, batteries are expected to deplete in 6 hours. Based on information from the plant, the CST of unit 1 will not be depleted until 9 hours of hot shutdown. The HEP for operator failure to restore offsite power is 4.E-2. The unit 1 CST has adequate capacity to support this 8 hours of operation. After offsite power is recovered, the operator needs to establish long term AFW make up. The HEP for operator failure to provide makeup to CST is 1.55E-5. The HEP for failure to cross tie to U2CST is 3.15 E-4. A credit of 2 is assigned considering the HEP associated with the recovery of offsite power which is limiting.

(6) The HEP for operator failure to initiate once through cooling in a transient is 7.5E-3.

Table 3.8 SDP Worksheet for St. Lucie, Unit 1 — Steam Generator Tube Rupture (SGTR)

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Auxiliary Feedwater System (AFW)	1/ 2 MDPs of AFW (1 multi-train system) or 1/1 TDP of AFW (1 ASD Train) to the unaffected SGs and steam relief through 1/1 ARV or 1/8 safety valves
Pressure Equalization (EQ)	Operator isolates the ruptured SG (MSIV, SG blowdown line, main steam bypass valve. AFW steam supply) and depressurizes RCS using SG RV and pressurizer spray to less than setpoint of SG relief valves (operator action = 3) (1)
High Pressure Safety Injection (HPSI)	1/ 2 high pressure injection train (1 multi-train system)
Feed and Bleed with 1 PORV (FB1)	1/ 2 PORVs (operator action=2) (2)
Feed and Bleed (FB)	2/2 PORVs (operator action = 2) (2)
Long Term AFW Makeup (LTAFWMU)	Automatic make up from demineralized water (1 train) or operator aligns AFW to take suction from Unit 2 CST or makeup to CST from treated water tank (operator action = 3) (3)
Shutdown Cooling (SDC)	1/3 charging pumps and 1/ 2 LPSI trains with SDC heat exchangers (operator action = 2) (4)
Shutdown Cooling (SDC2)	1/ 2 LPSI trains with SDC heat exchangers with long term RCS makeup from BAM tanks using 1/3 charging pumps and SITs and ultimate isolation of the faulted SG (operator action = 2) (1, 4)
High Pressure Recirculation (HPR)	1/ 2 high pressure safety injection trains in recirculation mode (1 multi-train system)
High Pressure Recirculation (HPR2)	1/ 2 high pressure safety injection trains in recirculation mode with long term RCS makeup from BAM tanks and SITs via 1/3 charging pumps and ultimate isolation of the faulted SG (operator action = 3) (1)
Containment Heat Removal (CHR)	2/4 fan coolers or 1/ 2 containment spray trains with SDC heat exchangers (1 multi-train system)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 SGTR - LTAFWMU - SDC - CHR (4) 3 + 5 + 2 + 3	13	5	5 + 2 + 2	1	15
2 SGTR - LTAFWMU - SDC - HPR (5) 3 + 5 + 2 + 3	13	5	5 + 2 + 2	1	15

3 SGTR - LTAFWMU - SDC - FB1 (6) 3 + 5 + 2 + 2	12	5	5 + 2 + 2	1	15
4 SGTR - LTAFWMU - SDC - HPSI (7) 3 + 5 + 2 + 3	13	5	5 + 2 + 2	1	15
5 SGTR - EQ - SDC2 (9) 3 + 3 + 2	8	5	3 + 2	1	11
6 SGTR - EQ - HPSI (10) 3 + 3 + 3	9	5	3 + 2	1	11
7 SGTR - AFW - CHR (12) 3 + 4 + 3	10	5	4 + 2	1	12
8 SGTR - AFW - HPR2 (13) 3 + 4 + 3	10	5	4 + 2	1	12
9 SGTR - AFW - FB (14) 3 + 4 + 2	9				
10 SGTR - AFW - HPSI (15) 3 + 4 + 3	10	5	4 + 2	1	12

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 HEP for operator failure to terminate leakage on faulted SG is 7.5E-4.

(2) The HEP for operator failure to initiate once through cooling in a transient is 7.5E-3.

(3) The HEP for operator failure to provide makeup to CST is 1.55E-5. The HEP for failure to cross tie to U2CST is 3.15 E-4. In this worksheet, a credit of 3 is assigned considering the hardware failures.

(4) The HEP for operator failure to initiate shutdown cooling is 1.22E-3. A credit of 2 is assigned based on a survey of the CE plants.

Table 3.9 SDP Worksheet for St. Lucie, Unit 1 — Anticipated Transients without Scram (ATWS)

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Turbine Trip (TTP)	Manually trip the turbine (operator action = 2) [1]
Auxiliary Feedwater System (AFW)	2/2 MDPs of AFW (1 train) or 1/1 TDP of AFW (1 ASD Train) to both SGs and steam relief through 2/2 ARVs or 2/16 safety valves
Primary Safety Valves Open (SRVO)	3/3 SRVs and 2/2 PORVs open (1 train)
Emergency Boration (EB)	Operator conducts emergency boration using 1/3 charging pumps from boric acid tank (operator action = 2) [2]
Primary Safety Valves Reclose (SRVR)	3/3 SRVs and 2/2 PORVs reclose (1 train)
Long Term AFW Makeup (LTAFWMU)	Automatic make up from demineralized water (1 train) or operator aligns AFW to take suction from Unit 2 CST or makeup to CST from treated water tank. (operator action = 3) [3]
Shutdown Cooling (SDC)	1/3 charging pumps and 1/ 2 LPSI trains with SDC heat exchangers (operator action = 2) [4]
High Pressure Safety Injection (HPSI)	1/ 2 high pressure injection train (1 multi-train system)
High Pressure Recirculation (HPR)	1/ 2 high pressure safety injection trains in recirculation mode (1 multi-train system)
Containment Heat Removal (CHR)	2/4 fan coolers or 1/ 2 containment spray trains with SDC heat exchangers (1 multi-train system)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 ATWS - TTP (11) 6 + 2	8				
2 ATWS - AFW (10) 6 + 3	9				
3 ATWS - SRVO (9) 6 + 2	8				
4 ATWS - EB (8) 6 + 2	8				
5 ATWS - SRVR - HPSI (7) 6 + 2 + 3	11	8	2 + 2	1	13
6 ATWS - SRVR - HPR (6) 6 + 2 + 3	11	8	2 + 2	1	13
7 ATWS - SRVR - CHR (5) 6 + 2 + 3	11	8	2 + 2	1	13
8 ATWS - LTAFWMU - SDC (3) 6 + 5 + 2	13	8	5 + 2	1	16

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 did not model this operator action. A generic credit of 2 is given to this operator action.

(2) The HEP for operator failure to borate in an ATWS is 6.E-3.

(3) The HEP for operator failure to provide makeup to CST is 1.55E-4. The HEP for failure to cross tie to U2CST is 3.15E-4. In this worksheet, a credit of 3 is assigned considering the hardware failures.

(4) The HEP for operator failure to initiate shutdown cooling is 1.22E-3. A credit of 2 is assigned based on a survey of the CE plants.

Table 3.10 SDP Worksheet for St. Lucie, Unit 1 — Main Steam Line Break Outside (MSLB)

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Closure of 1 MSIV (MSIV)	Closure of ½ MSIVs (1 multi-train system)
Isolation of Feed to Faulted SG (ISOF)	Isolation of feedwater to the faulted SG (1 train)
Auxiliary Feedwater System (AFW)	1/1 MD AFW trains (1 train) or 1/1 TD AFW train (1 ASD train) and steam relief through 1/ 2 ARVs or 1/16 safety valves
High Pressure Injection (HPSI)	1/ 2 HPSI trains (1 multi-train system)
Feed and Bleed with 1 PORV (FB1)	1/ 2 PORVs (operator action=2)[1]
Feed and Bleed (FB)	2/2 PORVs (operator action = 2) [1]
Long Term AFW Makeup (LTAFWMU)	Automatic makeup from demineralized water (1 train) or operator aligns AFW to take suction from Unit 2 CST or makeup to CST from treated water tank (operator action = 3) [2]
Shutdown Cooling (SDC)	1/3 charging pumps and ½ LPSI trains with SDC heat exchangers (operator action = 2)[3]
High Pressure Recirculation (HPR)	1/ 2 high pressure recirculation trains (1 multi-train system)
Containment Heat Removal (CHR)	2/4 fan coolers or 1/ 2 containment spray trains with SDC heat exchangers (1 multi-train system)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 MSLB - LTAFWMU - SDC - CHR (4) 3 + 5 + 2 + 3	13	5	5 + 2 + 2	1	15
2 MSLB - LTAFWMU - SDC - HPR (5) 3 + 5 + 2 + 3	13	5	5 + 2 + 2	1	15
3 MSLB - LTAFWMU - SDC - FB1 (6) 3 + 5 + 2 + 2	12	5	5 + 2 + 2	1	15
4 MSLB - LTAFWMU - SDC - HPSI (7) 3 + 5 + 2 + 3	13	5	5 + 2 + 2	1	15
5 MSLB - AFW - CHR (9) 3 + 3 + 3	9	5	3 + 2	1	11
6 MSLB - AFW - HPR (10) 3 + 3 + 3	9	5	3 + 2	1	11
7 MSLB - AFW - FB (11) 3 + 3 + 2	8				
8 MSLB - AFW - HPSI (12) 3 + 3 + 3	9	5	3 + 2	1	11
9 MSLB - ISOF (13) 3 + 2	5				
10 MSLB - MSIV (14) 3 + 3	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.

Notes:

(1) The HEP for operator failure to initiate once through cooling in a transient is 7.5E-3.

(2) The HEP for operator failure to provide makeup to CST is 1.55E-5. The HEP for failure to cross tie to U2CST is 3.15E-4. In this worksheet, a credit of 3 is assigned considering the hardware failures.

(3) The HEP for operator failure to initiate shutdown cooling is 1.22E-3. A credit of 2 is assigned based on a survey of the CE plants.

Table 3.11 SDP Worksheet for St. Lucie, Unit 1 — Loss of a DC Bus (LDCBUS) [1]

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Isolate Open PORV (ISO)	Closing the block valve (1 train) [2]
Auxiliary Feedwater System (AFW)	1/1 MD AFW trains (1 train) or 1/1 TD AFW train (1 ASD train) and steam relief through 1/1 ARV and 1/16 safety valves
High Pressure Injection (HPSI)	1/1 HPSI trains (1 train)
Long Term AFW Makeup (LTAFWMU)	Automatic makeup from demineralized water (1 train) or operator aligns AFW to take suction from Unit 2 CST or makeup to CST from treated water tank (operator action = 3) [3]
Shutdown Cooling (SDC)	1/ 2 charging pumps and 1/1 LPSI train with SDC heat exchangers with RCS makeup from BAM tanks and SITs (operator action = 2) [4]
High Pressure Recirculation (HPR)	1/1 high pressure recirculation train (1 train)
Containment Heat Removal (CHR)	2/2 fan coolers or 1/1 containment spray train (1 multi-train system)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 LDCBUS - LTAFWMU - SDC (3) 4 + 5 + 2	11	6	5 + 0	1	12
2 LDCBUS - AFW (4,10) 4 + 3	7				
3 LDCBUS - ISO - SDC - CHR (7) 4 + 2 + 2 + 3	11	6	2 + 0 + 0	1	9
4 LDCBUS - ISO - SDC - HPR (8) 4 + 2 + 2 + 2	10	6	2 + 0 + 0	1	9
5 LDCBUS - ISO - HPSI (9) 4 + 2 + 2	8	6	2 + 0	1	9

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 initiating event frequency for loss of a DC bus is 5E-04 per year. On loss of a dc bus, a spurious actuation signal would be generated to open both PORVs. One PORV will fail closed due to the loss of dc, and the other one will open. The open PORV can be isolated by closing the block valve. The turbine driven AFW pump is unaffected by the initiating event, because it can receive power from either DC bus.

(2) The HEP used in the IPE for operator failure to isolate PORV flow path is 3.E-3.

(3) The HEP for operator failure to provide makeup to CST is 1.55E-5. The HEP for failure to cross tie to U2CST is 3.15E-4. In this worksheet, a credit of 3 is assigned considering the hardware failures.

(4) The HEP for operator failure to initiate shutdown cooling is 1.22E-3. A credit of 2 is assigned based on a survey of the CE plants.

Table 3.12 SDP Worksheet for St. Lucie, Unit 1 — Loss of Instrument Air (LIA) [1]

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Auxiliary Feedwater System (AFW)	1/ 2 MD AFW trains(1 multi-train system) or 1/1 TD AFW train (1 ASD train) with 1/16 secondary safety valves
Feed and Bleed with 1 PORV (FB1)	1/ 2 PORVs (operator action = 2) [2]
Feed and Bleed (FB)	2/2 PORVs (operator action = 2) [2]
High Pressure Safety Injection (HPSI)	1/ 2 high pressure injection trains (1 multi-train system)
Long Term AFW Makeup (LTAFWMU))	Align AFW to take suction from Unit 2 CST or makeup to CST from treated water tank. (operator action = 3) [3]
Shutdown Cooling (SDC)	1/3 charging pumps and 1/ 2 LPSI trains with SDC heat exchangers; manual local action to open the heat exchanger outlet valve (operator action=2) [4]
High Pressure Recirculation (HPR)	1/ 2 high pressure safety injection trains in recirculation mode (1 multi-train system)
Containment Heat Removal (CHR)	2/4 fan coolers or 1/ 2 containment spray trains with SDC heat exchangers (1 multi-train system)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 LIA - LTAFWMU - SDC - CHR (4) 2 + 3 + 2 + 3	10	4	3 + 2 + 2	1	12
2 LIA - LTAFWMU - SDC - HPR (5) 2 + 3 + 2 + 3	10	4	3 + 2 + 2	1	12
3 LIA - LTAFWMU - SDC - HPSI (6) 2 + 3 + 2 + 3	10	4	3 + 2 + 2	1	12
4 LIA - LTAFWMU - SDC - FB1 (7) 2 + 3 + 2 + 2	9	4	3 + 2 + 2	1	12
5 LIA - AFW - CHR (9) 2 + 4 + 3	9	4	4 + 2	1	11
6 LIA - AFW - HPR (10) 2 + 4 + 3	9	4	4 + 2	1	11
7 LIA - AFW - HPSI (11) 2 + 4 + 3	9	4	4 + 2	1	11
8 LIA - AFW - FB (12) 2 + 4 + 2	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 frequency of this initiating event is 9.02E-2 per year. St. Lucie Unit 1 has a containment instrument air system and an instrument air system which can be cross connected to the unit 2 system. It is assumed that for this initiating event all the loads on the systems lose air supply. Loss of air to the feedwater control valves and MSIVs would cause a reactor trip. In addition, air supply is lost to the SDC heat exchanger outlet valves, ADVs, and steam dump and bypass valves. The only steam relief capability remaining is through the safety valves. Automatic makeup to the unit 1 CST is not available due to loss of air to the air operated valve. Containment spray control valves fail open on loss of air. It is assumed that containment spray system can operate successfully in this condition.

(2) The HEP for operator failure to initiate once through cooling in a transient is 7.5E-3.

(3) The HEP for operator failure to provide makeup to CST is 1.55E-5. The HEP for failure to cross tie to U2CST is 3.15E-4. In this worksheet, a credit of 3 is assigned considering the hardware failures.

(4) Manual local action with an operator action credit of 2 is given for opening the SDC heat exchanger outlet valve allowing SDC. This action is currently not credited in the P.A., but will be in the next revision of the P.A. as per discussions during benchmarking.

Table 3.13 SDP Worksheet for St. Lucie, Unit 1 — Loss of Component Cooling Water (LCCW) (1)

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Tripping RCPs (RCPTRIP)	Operator trips RCPs to prevent a seal LOCA (operator action=3) (2)
Power Conversion System (PCS)	1/ 2 Main Feedwater trains (operator action = 3) (3)
Auxiliary Feedwater System (AFW)	1/ 2 MD AFW trains (1 multi-train system) or 1/1 TD AFW train (1 ASD train) and steam relief through 1/ 2 ARVs or 1/16 safety valves
Long Term AFW Makeup (LTAFWMU)	Automatic CST makeup from demineralized water (1 train) or operator aligns AFW to take suction from Unit 2 CST or makeup to CST from treated water tank. (operator action = 3) (4)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 LCCW - PCS - LTAFWMU (3) 4 + 3 + 3	10	5	3 + 3	1	12
2 LCCW - PCS - AFW (4) 4 + 3 + 4	11	5	3 + 4	1	13
3 LCCW - RCPTRIP (5) 4 + 3	7	5	3	1	9

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 frequency of loss of CCW is 9.41E-4 per year. CCW cools containment cooling system, HPSI pumps, containment spray pumps, control room air conditioning, containment air compressor, RCP motors and thermal barrier, and shutdown cooling heat exchangers. It is assumed that CCW is not recovered and all equipment that depends on it is failed. A loss of cooling to the RCPs would require the reactor be tripped. It is assumed that once the RCPs are tripped, RCP seal is no long a concern. Loss of other loads on the CCW system would make feed and bleed impossible. Heat removal through the steam generators is not affected by the loss of CCW. The licensee considered the probability of RCP seal failure after the operators successfully trip the RCPs to be negligible and therefor it is not modeled in the worksheet.

(2) The HEP for this action in the P.A. is 3E-04. A generic credit of 3 based on other CE plants is used.

(3) The HEP used in the IPE for operator failure to recover main feedwater is 1.21E-3.

(4) The HEP for operator failure to provide makeup to CST is 1.55E-5. The HEP for failure to cross tie to U2CST is 3.15E-4. In this worksheet, a credit of 3 is assigned considering the hardware failures.

The eighth step in performing a Phase 2 analysis of this finding is to determine the risk significance of the inspection finding due to internal initiating events. (See IMC 0609, Appendix A, Attachment 1, Step 2.4.2).

- Complete Table 6, "Counting Rule Worksheet." These worksheets contain 70 sequences that are required to be solved. Eight have sequence results of 9 and one has a sequence result of 8. The remaining sequences are less than 9. Therefore, the risk significance of the inspection finding due to internal initiating events is 7 or Green.

  The completed Table 6 is shown below.

Counting Rule Worksheet			
Step	**Instructions**		
(1)	Enter the number of sequences with a risk significance equal to 9.	(1)	7
(2)	Divide the result of Step (1) by 3 and round down.	(2)	2
(3)	Enter the number of sequences with a risk significance equal to 8.	(3)	1
(4)	Add the result of Step (3) to the result of Step (2).	(4)	3
(5)	Divide the result of Step (4) by 3 and round down.	(5)	1
(6)	Enter the number of sequences with a risk significance equal to 7.	(6)	0
(7)	Add the result of Step (6) to the result of Step (5).	(7)	1
(8)	Divide the result of Step (7) by 3 and round down.	(8)	0
(9)	Enter the number of sequences with a risk significance equal to 6.	(9)	0
(10)	Add the result of Step (9) to the result of Step (8).	(10)	0
(11)	Divide the result of Step (10) by 3 and round down.	(11)	0
(12)	Enter the number of sequences with a risk significance equal to 5.	(12)	0
(13)	Add the result of Step (12) to the result of Step (11).	(13)	0
(14)	Divide the result of Step (13) by 3 and round down.	(14)	0
(15)	Enter the number of sequences with a risk significance equal to 4.	(15)	0
(16)	Add the result of Step (15) to the result of Step (14).	(16)	0

- If the result of Step 16 is greater than zero, then the risk significance of the inspection finding is of high safety significance (RED).
- If the result of Step 13 is greater than zero, then the risk significance of the inspection finding is at least of substantial safety significance (YELLOW).
- If the result of Step 10 is greater than zero, then the risk significance of the inspection finding is at least of low to moderate safety significance (WHITE).
- If the result of Steps 10, 13, and 16 are zero, then the risk significance of the inspection finding is of very low safety significance (GREEN).

Phase 2 Result: ■ GREEN ☐ WHITE ☐ YELLOW ☐ RED

Table 6 - Counting Rule Worksheet

EXERCISE 5

Exercise 5

Scenario

Use the Generic PWR Risk-Informed Inspection Notebook for this exercise. During an 18-month surveillance test, the 24 hour endurance run, the "B" diesel generator catastrophically failed 1.5 hours into the test. It was subsequently determined that the diesel generator failed because of improperly performed maintenance during the last overhaul of the diesel which had been performed during the last refueling outage. The "B" diesel generator successfully completed a 24 hour endurance run 18 months prior. The licensee had performed the required 1 hour monthly surveillance runs of the diesel generator since the last 24 hour endurance run. However, the monthly surveillance tests did not demonstrate that the "B" diesel generator would successfully perform its safety function for its mission time of 24 hours. The inspectors determined that the criteria for crediting operator recovery of the "B" diesel generator were not satisfied and that credit for recovery of the diesel generator was not appropriate.

Solution

The first step in performing a Phase 2 analysis of this finding is to determine which initiating event worksheets must be evaluated. (See IMC 0609, Appendix A, Attachment 1, Step 2.1)

- Enter the row for the electric power system, diesel generators on Table 2, "Initiators and System Dependency for Generic PWR Nuclear Power Plant."
- The Initiating Event Scenarios column of Table 2 for this row identifies that the loss of offsite power (LOOP) and the LOOP with loss of one class 1E 4.16kV bus (LEAC) worksheets need to be evaluated. The appropriate page from Table 2 is shown below.

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

The second step in performing a Phase 2 analysis of this finding is to determine the initiating event likelihood for each of the worksheets that must be evaluated. (See IMC 0609, Appendix A, Attachment 1, Step 2.2)

- Enter Table 1, "Categories of Initiating Events for Generic PWR Nuclear Power Plant." Because the inception of this condition is unknown, then an exposure time of one-half of the time period since the last successful demonstration of the component should be used (i.e., 18 months ÷ 2 = 9 months). Accordingly, an exposure time of 9 months should be used when evaluating this finding. Therefore, the column for an exposure time of greater than 30 days should be entered.
    - The LOOP initiating event is located in Row II. Therefore, an initiating event likelihood of 2 should be used when solving this initiating event worksheet.
    - The LEAC initiating event is located in Row IV. As a result, an initiating event likelihood of 4 would normally be assigned when solving LEAC sequences; but, because the finding involves a diesel generator and increases the likelihood of a LEAC event, an initiating event likelihood of 2 should be used. (See IMC 0609, Appendix A, Attachment 2, Rule 1.1 and 1.6)

- Table 1 is shown below.

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		

The third step in performing a Phase 2 analysis of this finding is to determine which safety functions are impacted on each of the worksheets for this finding. (See IMC 0609, Appendix A, Attachment 1, Step 2.3.1)

- In a LOOP event, the diesel generators are needed to supply electric power for the motor-driven auxiliary feedwater pumps, the high head safety injection pumps, and the low head safety injection pumps. Accordingly, the emergency AC power (EAC), secondary heat removal (AFW), early inventory high pressure injection (EIHP), and low pressure recirculation (LPR) safety functions are impacted by this finding.

- The LEAC worksheet assumes that a loss of one class 1E 4.16-kV bus occurred (due to the loss of the diesel generator in this scenario); therefore, the safety functions needed to mitigate the event do not rely on the lost diesel generator.

The fourth step in performing a Phase 2 analysis of this finding is to determine which sequences contain the affected safety functions on these worksheets. These sequences need to be solved. (See IMC 0609, Appendix A, Attachment 1, Step 2.3.2).

- All of the sequences on the LOOP and LEAC worksheets need to be solved.

The fifth step in performing a Phase 2 analysis of this finding is to determine the remaining mitigation capability credit for each of these sequences. (See IMC 0609, Appendix A, Attachment 1, Step 2.3.3).

- The success criteria for the EAC function on the LOOP worksheet is: 1/3 diesel generators (1 multi-train system). Therefore, the full credit mitigation capability for the EAC function is 3. (See Table 5, "Remaining Mitigation Capability Credit.") Because one of the diesel generators is not available, the remaining mitigation capability of the EAC function is 1/2 remaining diesel generators. Therefore, the remaining mitigation capability for the EAC function is 3.

- The success criteria for the AFW function on the LOOP worksheet is: 1/3 MDAFW trains (1 multi-train system) or 1/1 TDAFW train (1 ASD train). Therefore, the full credit mitigation capability for the AFW function is 4. (See Table 5, "Remaining Mitigation Capability Credit.") Because one of the diesel generators is not available, the remaining mitigation capability of the AFW function when AC power has not been recovered is 1/2 MDAFW trains (1 multi-train system) or 1/1 TDAFW train (1 ASD train).. Therefore, the remaining mitigation capability for the AFW function is 4.

- The success criteria for the EIHP function on the LOOP worksheet is: 1/3 HHSI trains (1 multi-train system). Therefore, the full credit mitigation capability for the EIHP function is 3. (See Table 5, "Remaining Mitigation Capability Credit.") Because one of the diesel generators is not available, the remaining mitigation capability of the EIHP function when AC power has not been recovered is 1/2 remaining HHSI trains. Therefore, the remaining mitigation capability for the EIHP function is 3.

- The success criteria for the LPR function on the LOOP worksheet is: 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). Therefore, the full credit mitigation capability for the LPR function is 3. (See Table 5, "Remaining Mitigation Capability Credit.") Because one of the diesel generators is not available, the remaining mitigation capability of the LPR function when AC power has not been recovered is 1/2 LHSI trains and with the associated 1/2 RHR heat exchangers or 2/4 RCFCs with cooling flow aligned to CCW (1 multi-train system). Therefore, the remaining mitigation capability for the LPR function is 3.

- The LEAC worksheet assumes that a loss of one class 1E 4.16-kV bus occurred (due to the loss of the diesel generator in this scenario); therefore, the safety functions needed to mitigate the event do not rely on the lost diesel generator and full mitigation credit should be given.

The sixth step in performing a Phase 2 analysis of this finding is to determine if the nature of the degradation is such that an operator could recover the unavailable equipment or function in time to mitigate the assumed initiating event. (See IMC 0609, Appendix A, Attachment 1, Step 2.3.4). For this example, assume that no recovery credit should be given.

The seventh step in performing a Phase 2 analysis of this finding is to determine the sequence risk significance for each of the affected sequences. (See IMC 0609, Appendix A, Attachment 1, Step 2.4.1). Each of the solved worksheets are shown below.

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)	**1/3 Standby Diesel Generators (1 multi-train system)**
Secondary Heat Removal (TDAFW)	1/1 TDAFW pump (1 ASD train) with 1/ 5 safety relief valves per SG that is fed by AFW
Secondary Heat Removal (AFW)	**1/3 MDAFW trains (1 multi-train system)** or 1/1 TDAFW train (1 ASD train)
Recovery of AC Power in < 2 hrs (REC2)	Recovery of AC power (operator action = 1)[1]
Recovery of AC power in < 5 hrs (REC5)	Recovery of AC power (operator action = 2)[3,4]
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)
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)**

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery of Failed Train	Results
1 LOOP - **AFW** - **LPR** (3) 2 + 4 + 3	9	2	4 + 3	0	9
2 LOOP - **AFW** - FB (4) 2 + 4 + 2	8	2	4 + 2	0	8
3 LOOP - **AFW** - **EIHP** (5) 2 + 4 + 3	9	2	4 + 3	0	9
4 LOOP - **EAC** - LPR (7, 11) 2 + 3 + 3 (AC Recovered)	8	2	3 + 3	0	8
5 LOOP - **EAC** - EIHP (8, 13) 2 + 3 + 3 (AC Recovered)	8	2	3 + 3	0	8
6 LOOP - **EAC** - REC5 (9) 2 + 3 + 2	7	2	3 + 2	0	7
7 LOOP - **EAC** - TDAFW - FB (12) 2 + 3 + 1 + 2	8	2	3 + 1 + 2	0	8
8 LOOP - **EAC** - TDAFW - REC2 (14) 2 + 3 + 1 + 1	7	2	3 + 1 + 1	0	7

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

None

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 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 of Failed Train	Results
1 **LEAC** - AFW - LPR (3) 4 + 4 + 3	11	2	4 + 3	0	9
2 **LEAC** - AFW - FB (4) 4 + 4 + 2	10	2	4 + 2	0	8
3 **LEAC** - AFW - EIHP (5) 4 + 4 + 3	11	2	4 + 3	0	9
4 **LEAC** - PORV - LPR (7) 4 + 2 + 3	9	2	2 + 3	0	7
5 **LEAC** - PORV - EIHP (8) 4 + 2 + 3	9	2	2 + 3	0	7
6 **LEAC** - PORV - AFW (9) 4 + 2 + 4	10	2	2 + 4	0	8

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

None

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.

The eighth step in performing a Phase 2 analysis of this finding is to determine the risk significance of the inspection finding due to internal initiating events. (See IMC 0609, Appendix A, Attachment 1, Step 2.4.2).

- Complete Table 6, "Counting Rule Worksheet." These worksheets contain 14 sequences that are required to be solved. Four have sequence results of 9, six have sequence results of 8, and four have sequence results of 7. Therefore, the risk significance of the inspection finding due to internal initiating events is 6 or White.

  The completed Table 6 is shown below.

Counting Rule Worksheet			
Step	**Instructions**		
(1)	Enter the number of sequences with a risk significance equal to 9.	(1)	4
(2)	Divide the result of Step (1) by 3 and round down.	(2)	1
(3)	Enter the number of sequences with a risk significance equal to 8.	(3)	6
(4)	Add the result of Step (3) to the result of Step (2).	(4)	7
(5)	Divide the result of Step (4) by 3 and round down.	(5)	2
(6)	Enter the number of sequences with a risk significance equal to 7.	(6)	4
(7)	Add the result of Step (6) to the result of Step (5).	(7)	6
(8)	Divide the result of Step (7) by 3 and round down.	(8)	2
(9)	Enter the number of sequences with a risk significance equal to 6.	(9)	0
(10)	Add the result of Step (9) to the result of Step (8).	(10)	2
(11)	Divide the result of Step (10) by 3 and round down.	(11)	0
(12)	Enter the number of sequences with a risk significance equal to 5.	(12)	0
(13)	Add the result of Step (12) to the result of Step (11).	(13)	0
(14)	Divide the result of Step (13) by 3 and round down.	(14)	0
(15)	Enter the number of sequences with a risk significance equal to 4.	(15)	0
(16)	Add the result of Step (15) to the result of Step (14).	(16)	0

- If the result of Step 16 is greater than zero, then the risk significance of the inspection finding is of high safety significance (RED).
- If the result of Step 13 is greater than zero, then the risk significance of the inspection finding is at least of substantial safety significance (YELLOW).
- If the result of Step 10 is greater than zero, then the risk significance of the inspection finding is at least of low to moderate safety significance (WHITE).
- If the result of Steps 10, 13, and 16 are zero, then the risk significance of the inspection finding is of very low safety significance (GREEN).

Phase 2 Result: ☐ **GREEN** ■ **WHITE** ☐ **YELLOW** ☐ **RED**

Table 6 - Counting Rule Worksheet

EXERCISE 6

Exercise 6 Phase 2 Analysis

The Saint Lucie Nuclear Power Plant Unit 1 Risk-Informed Inspection Notebook will be used for this example. Consider a hypothetical inspection finding that involves the unavailability of the "A" train safety-related battery charger for 1 day. For this example assume no spare battery chargers are available. Assume that recovery credit is appropriate for the circumstances surrounding this hypothetical finding.

Solution

The first step in performing a Phase 2 analysis of this finding is to determine which initiating event worksheets must be evaluated. (See IMC 0609, Appendix A, Attachment 1, Step 2.1)

- In accordance with Usage Rule 1.7 "Inspection Findings Involving Safety-Related Battery Chargers," the unavailability of the battery charger should be treated in the same fashion as a finding that increases the likelihood of the loss of DC bus special initiator . In addition, each of the of the worksheets specified in Table 2 for the equipment powered by the affected DC train needs to be solved considering this equipment unavailable. Enter the row for the DC system on Table 2, "Initiators and System Dependency St. Lucie Nuclear Power Plant, Unit 1."

- The Initiating Event Scenarios column of Table 2 for this row identifies that all of the worksheets need to be evaluated. Also identify all the trains that will also be rendered unavailable when train "A" of safety-related DC is also unavailable. Table 2 is shown below.

  From Table 2 the following trains of front line systems are also unavailable.

  1. Train "A" of Containment Spray System (CSS)
  2. Train "A" of Containment Cooling System (CCS)
  3. Train "A" of High Pressure Injection System (HPSI)
  4. Train "A" of control room air conditioning system
  5. Train "A" of Low Pressure Safety Injection/Shutdown Cooling System (LPSI/SDC)
  6. Train "A" of Auxiliary Feedwater System (AFW)
  7. Train "A" of Component Cooling Water System (CCW) following a LOOP
  8. Train "A" of Intake Cooling Water System (ICW) following a LOOP
  9. Train "A" of Emergency AC Power System (EDG)
  10. Train "A" Charging Pump
  11. Train "A" Primary PORV

Table 2 Initiators and System Dependency St. Lucie Nuclear Power Plant, Unit 1 [1 2]

Affected Systems	Major Components	Support Systems	Initiating Event
AC Power System (AC)	AC Power Distribution (two safety related buses), AC Instrument Power, and fast transfer	*DC*, HVAC[3]	All
Auxiliary Feedwater (AFW)	Two MDPs (one per SG) with normally closed cross-connections, Unit 1 condensate storage tank (UICST)	AC, ESFAS, *DC*	All except MLOCA and LLOCA
	One TDP to both SGs, UICST	ESFAS, DC, Main Steam	
Long Term AFW Make up	Automatic CST make up from demineralized water through an air operated valve LCV-12-9	IA backed by EDG	
	AFW cross tie to Unit 2 CST through a manual valve	None	
	CST make up from Treated Water Storage Tank (TWST) through TWST pumps and manual valves	Non safety related AC	
CCW	Three pumps in two trains with one CCW heat exchanger in each train and the third pump as a swing pump	AC, ESFAS, ICW, *DC*	All except LICW
Condensate / MFW	Three Condensate pumps	AC, DC, TCW	TRANS, LCCW, SLOCA
	Two MFW pumps	AC, DC, IA, TCW	
Containment Cooling System (CCS)	Four fan coolers	AC, ESFAS, CCW.*DC*	All except LCCW and LICW

Affected Systems	Major Components	Support Systems	Initiating Event
Containment Spray System (CSS)	Two trains with normally closed cross-connections, each with one pump and one shutdown cooling (SDC) heat exchanger	AC, *DC*, ESFAS, HVAC[3], CCW	All except LCCW and LICW
HPSI	Two HPSI trains, pumps shutoff at 1083 psi	AC, *DC*, ESFAS, CCW, HVAC[3]	All except LCCW and LICW
Charging Pumps (CHG)	Three Pumps	AC, *DC*, ESFAS	TRANS, TPCS, SLOCA, SORV, LDCBUS, SGTR, ATWS, MSLB, LIA
DC Power System	Buses, Battery Chargers[4] and Batteries	AC Dist. (without AC, battery capacity is 6 hrs.), HVAC	**All**
EDG	Two EDGs, fuel transfer pumps and storage tanks[5]	*DC*, ESFAS	LOOP
HVAC	Supply and Exhaust Fans	AC, ESFAS, *DC*, CCW (control room air conditioning)	All except LCCW and LICW
Instrument Air (IA)	Two Inside Air Compressors and Four Outside Compressors	AC, TCW (backed by alternate cooling fans)	LIA
Intake Cooling Water (ICW)	Three Pumps in two trains with normally closed cross-connections	AC, ESFAS, *DC*	All
Turbine Cooling Water (TCW)	2 pumps, 2 heat exchangers	AC, DC, ICW	TRANS, LCCW, SLOCA
Main Steam[6]	Two SGs, each with one ARV (can be manually operated on loss of IA), eight safety valves, and one MSIV, Five turbine bypass valves with 45% capacity	*DC*, IA, AC	All except MLOCA and LLOCA
Pressurizer Pressure Relief[6]	Three Safety valves open at 2500 psia, 2 PORVs with block valves open at 2335 psia	*DC*, AC (block valves)	All except MLOCA, LLOCA, LCCW and LICW
RCP	Seals	CCW to thermal barrier heat exchanger (loss on ESFAS), IA for CCW supply and return valves	SLOCA
Safety Injection Tank (SIT)	Four SITs	None	LLOCA
LPSI/SDC[6]	Two LPSI pumps and two shutdown cooling (SDC) heat exchangers	AC, *DC*, ESFAS, *CCW*, HVAC[3]	All except MLOCA, LOOP, LCCW and LICW
Long Term RCS Makeup Sources	Charging pumps from Boric Acid Makeup (BAM) Tanks (5400 gallons each), Alignment of SITs (8183 gallons each) to VCT for CVCS pump operation	AC, DC	SLOCA, SORV, LDCBUS, SGTR

Notes:

1. This table was built using the dependency table of the IPE and subsequent input from licensee during benchmarking. It is assumed that AFW pumps, CCW pumps, LPSI and HPSI pumps require DC power to start.

2. Plant internal event CDF (including internal floods) = 1.99E-5/yr.

3. No cooling medium is needed for HVAC systems for ECCS pump room and switchgear room cooling. HVAC is air cooled.

4. Battery charger capacity is not adequate to carry the SI loads. Inspection finding on the batteries should be treated similar to the loss of the associated DC bus.

5. Each diesel generator set is served by two diesel day oil tanks each of which has a usable capacity of 159 gallons that is sufficient to allow 1.25 hours of full post-accident load condition.

6. Benchmarking identified the following under and overestimation by the notebook. One LPSI train including the associated H'S is estimated to be conservative by one order-of-magnitude in the notebook compared to the plant PSA. No underestimation was noted.
   In addition, difference in assumption between the notebook and the plant P.A. results was noted to affect the results. PSIA credits once-through cooling when both MSIVs fail. This results in lower color for MSIV failures and the operator failure to isolate the affected SG, but higher color for PORVs and the operator failure to conduct feed and bleed.

The second step in performing a Phase 2 analysis of this finding is to determine the initiating event likelihood for each of the worksheets that must be evaluated. (See IMC 0609, Appendix A, Attachment 1, Step 2.2)

- Enter Table 1, "Categories of Initiating Events for St. Lucie Nuclear Power Plant." The exposure time associated with this finding is 1 day. Therefore, the column for an exposure time between less than 3 days should be entered. Since the unavailability of the "A" safety-related battery charger increases the likelihood of a total loss of DC, then by usage rule 1.7 the initiating event likelihood for loss of DC should be increased by one order of magnitude.

  - The transient (TRAN) and loss of power conversion system (TPCS) initiating events are located in Row I. Therefore, an initiating event likelihood of 3 should be used when solving these initiating event worksheets.

  - The loss of offsite power (LOOP) and loss of instrument air (LOIA) initiating events are located in Row II. Therefore, an initiating event likelihood of 4 should be used when solving these initiating event worksheets.

  - The steam generator tube rupture (SGTR), stuck open PORV/SRV (SORV), small LOCA including RCP seal failures (SLOCA) and main steam line break (MSLB) initiating events are located in Row III. Therefore, an initiating event likelihood of 5 should be used when solving these initiating events worksheets.

  - The medium LOCA (MLOCA), loss of CCW (LCCW), loss of ICW (LICW) and loss of a DC bus (LDCBUS) initiating events are located in Row IV. Therefore, except for LDCBUS, an initiating event likelihood of 6 should be used when solving these initiating event worksheets. For LDCBUS an event likelihood of 5 should be used as directed by usage rule 1.7.

  - The large LOCA (LLOCA) initiating event is located in Row V. Therefore, an initiating event likelihood of 7 should be used when solving this worksheet.

  - The anticipated transient without scram (ATWS) initiating event is located in Row VI. Therefore, an initiating event likelihood of 8 should be used when solving this worksheet.

- Table 1 is shown below.

Table 1 Categories of Initiating Events for St. Lucie Nuclear Power Plant, Unit 1

Row	Approximate Frequency	Example Event Type	Initiating Event Likelihood (IEL)		
I	> 1 per 1-10 yr	Reactor Trip (**TRANS**), Loss of Power Conversion System (**TPCS**)	1	2	3
II	1 per 10-10^2 yr	Loss of Offsite Power (**LOOP**), Loss of Instrument Air (**LIA**)	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 (**MSLB**)	3	4	5
IV	1 per 10^3 - 10^4 yr	Medium LOCA (**MLOCA**), Loss of CCW (**LCCW**), Loss of ICW (**LICW**), Loss of a DC Bus (**LDCBUS**)	4	5	6
V	1 per 10^4 - 10^5 yr	Large LOCA (**LLOCA**)	5	6	7
VI	less than 1 per 10^5 yr	**ATWS**, Interfacing System LOCA (ISLOCA)	6	7	8
			> 30 days	3-30 days	< 3 days
			Exposure Time for Degraded Condition		

Note:

(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 for consideration of the probability of a successful manual trip.

The third step in performing a Phase 2 analysis of this finding is to determine which safety functions are impacted on each of the worksheets for this finding. (See IMC 0609, Appendix A, Attachment 1, Step 2.3.1)

- The "A" train of safety-related DC supports the "A" train of HPSI, so the high pressure safety injection and high pressure recirculation safety functions on each of the worksheets are required to be evaluated.
- The "A" train of safety-related DC supports the "A" train of LPSI/SDC, so the low pressure safety injection and shutdown cooling safety functions on each of the worksheets are required to be evaluated.
- The "A" train of safety-related DC supports the "A" train of CSS and CCS, so the containment heat removal function safety on each of the worksheets are required to be evaluated.
- The "A" train of safety-related DC supports the "A" of AFW, so the auxiliary feedwater/secondary heat removal function safety on each of the worksheets are required to be evaluated
- The "A" train of safety-related DC supports the "A" primary PORV, so the feed and bleed safety function on each of the worksheets are required to be evaluated.
- The "A" train of safety-related DC supports the "A" of the EDGs, so the emergency diesel generator safety function on the LOOP worksheet is required to be evaluated.
- The "A" train of safety-related DC supports the "A" charging pump, so the shutdown cooling and emergency boration safety functions on each of the worksheets are required to be evaluated.
- The "A" train of safety-related DC supports the "A" RCS PORV. Since this valve is assumed to be unavailable, the feed and bleed function safety function on each of the worksheets are required to be evaluated.

The fourth step in performing a Phase 2 analysis of this finding is to determine which sequences contain the affected safety functions on these worksheets. These sequences need to be solved. (See IMC 0609, Appendix A, Attachment 1, Step 2.3.2). Therefore, the following sequences need to be solved.

- Sequences 1 through 8 on the TRAN worksheet
- Sequences 1 through 8 on the TPCS worksheet
- Sequences 1 through 6 on the SLOCA worksheet
- Sequences 1 through 6 on the SORV worksheet
- Sequences 1 through 3 on the MLOCA worksheet
- Sequences 1 through 3 on the LLOCA worksheet
- Sequences 1through 10 on the LOOP worksheet
- Sequences 1 through 10 on the SGTR worksheet
- Sequences 2 through 8 on the ATWS worksheet
- Sequences 1 through 8 on the MSLB worksheet
- Sequence 1 through 5 on the LDCBUS worksheet
- Sequences 1 through 8 on the LIA worksheet
- Sequence 2 on the LCCW worksheet
- Sequence 2 on the LICW worksheet

The fifth step in performing a Phase 2 analysis of this finding is to determine the remaining mitigation capability credit for each of these sequences. (See IMC 0609, Appendix A, Attachment 1, Step 2.3.3).

- The success criteria for the HPSI function on each of these worksheets (except LDCBUS) is: ½ high pressure injection trains (1 multi train system). Therefore, the full credit mitigation capability for the HPSI function is 3 (See Table 5, "Remaining Mitigation Capability Credit"). Because train A of HPSI is not available, the remaining mitigation capability of the HPSI function is 1 train or credit of 2.

- The success criteria for the HPSI function on the LDCBUS worksheet is: 1/1 high pressure injection trains (1 train). Therefore, the full credit mitigation capability for the HPSI function is 2 (See Table 5, "Remaining Mitigation Capability Credit"). Because train A of HPSI is not available and because it is assumed that the failure of safety-related DC train B is the initiating event, the remaining mitigation capability of the HPSI function is 0 train or credit of 0.

- The success criteria for the HPR function on each of these worksheets (except LDCBUS) is: ½ high pressure injection trains in the recirculation mode (1 multi train system). Therefore, the full credit mitigation capability for the HPR function is 3 (See Table 5, "Remaining Mitigation Capability Credit"). Because train A of HPSI is not available the remaining mitigation capability of the HPR function is 1 train or credit of 2.

- The success criteria for the HPR function on the LDCBUS worksheet (except LDCBUS) is: ½ high pressure injection trains in the recirculation mode (1 multi train system). Therefore, the full credit mitigation capability for the HPR function is 3 (See ,Table 5, "Remaining Mitigation Capability Credit"). Because train A of HPSI is not available and because it is assumed that the failure of safety-related DC train B is the initiating event, the remaining mitigation capability of the HPSI function is 0 train or credit of 0.

- The success criteria for the AFW on each of these worksheets (except ATWS, MSLB and LDCBUS) is: ½ MD AFW trains (1 multi-train system) or 1/1 TD AFW train (1 ASD train). Therefore, the full credit mitigation capability for the AFW function is 3 (See Table 5, "Remaining Mitigation Capability Credit"). Because train A of AFW is not available, the remaining mitigation capability of the AFW function is 1 train and 1 ASD train or credit of 3.

- The success criteria for the AFW on the ATWS worksheet is: 2/2 MD AFW trains (1 train) or 1/1 TD AFW train (1 ASD train). Therefore, the full credit mitigation capability for the AFW function is 3 (See Table 5, "Remaining Mitigation Capability Credit"). Because train A of AFW is not available, the remaining mitigation capability of the AFW function is 1 ASD train or credit of 1.

- The success criteria for the AFW on the MSLB worksheet is: 1/1 MD AFW trains (1 train) or 1/1 TD AFW train (1 ASD train). Therefore, the full credit mitigation capability for the AFW function is 3 (See Table 5, "Remaining Mitigation Capability Credit"). It should be assumed that the "B" SG is faulted and therefore the B train MD AWF train is unavailable. Because trains A and B of MD AFW are not available, the remaining mitigation capability of the AFW function is 1 ASD train or credit of 1.

- The success criteria for the AFW on the LDCBUS worksheet is: 1/1 MD AFW trains (1 train) or 1/1 TD AFW train (1 ASD train). Therefore, the full credit mitigation capability for the AFW function is 3 (See Table 5, "Remaining Mitigation Capability Credit"). It should be assumed the "B" train DC bus fails so that no DC safety-related buses are available. Because of no trains of AFW would be available, the remaining mitigation capability of the AFW function is 0 or credit of 0.

- The success criteria for the CHR function each of these worksheets (except LDCBUS) is: 2/4 fan coolers or 1/ 2 high containment spray trains with SDC heat exchangers (1 multi train system). Therefore, the full credit mitigation capability for the CHR function is 3 (See Table 5, "Remaining Mitigation Capability Credit.") Because train A of CSS and CCS are not available, the remaining mitigation capability of the CHR function is 1 train or credit of 2.

- The success criteria for the CHR function for the LDCBUS worksheet) is: 2/2 fan coolers or 1/ 2 high containment spray trains with SDC heat exchangers (1 multi train system). Therefore, the full credit mitigation capability for the CHR function is 3 (See Table 5, "Remaining Mitigation Capability Credit.") Because train A of CSS and CCS are not available, the remaining mitigation capability of the CHR function is 0 or credit of 0.

- The success criteria for the LPSI on each of these worksheets is: ½ low pressure injection trains (1 multi train system). Therefore, the full credit mitigation capability for the LPSI function is 3 (See Table 5, "Remaining Mitigation Capability Credit.") Because train B of LPSI is not available the remaining mitigation capability of the LPSI function is 1 train or credit of 2.

- The success criteria for the SDC and SDC2 functions on each of these worksheets is: 1/3 charging pumps and 1/ 2 LPSI trains with SDC heat exchangers (operator action = 2). Therefore, the full credit mitigation capability for the SDC and SDC2 safety functions is 2. The remaining mitigation capability of the SDC safety function has not changed since the credit for the remaining train is not less than the credit for operator action.

- The success criteria for the FB1 functions on each of these worksheets is: 1/ 2 PORVs (operator action = 2). Therefore, the full credit mitigation capability for the FB1 safety function is 2. The remaining mitigation capability of the FB safety function has not changed since the credit for the remaining train is not less than the credit for operator action.

- The success criteria for the FB functions on each of these worksheets (except SORV) is: 2/2 PORVs (operator action = 2). Therefore, the full credit mitigation capability for the FB safety function is 2. Because one PORV is not available, the remaining mitigation capability of the FB safety function is 0 or credit of 0.

- The success criteria for the FB function on the SORV worksheet is: 1/12 PORVs (operator action = 2). Therefore, the full credit mitigation capability for the FB safety function is 2. The remaining mitigation capability of the FB safety function has not changed since the credit for the remaining train is not less than the credit for operator action.

- The success criteria for the SRVO on the ATWS worksheet is: 3/3 SRVs and 2/2 PORVs (1 train). Therefore, the full credit mitigation capability for the SRVO function is 2 (See Table 5, "Remaining Mitigation Capability Credit.") Because the train A PORV is not available, the remaining mitigation capability of the SRVO function is 0 train or credit of 0.

- The success criteria for the EB function on the ATWS worksheet is: operator conducts emergency boration using 1/3 charging pumps from boric acid tank (operator action = 2). Therefore, the full credit mitigation capability for the EB safety function is 2. The remaining mitigation capability of the SDC safety function has not changed since the credit for the remaining train is not less than the credit for operator action.

The sixth step in performing a Phase 2 analysis of this finding is to determine if the nature of the degradation is such that an operator could recover the unavailable equipment or function in time to mitigate the assumed initiating event. (See IMC 0609, Appendix A, Attachment 1, Step 2.3.4). For this example, assume that recovery credit should be given and a value of 1 should be credited.

The seventh step in performing a Phase 2 analysis of this finding is to determine the sequence risk significance for each of the affected sequences. (See IMC 0609, Appendix A, Attachment 1, Step 2.4.1). Each of the solved worksheets are shown below.

Table 3.1 SDP Worksheet for St. Lucie, Unit 1 — Transients (Reactor Trip) (TRANS)

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Power Conversion System (PCS)	1/ 2 Main Feedwater trains and 1/3 condensate pumps (operator action = 3) [1]
Auxiliary Feedwater System (AFW)	1/ 2 MD AFW trains (1 multi-train system) or 1/1 TD AFW train (1 ASD train)
Feed and Bleed with 1 PORV (FB1)	1/ 2 PORVs (operator action=2)
Feed and Bleed (FB)	2/2 PORVs (operator action = 2) [2]
High Pressure Safety Injection (HPSI)	1/ 2 high pressure injection trains (1 multi-train system)
Long Term AFW Makeup (LTAFWMU)	Automatic makeup from demineralized water (1 train) or operator aligns AFW to take suction from Unit 2 CST or makeup to CST from treated water tank (operator action = 3) [3]
Shutdown Cooling (SDC)	1/3 charging pumps and 1/ 2 LPSI trains with SDC heat exchangers (operator action = 2) [4]
High Pressure Recirculation (HPR)	1/ 2 high pressure safety injection trains in recirculation mode (1 multi-train system)
Containment Heat Removal (CHR)	2/4 fan coolers or 1/ 2 containment spray trains with SDC heat exchangers (1 multi-train system)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 TRANS - PCS - LTAFWMU - SDC - CHR(5) **1 + 3 + 5 + 2 + 3**	**14**	**3**	**3 + 5 + 2 + 2**	**1**	**16**
2 TRANS - PCS - LTAFWMU - SDC - HPR (6) **1 + 3 + 5 + 2 + 3**	**14**	**3**	**3 + 5 + 2 + 2**	**1**	**16**
3 TRANS - PCS - LTAFWMU - SDC - HPSI (7) **1 + 3 + 5 + 2 + 3**	**14**	**3**	**3 + 5 + 2 + 2**	**1**	**16**
4 TRANS - PCS - LTAFWMU - SDC - FB1 (8) **1 + 3 + 5 + 2 + 2**	**13**	**3**	**3 + 5 + 2 + 2**	**1**	**16**
5 TRANS - PCS - AFW - CHR (10) **1 + 3 + 4 + 3**	**11**	**3**	**3 + 3 + 2**	**1**	**12**
6 TRANS - PCS - AFW - HPR (11) **1 + 3 + 4 + 3**	**11**	**3**	**3 + 3 + 2**	**1**	**12**
7 TRANS - PCS -AFW - HPSI (12) **1 + 3 + 4 + 3**	**11**	**3**	**3 + 3 + 2**	**1**	**12**
8 TRANS - PCS - AFW - FB (13) **1 + 3 + 4 + 2**	**10**	**3**	**3 + 3 + 0**	**1**	**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.

Notes:

1. The HEP used in the IPE for operator failure to recover main feedwater is 1.21E-3.
2. The HEP for operator failure to initiate once through cooling in a transient is 7.5E-3.
3. The HEP for operator failure to provide makeup to CST is 1.55E-5 . The HEP for failure to cross tie to U2CST is 3.15 E-4. In this worksheet, a credit of 3 is assigned considering the hardware failures.
4. The HEP for operator failure to initiate shutdown cooling is 1.22E-3. A credit of 2 is assigned based on a survey of the CE plants.

Table 3.2 SDP Worksheet for St. Lucie, Unit 1 — Transients without PCS (TPCS)

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Auxiliary Feedwater System (AFW)	1/ 2 MD AFW trains (1 multi-train system) or 1/1 TD AFW train (1 ASD train) and steam relief through 1/ 2 ARVs or 1/16 safety valves
Feed and Bleed with 1 PORV (FB1)	1/ 2 PORVs (operator action=2)
Feed and Bleed (FB)	2/2 PORVs (operator action = 2) (1)
High Pressure Safety Injection (HPSI)	1/ 2 high pressure injection trains (1 multi-train system)
Long Term AFW Makeup (LTAFWMU)	Automatic makeup from demineralized water (1 train) or operator aligns AFW to take suction from trains Unit 2 CST or makeup to CST from treated water tank (operator action = 3) (2)
Shutdown Cooling (SDC)	1/3 charging pumps and 1/ 2 SDC trains with shutdown heat exchangers (operator action = 2) (3)
High Pressure Recirculation (HPR)	1/ 2 high pressure safety injection trains in recirculation mode (1 multi-train system)
Containment Heat Removal (CHR)	2/4 fan coolers or 1/ 2 containment spray trains with SDC heat exchangers (1 multi-train system)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 TPCS - LTAFWMU - SDC - CHR (4) 1 + 5 + 2 + 3	11	3	5 + 2 + 2	1	13
2 TPCS - LTAFWMU - SDC - HPR (5) 1 + 5 + 2 + 3	11	3	5 + 2 + 2	1	13
3 TPCS - LTAFWMU - SDC - HPSI (6) 1 + 5 + 2 + 3	11	3	5 + 2 + 2	1	13
4 TPCS - LTAFWMU - SDC - FB1 (7) 1 + 5 + 2 + 2	10	3	5 + 2 + 2	1	13
5 TPCS - AFW - CHR (9) 1 + 4 + 3	8	3	3 + 2	1	9
6 TPCS - AFW - HPR (10) 1 + 4 + 3	8	3	3 + 2	1	9
7 TPCS -AFW -HPSI (11) 1 + 4 + 3	8	3	3 + 2	1	9
8 TPCS - AFW - FB (12) 1 + 4 + 2	7	3	3 + 0	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) The HEP for operator failure to initiate once through cooling in a transient is 7.5E-3.

(2) The HEP for operator failure to provide makeup to CST is 1.55E-5 The HEP for failure to cross tie to U2CST is 3.15 E-4. In this worksheet, a credit of 3 is assigned considering the hardware failures.
(3) The HEP for operator failure to initiate shutdown cooling is 1.22 E-3. A credit of 2 is assigned based on a survey of the CE plants.

Table 3.3 SDP Worksheet for St. Lucie, Unit 1 — Small LOCA (SLOCA) (1/ 2"<D<3") [1]

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Secondary Heat Removal (SHR)	1/ 2 Main Feedwater trains and 1/3 condensate pumps (operator action = 1) [2] or 1/ 2 MD AFW trains (1 multi-train system) or 1/1 TD AFW train (1 ASD train) and steam relief through 1/ 2 ARVs or 1/16 safety valves
High Pressure Safety Injection (HPSI)	1/ 2 high pressure injection trains (1 multi-train system)
Feed and Bleed (FB)	2/2 PORV (operator action = 2) [3]
Shutdown Cooling (SDC)	1/3 charging pumps and 1/ 2 SDC trains with shutdown heat exchangers with long term AFW makeup and RCS makeup from BAM tanks and SITs (operator action = 2) [4]
High Pressure Recirculation (HPR)	1/ 2 high pressure safety injection trains in recirculation modes (1 multi-train system)
Containment Heat Removal (CHR)	2/4 fan coolers or 1/ 2 containment spray trains with SDC heat exchangers (1 multi-train system)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 SLOCA - SDC - HPR (3) 3 + 2 + 3	8	5	2 + 2	1	10
2 SLOCA - SDC - CHR (4) 3 + 2 + 3	8	5	2 + 2	1	10
3 SLOCA - HPSI (5, 10) 3 + 3	6	5	2	1	8
4 SLOCA - SHR - HPR (7) 3 + 5 + 3	11	5	4 + 2	1	12
5 SLOCA - SHR - CHR (8) 3 + 5 + 3	11	5	4 + 2	1	12
6 SLOCA - SHR - FB (9) 3 + 5 + 2	10	5	4 + 0	1	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.

Notes:(1) The IPE calls this LOCA a small-small LOCA.
(2) The HEP for PCS recovery in the PRA is 0.35. An operator action credit of 1 is assigned.
(3) The HEP for operator failure to initiate once through cooling in a small-small LOCA is 7.5E-3.
(4) The HEP for operator failure to initiate shutdown cooling is 1.22 E-3. A credit of 2 is assigned based on a survey of the CE plants.

Table 3.4 SDP Worksheet for St. Lucie, Unit 1 — Stuck Open Relief Valve (SORV)

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Isolation (BLK)	Operator closes the block valve (1 train) [1]
Auxiliary Feedwater System (AFW)	1/ 2 MD AFW trains (1 multi-train system) or 1/1 TD AFW train (1 ASD train) and steam relief through 1/ 2 ARVs or 1/16 safety valves

High Pressure Safety Injection (HPSI)	1/ 2 high pressure injection trains (1 multi-train system)
Feed and Bleed (FB)	Operator conducts FB using the remaining 1/1 PORV (operator action = 2) [2]
Shutdown Cooling (SDC)	1/3 charging pumps and 1/ 2 SDC trains with shutdown heat exchangers and long term AFW makeup and RCS makeup from BAM tanks and SITs (operator action = 2) [3]
High Pressure Recirculation (HPR)	1/ 2 high pressure safety injection trains in recirculation mode (1 multi-train system)
Containment Heat Removal (CHR)	2/4 fan coolers or 1/ 2 containment spray trains with SDC heat exchangers (1 multi-train system)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 SORV - BLK - SDC - HPR (4) 3 + 2 + 2 + 3	10	5	2 + 2 + 2	1	12
2 SORV - BLK - SDC - CHR (5) 3 + 2 + 2 + 3	10	5	2 + 2 + 2	1	12
3 SORV - BLK - HPSI (6,11) 3 + 2 + 3	8	5	2 + 2	1	10
4 SORV - BLK - AFW - HPR (8) 3 + 2 + 4 + 3	12	5	2 + 3 + 2	1	13
5 SORV - BLK - AFW - CHR (9) 3 + 2 + 4 + 3	12	5	2 + 3 + 2	1	13
6 SORV - BLK - AFW - FB (10) 3 + 2 + 4 + 2	11	5	2 + 3 + 2	1	13

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 HEP for operator failure to isolate the PORV path is 3.E-3. The credit for this function is limited by hardware failure.

(2) The HEP for operator failure to initiate once through cooling in a small-small LOCA is 7.5E-3.

(3) The HEP for operator failure to initiate shutdown cooling is 1.22 E-3. A credit of 2 is assigned based on a survey of the CE plants.

Table 3.5 SDP Worksheet for St. Lucie, Unit 1 — Medium LOCA (MLOCA) (3"<D<5") [1]

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
High Pressure Safety Injection (HPSI)	1/ 2 high pressure injection trains (1 multi-train system)
High Pressure Recirculation (HPR)	1/ 2 high pressure safety injection trains in recirculation mode [2] (1 multi-train system)
Containment Heat Removal (CHR)	2/4 fan coolers or 1/ 2 containment spray trains with SDC heat exchangers (1 multi-train system)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 MLOCA - CHR (2) 4 + 3	7	6	2	1	9
2 MLOCA - HPR (3) 4 + 3	7	6	2	1	9

3 MLOCA - HPSI (4) 4 + 3	7	6	2	1	9

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 plant P.A. calls this LOCA a small LOCA.
(2) In case of failure of HPSI pumps, LPSI pumps can be used for recirculation.

Table 3.6 SDP Worksheet for St. Lucie, Unit 1 — Large LOCA (LLOCA) (D > 5")

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Safety Injection Tank (SIT)	3/3 unaffected SITs (1 train)
Low Pressure Safety Injection (LPSI)	1/ 2 LPSI trains (1 multi-train system)
High Pressure Recirculation (HPR)	1/ 2 high pressure safety injection trains in recirculation mode [1] (1 multi-train system)
Containment Heat Removal (CHR)	2/4 fan coolers or 1/ 2 containment spray trains with SDC heat exchangers (1 multi-train system)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 LLOCA - CHR (2) 5 + 3	8	7	2	1	10
2 LLOCA - HPR (3) 5 + 3	8	7	2	1	10
3 LLOCA - LPSI (4) 5 + 3	8	7	2	1	10
4 LLOCA - SIT (5) 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.

Note:
(1) In case of failure of HPSI pumps, LPSI pumps can be used for recirculation.

(2)

Table 3.7 SDP Worksheet for St. Lucie, Unit 1 — Loss of Offsite Power (LOOP) [1]

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Emergency Diesel Generator (EDG)	1/ 2 Emergency Diesel Generators (1 multi-train system) or crosstie other unit EDG (operator action=1) [2]
Turbine-driven AFW pump (TDAFW)	1/1 TDP trains of AFW (1 ASD train) and steam relief through 1/ 2 ARVs or 1/16 safety valves
Recovery of AC Power in < 2 hrs (REC2)	(Operator action = 1) [3]
Auxiliary Feedwater (AFW)	[1/ 2 MDAFW trains (1 multi-train system) or 1/1 TDAFW train (1 ASD train) with steam relief through 1/ 2 ARVs or 1/16 safety valves] with [long term AFW make up from demineralized water or unit 2 CST [4]]
High Pressure Safety Injection (HPSI)	1/ 2 high pressure injection trains (1 multi-train system)
Recovery of AC Power in < 7 hrs (REC7)	Recovery of offsite power and establishment of long term AFW make up from demineralized water or unit 2 CST(Operator action = 2) [5]
Feed and Bleed (FB)	2/2 PORV (operator action = 2) [6]
High Pressure Recirculation (HPR)	1/ 2 high pressure safety injection trains in recirculation mode (1 multi-train system)
Containment Heat Removal (CHR)	2/4 fan coolers or ½ containment spray trains with SDC heat exchangers (1 multi-train system)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 LOOP - AFW - CHR (3) 2 + 4 + 3	9	4	3 + 2	1	10
2 LOOP - AFW - HPR (4) 2 + 4 + 3	9	4	3 + 2	1	10
3 LOOP - AFW - FB (5) 2 + 4 + 2	8	4	3 + 0	1	8
4 LOOP - AFW - HPSI (6) 2 + 4 + 3	9	4	3 + 2	1	10
5 LOOP - EDG - REC7 (8) 2 + 4 + 2	8	4	3 + 2	1	10
6. LOOP - EDG - TDAFW - CHR (10) 2 + 4 + 1 + 3	10	4	3 + 1 + 2	1	11
7 LOOP - EDG - TDAFW - HPR (11) 2 + 4 + 1 + 3	10	4	3 + 1 + 2	1	11
8 LOOP - EDG - TDAFW - FB (12) 2 + 4 + 1 + 2	9	4	3 + 1 + 0	1	9
9 LOOP - EDG - TDAFW - HPSI (13) 2 + 4 + 1 + 3	10	4	3 + 1 + 2	1	11
10 LOOP - EDG - TDAFW - REC2 (14) 2 + 4 + 1 + 1	8	4	3 + 1 + 1	1	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.					

Notes:(1) The frequency of LOOP is 5.4E-2 per year.

(2) The operator action associated with crosstie has an HEP of 1.1E-02. The hardware contribution is 5.5E-02. Considering the combined unavailability, a credit of 1 is assigned.

(3) Upon loss of heat removal, in approximately 2 hours, core damage would result. The HEP for operator failure to restore offsite power is 0.184. A credit of 1 is assigned.

(4) The HEP for operator failure to provide makeup to CST is 1.55E-5. The HEP for failure to cross tie to U2CST is 3.15 E-4. In this worksheet, a credit of 3 is assigned considering the hardware failures.

(5) In a SBO, batteries are expected to deplete in 6 hours. Based on information from the plant, the CST of unit 1 will not be depleted until 9 hours of hot shutdown. The HEP for operator failure to restore offsite power is 4.E-2. The unit 1 CST has adequate capacity to support this 8 hours of operation. After offsite power is recovered, the operator needs to establish long term AFW make up. The HEP for operator failure to provide makeup to CST is 1.55E-5. The HEP for failure to cross tie to U2CST is 3.15 E-4. A credit of 2 is assigned considering the HEP associated with the recovery of offsite power which is limiting.

(6) The HEP for operator failure to initiate once through cooling in a transient is 7.5E-3.

Table 3.8 SDP Worksheet for St. Lucie, Unit 1 — Steam Generator Tube Rupture (SGTR)

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Auxiliary Feedwater System (AFW)	1/ 2 MDPs of AFW (1 multi-train system) or 1/1 TDP of AFW (1 ASD Train) to the unaffected SGs and steam relief through 1/1 ARV or 1/8 safety valves
Pressure Equalization (EQ)	Operator isolates the ruptured SG (MSIV, SG blowdown line, main steam bypass valve. AFW steam supply) and depressurizes RCS using SG RV and pressurizer spray to less than setpoint of SG relief valves (operator action = 3) [1]
High Pressure Safety Injection (HPSI)	1/ 2 high pressure injection train (1 multi-train system)
Feed and Bleed with 1 PORV (FB1)	1/ 2 PORVs (operator action=2) [2]
Feed and Bleed (FB)	2/2 PORVs (operator action = 2) [2]
Long Term AFW Makeup (LTAFWMU)	Automatic make up from demineralized water (1 train) or operator aligns AFW to take suction from Unit 2 CST or makeup to CST from treated water tank (operator action = 3) [3]
Shutdown Cooling (SDC)	1/3 charging pumps and 1/ 2 LPSI trains with SDC heat exchangers (operator action = 2) [4]
Shutdown Cooling (SDC2)	1/ 2 LPSI trains with SDC heat exchangers with long term RCS makeup from BAM tanks using 1/3 charging pumps and SITs and ultimate isolation of the faulted SG (operator action = 2) [1, 4]
High Pressure Recirculation (HPR)	1/ 2 high pressure safety injection trains in recirculation mode (1 multi-train system)
High Pressure Recirculation (HPR2)	1/ 2 high pressure safety injection trains in recirculation mode with long term RCS makeup from BAM tanks and SITs via 1/3 charging pumps and ultimate isolation of the faulted SG (operator action = 3) [1]
Containment Heat Removal (CHR)	2/4 fan coolers or 1/ 2 containment spray trains with SDC heat exchangers (1 multi-train system)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 SGTR - LTAFWMU - SDC - CHR (4) 3 + 5 + 2 + 3	13	5	5 + 2 + 2	1	15
2 SGTR - LTAFWMU - SDC - HPR (5) 3 + 5 + 2 + 3	13	5	5 + 2 + 2	1	15
3 SGTR - LTAFWMU - SDC - FB1 (6) 3 + 5 + 2 + 2	12	5	5 + 2 + 2	1	15
4 SGTR - LTAFWMU - SDC - HPSI (7) 3 + 5 + 2 + 3	13	5	5 + 2 + 2	1	15
5 SGTR - EQ - SDC2 (9) 3 + 3 + 2	8	5	3 + 2	1	11
6 SGTR - EQ - HPSI (10) 3 + 3 + 3	9	5	3 + 2	1	11
7 SGTR - AFW - CHR (12) 3 + 4 + 3	10	5	3 + 2	1	11
8 SGTR - AFW - HPR2 (13) 3 + 4 + 3	10	5	3 + 2	1	11
9 SGTR - AFW - FB (14) 3 + 4 + 2	9	5	3 + 0	1	9

10 SGTR - AFW - HPSI (15) 3 + 4 + 3	10	5	3 + 2	1	11

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 HEP for operator failure to terminate leakage on faulted SG is 7.5E-4.
(2) The HEP for operator failure to initiate once through cooling in a transient is 7.5E-3.
(3) The HEP for operator failure to provide makeup to CST is 1.55E-5. The HEP for failure to cross tie to U2CST is 3.15 E-4. In this worksheet, a credit of 3 is assigned considering the hardware failures.
(4) The HEP for operator failure to initiate shutdown cooling is 1.22E-3. A credit of 2 is assigned based on a survey of the CE plants.

Table 3.9 SDP Worksheet for St. Lucie, Unit 1 — Anticipated Transients without Scram (ATWS)

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Turbine Trip (TTP)	Manually trip the turbine (operator action = 2)[1]
Auxiliary Feedwater System (AFW)	2/2 MDPs of AFW (1 train) or 1/1 TDP of AFW (1 ASD Train) to both SGs and steam relief through 2/2 ARVs or 2/16 safety valves
Primary Safety Valves Open (SRVO)	3/3 SRVs and 2/2 PORVs open (1 train)
Emergency Boration (EB)	Operator conducts emergency boration using 1/3 charging pumps from boric acid tank (operator action = 2)[2]
Primary Safety Valves Reclose (SRVR)	3/3 SRVs and 2/2 PORVs reclose (1 train)
Long Term AFW Makeup (LTAFWMU)	Automatic make up from demineralized water (1 train) or operator aligns AFW to take suction from Unit 2 CST or makeup to CST from treated water tank. (operator action = 3)[3]
Shutdown Cooling (SDC)	1/3 charging pumps and 1/ 2 LPSI trains with SDC heat exchangers (operatoraction = 2)[4]
High Pressure Safety Injection (HPSI)	1/ 2 high pressure injection train (1 multi-train system)
High Pressure Recirculation (HPR)	1/ 2 high pressure safety injection trains in recirculation mode (1 multi-train system)
Containment Heat Removal (CHR)	2/4 fan coolers or 1/ 2 containment spray trains with SDC heat exchangers (1 multi-train system)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 ATWS - TTP (11) 6 + 2	8				
2 ATWS - AFW (10) 6 + 3	9	8	1	1	10
3 ATWS - SRVO (9) 6 + 2	8	8	0	1	9
4 ATWS - EB (8) 6 + 2	8	8	2	1	11
5 ATWS - SRVR - HPSI (7) 6 + 2 + 3	11	8	2 + 2	1	13
6 ATWS - SRVR - HPR (6) 6 + 2 + 3	11	8	2 + 2	1	13
7 ATWS - SRVR - CHR (5) 6 + 2 + 3	11	8	2 + 2	1	13
8 ATWS - LTAFWMU - SDC (3) 6 + 5 + 2	13	8	5 + 2	1	16

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 did not model this operator action. A generic credit of 2 is given to this operator action.
(2) The HEP for operator failure to borate in an ATWS is 6.E-3.
(3) The HEP for operator failure to provide makeup to CST is 1.55E-4. The HEP for failure to cross tie to U2CST is 3.15E-4. In this worksheet, a credit of 3 is assigned considering the hardware failures.
(4) The HEP for operator failure to initiate shutdown cooling is 1.22E-3. A credit of 2 is assigned based on a survey of the CE plants.

Table 3.10 SDP Worksheet for St. Lucie, Unit 1 — Main Steam Line Break Outside (MSLB)

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Closure of 1 MSIV (MSIV)	Closure of ½ MSIVs (1 multi-train system)
Isolation of Feed to Faulted SG (ISOF)	Isolation of feedwater to the faulted SG (1 train)
Auxiliary Feedwater System (AFW)	1/1 MD AFW trains (1 train) or 1/1 TD AFW train (1 ASD train) and steam relief through 1/ 2 ARVs or 1/16 safety valves
High Pressure Injection (HPSI)	1/ 2 HPSI trains (1 multi-train system)
Feed and Bleed with 1 PORV (FB1)	1/ 2 PORVs (operator action=2)[1]
Feed and Bleed (FB)	2/2 PORVs (operator action = 2) [1]
Long Term AFW Makeup (LTAFWMU)	Automatic makeup from demineralized water (1 train) or operator aligns AFW to take suction from Unit 2 CST or makeup to CST from treated water tank (operator action = 3) [2]
Shutdown Cooling (SDC)	1/3 charging pumps and ½ LPSI trains with SDC heat exchangers (operator action = 2)[3]
High Pressure Recirculation (HPR)	1/ 2 high pressure recirculation trains (1 multi-train system)
Containment Heat Removal (CHR)	2/4 fan coolers or 1/ 2 containment spray trains with SDC heat exchangers (1 multi-train system)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 MSLB - LTAFWMU - SDC - CHR (4) 3 + 5 + 2 + 3	13	5	5 + 2 + 2	1	15
2 MSLB - LTAFWMU - SDC - HPR (5) 3 + 5 + 2 + 3	13	5	5 + 2 + 2	1	15
3 MSLB - LTAFWMU - SDC - FB1 (6) 3 + 5 + 2 + 2	12	5	5 + 2 + 2	1	15
4 MSLB - LTAFWMU - SDC - HPSI (7) 3 + 5 + 2 + 3	13	5	5 + 2 + 2	1	15
5 MSLB - AFW - CHR (9) 3 + 3 + 3	9	5	1 + 2	1	9
6 MSLB - AFW - HPR (10) 3 + 3 + 3	9	5	1 + 2	1	9
7 MSLB - AFW - FB (11) 3 + 3 + 2	8	5	1 + 0	1	7
8 MSLB - AFW - HPSI (12) 3 + 3 + 3	9	5	1 + 2	1	9
9 MSLB - ISOF (13) 3 + 2	5				

10 MSLB - MSIV (14) 3 + 3	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.

Notes:(1) The HEP for operator failure to initiate once through cooling in a transient is 7.5E-3.
(2) The HEP for operator failure to provide makeup to CST is 1.55E-5. The HEP for failure to cross tie to U2CST is 3.15E-4. In this worksheet, a credit of 3 is assigned considering the hardware failures.
(3) The HEP for operator failure to initiate shutdown cooling is 1.22E-3. A credit of 2 is assigned based on a survey of the CE plants.

Table 3.11 SDP Worksheet for St. Lucie, Unit 1 — Loss of a DC Bus (LDCBUS) (1)

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Isolate Open PORV (ISO)	Closing the block valve (1 train) (2)
Auxiliary Feedwater System (AFW)	1/1 MD AFW trains (1 train) or 1/1 TD AFW train (1 ASD train) and steam relief through 1/1 ARV and 1/16 safety valves
High Pressure Injection (HPSI)	1/1 HPSI trains (1 train)
Long Term AFW Makeup (LTAFWMU)	Automatic makeup from demineralized water (1 train) or operator aligns AFW to take suction from Unit 2 CST or makeup to CST from treated water tank (operator action = 3) (3)
Shutdown Cooling (SDC)	1/ 2 charging pumps and 1/1 LPSI train with SDC heat exchangers with RCS makeup from BAM tanks and SITs (operator action = 2) (4)
High Pressure Recirculation (HPR)	1/1 high pressure recirculation train (1 train)
Containment Heat Removal (CHR)	2/4 fan coolers or 1/1 containment spray train (1 multi-train system)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 LDCBUS - LTAFWMU - SDC (3) 4 + 5 + 2	11	5	5 + 0	1	11
2 LDCBUS - AFW (4,10) 4 + 3	7	5	0	1	6
3 LDCBUS - ISO - SDC - CHR (7) 4 + 2 + 2 + 3	11	5	2 + 0 + 2	1	10
4 LDCBUS - ISO - SDC - HPR (8) 4 + 2 + 2 + 2	10	5	2 + 0 + 0	1	8
5 LDCBUS - ISO - HPSI (9) 4 + 2 + 2	8	5	2 + 0	1	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 initiating event frequency for loss of a DC bus is 5E-04 per year. On loss of a dc bus, a spurious actuation signal would be generated to open both PORVs. One PORV will fail closed due to the loss of dc, and the other one will open. The open PORV can be isolated by closing the block valve. The turbine driven AFW pump is unaffected by the initiating event, because it can receive power from either DC bus.
(2) The HEP used in the IPE for operator failure to isolate PORV flow path is 3.E-3.
(3) The HEP for operator failure to provide makeup to CST is 1.55E-5. The HEP for failure to cross tie to U2CST is 3.15E-4. In this worksheet, a credit of 3 is assigned considering the hardware failures.
.(4) The HEP for operator failure to initiate shutdown cooling is 1.22E-3. A credit of 2 is assigned based on a survey of the CE plants.

Table 3.12 SDP Worksheet for St. Lucie, Unit 1 — Loss of Instrument Air (LIA) (1)

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Auxiliary Feedwater System (AFW)	1/ 2 MD AFW trains(1 multi-train system) or 1/1 TD AFW train (1 ASD train) with 1/16 secondary safety valves

Feed and Bleed with 1 PORV (FB1)	1/ 2 PORVs (operator action = 2) [2]
Feed and Bleed (FB)	2/2 PORVs (operator action = 2) [2]
High Pressure Safety Injection (HPSI)	1/ 2 high pressure injection trains (1 multi-train system)
Long Term AFW Makeup (LTAFWMU))	Align AFW to take suction from Unit 2 CST or makeup to CST from treated water tank. (operator action = 3) [3]
Shutdown Cooling (SDC)	1/3 charging pumps and 1/ 2 LPSI trains with SDC heat exchangers; manual local action to open the heat exchanger outlet valve (operator action=2) [4]
High Pressure Recirculation (HPR)	1/ 2 high pressure safety injection trains in recirculation mode (1 multi-train system)
Containment Heat Removal (CHR)	2/4 fan coolers or 1/ 2 containment spray trains with SDC heat exchangers (1 multi-train system)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 LIA - LTAFWMU - SDC - CHR (4) 2 + 3 + 2 + 3	10	4	3 + 2 + 2	1	12
2 LIA - LTAFWMU - SDC - HPR (5) 2 + 3 + 2 + 3	10	4	3 + 2 + 2	1	12
3 LIA - LTAFWMU - SDC - HPSI (6) 2 + 3 + 2 + 3	10	4	3 + 2 + 2	1	12
4 LIA - LTAFWMU - SDC - FB1 (7) 2 + 3 + 2 + 2	9	4	3 + 2 + 2	1	12
5 LIA - AFW - CHR (9) 2 + 4 + 3	9	4	3 + 2	1	10
6 LIA - AFW - HPR (10) 2 + 4 + 3	9	4	3 + 2	1	10
7 LIA - AFW - HPSI (11) 2 + 4 + 3	9	4	3 + 2	1	10
8 LIA - AFW - FB (12) 2 + 4 + 2	8	4	3 + 0	1	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 frequency of this initiating event is 9.02E-2 per year. St. Lucie Unit 1 has a containment instrument air system and an instrument air system which can be cross connected to the unit 2 system. It is assumed that for this initiating event all the loads on the systems lose air supply. Loss of air to the feedwater control valves and MSIVs would cause a reactor trip. In addition, air supply is lost to the SDC heat exchanger outlet valves, ADVs, and steam dump and bypass valves. The only steam relief capability remaining is through the safety valves. Automatic makeup to the unit 1 CST is not available due to loss of air to the air operated valve. Containment spray control valves fail open on loss of air. It is assumed that containment spray system can operate successfully in this condition.

(2) The HEP for operator failure to initiate once through cooling in a transient is 7.5E-3.

(3) The HEP for operator failure to provide makeup to CST is 1.55E-5. The HEP for failure to cross tie to U2CST is 3.15E-4. In this worksheet, a credit of 3 is assigned considering the hardware failures.

(4) Manual local action with an operator action credit of 2 is given for opening the SDC heat exchanger outlet valve allowing SDC. This action is currently not credited in the P.A., but will be in the next revision of the P.A. as per discussions during benchmarking.

Table 3.13 SDP Worksheet for St. Lucie, Unit 1 — Loss of Component Cooling Water (LCCW) [1]

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Tripping RCPs (RCPTRIP)	Operator trips RCPs to prevent a seal LOCA (operator action=3) [2]
Power Conversion System (PCS)	1/ 2 Main Feedwater trains (operator action = 3) [3]
Auxiliary Feedwater System (AFW)	1/ 2 MD AFW trains (1 multi-train system) or 1/1 TD AFW train (1 ASD train) and steam relief through 1/ 2 ARVs or 1/16 safety valves
Long Term AFW Makeup (LTAFWMU)	Automatic CST makeup from demineralized water (1 train) or operator aligns AFW to take suction from Unit 2 CST or makeup to CST from treated water tank. (operator action = 3) [4]

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 LCCW - PCS - LTAFWMU (3) **4 + 3 + 3**	**10**				
2 LCCW - PCS - AFW (4) **4 + 3 + 4**	**11**	**6**	**3 + 3**	**1**	**13**
3 LCCW - RCPTRIP (5) **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.

Notes:

(1) The frequency of loss of CCW is 9.41E-4 per year. CCW cools containment cooling system, HPSI pumps, containment spray pumps, control room air conditioning, containment air compressor, RCP motors and thermal barrier, and shutdown cooling heat exchangers. It is assumed that CCW is not recovered and all equipment that depends on it is failed. A loss of cooling to the RCPs would require the reactor be tripped. It is assumed that once the RCPs are tripped, RCP seal is no long a concern. Loss of other loads on the CCW system would make feed and bleed impossible. Heat removal through the steam generators is not affected by the loss of CCW. The licensee considered the probability of RCP seal failure after the operators successfully trip the RCPs to be negligible and therefor it is not modeled in the worksheet.

(2) The HEP for this action in the P.A. is 3E-04. A generic credit of 3 based on other CE plants is used.

(3) The HEP used in the IPE for operator failure to recover main feedwater is 1.21E-3.

(4) The HEP for operator failure to provide makeup to CST is 1.55E-5. The HEP for failure to cross tie to U2CST is 3.15E-4. In this worksheet, a credit of 3 is assigned considering the hardware failures.

Table 3.14 SDP Worksheet for St. Lucie, Unit 1 — Loss of Intake Cooling Water (LICW) [1]

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Tripping RCPs (RCPTRIP)	Operator trips RCPs to prevent a seal LOCA (operator action = 3) [2]
Auxiliary Feedwater System (AFW)	1/ 2 MD AFW trains (1 multi-train system) or 1 TD AFW train (1 ASD train) and steam relief through 1/ 2 ARVs or 1/16 safety valves
Long Term AFW Makeup (LTAFWMU)	Automatic CST makeup from demineralized water (1 train) or operator align AFW to take suction from Unit 2 CST or makeup to CST from treated water tank. (operator action = 3) [3]

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 LICW - LTAFWMU (2) **4 + 5**	**9**				
2 LICW - AFW (3) **4 + 4**	**8**	**6**	**3**	**1**	**10**

3 LICW - RCPTRIP (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.					

Notes:(1) The frequency of loss of ICW is 2.68E-4 per year. ICW cools CCW and TCW. TCW provides cooling to feedwater pumps, condensate pumps, and instrument air compressors. Loss of TCW would cause PCS to fail. CCW cools containment cooling system, HPSI pumps, containment spray pumps, control room air conditioning, containment air compressor, RCP motors and thermal barrier, and shutdown cooling heat exchangers. It is assumed that CCW is not recovered and all equipment that depends on it is failed. A loss of cooling to the RCPs would require the reactor be tripped. It is assumed that once the RCPs are tripped, RCP seal is no long a concern. Loss of other loads on the CCW system would make feed and bleed impossible. Heat removal through the steam generators is not affected by the loss of CCW.

(2) The HEP for this action in the PRA is 3E-04. A generic credit of 3 based on other CE plants is used.

(3) The HEP for operator failure to provide makeup to CST is 1.55E-5. The HEP for failure to cross tie to U2CST is 3.15E-4. In this worksheet, a credit of 3 is assigned considering the hardware failures.

The eighth step in performing a Phase 2 analysis of this finding is to determine the risk significance of the inspection finding due to internal initiating events. (See IMC 0609, Appendix A, Attachment 1, Step 2.4.2).• Complete Table 6, "Counting Rule Worksheet." These worksheets contain 84 sequences that are required to be solved. Eight have sequence results of 9, four have sequence results of 8 and two have sequence results of 7. The remaining sequences are less than 9. Therefore, the risk significance of the inspection finding due to internal initiating events is 7 or Green.The completed Table 6 is shown below.

Counting Rule Worksheet			
Step	**Instructions**		
(1)	Enter the number of sequences with a risk significance equal to 9.	(1)	12
(2)	Divide the result of Step (1) by 3 and round down.	(2)	3
(3)	Enter the number of sequences with a risk significance equal to 8.	(3)	5
(4)	Add the result of Step (3) to the result of Step (2).	(4)	8
(5)	Divide the result of Step (4) by 3 and round down.	(5)	2
(6)	Enter the number of sequences with a risk significance equal to 7.	(6)	2
(7)	Add the result of Step (6) to the result of Step (5).	(7)	4
(8)	Divide the result of Step (7) by 3 and round down.	(8)	1
(9)	Enter the number of sequences with a risk significance equal to 6.	(9)	1
(10)	Add the result of Step (9) to the result of Step (8).	(10)	2
(11)	Divide the result of Step (10) by 3 and round down.	(11)	0
(12)	Enter the number of sequences with a risk significance equal to 5.	(12)	0
(13)	Add the result of Step (12) to the result of Step (11).	(13)	0
(14)	Divide the result of Step (13) by 3 and round down.	(14)	0
(15)	Enter the number of sequences with a risk significance equal to 4.	(15)	0
(16)	Add the result of Step (15) to the result of Step (14).	(16)	0

- If the result of Step 16 is greater than zero, then the risk significance of the inspection finding is of high safety significance (RED).
- If the result of Step 13 is greater than zero, then the risk significance of the inspection finding is at least of substantial safety significance (YELLOW).
- If the result of Step 10 is greater than zero, then the risk significance of the inspection finding is at least of low to moderate safety significance (WHITE).
- If the result of Steps 10, 13, and 16 are zero, then the risk significance of the inspection finding is of very low safety significance (GREEN).

Phase 2 Result: ☐ GREEN ■ **WHITE** ☐ YELLOW ☐ RED

Table 6 - Counting Rule Worksheet

EXERCISE 7

Example 7 Phase 2 Analysis

The Generic BWR Risk-Informed Inspection Notebook will be used for this example. Consider a hypothetical inspection finding that involves the reactor core isolation cooling (RCIC) pump being unavailable for 28 days. Also, assume that recovery credit is appropriate for the circumstances surrounding this hypothetical finding.

Solution

The first step in performing a Phase 2 analysis of this finding is to determine which initiating event worksheets must be evaluated. (See IMC 0609, Appendix A, Attachment 1, Step 2.1)

- Enter the row for the reactor core isolation cooling system on Table 2, "Initiators and System Dependency for Generic BWR Nuclear Power Plant."
- The Initiating Event Scenarios column of Table 2 for this row identifies that all of the worksheets except large loss of coolant accident (LLOCA), medium loss of coolant accident (MLOCA), loss of service water (LOSW), and anticipated transients without scram (ATWS) as the worksheets that need to be evaluated. The appropriate page from Table 2 is shown below.

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

Affected System		Major Components	Support Systems	Initiating Event Scenarios
Code	**Name**			
DGCW	Diesel generator Cooling Water	Pumps	480 V-AC	All
SW	Service water	5 pumps in Unit 1/ 2 Crib house; shared system supplying a common header	4160 V-AC, 125 V-DC, IA	LOSW
TBCCW	Turbine Building Closed Cooling Water System	2 pumps, 2 HXs, an expansion tank	SW, IA, 4160 V-AC	TRAN, TPCS, SLOCA, IORV, LOOP, ATWS
HPCI	High Pressure Coolant Injection	1 TDP, MOV	125 V-DC, 250 V-DC, Room HVAC	All except LLOCA, LOSW
LPCS	Low Pressure Core Spray	2 Trains or Loops; 1 LPCS pump per train	4160 V-AC, 480 V-AC, 125 V-DC, SW, Pump Room HVAC	All except LOSW
RCIC	**Reactor Core Isolation Cooling**	1 TDP, MOV	125 V-DC, Room HVAC	**All except LLOCA, MLOCA, LOSW, ATWS**
FPS	Fire Protection System	2 diesel fire pumps, MOV	120V AC, SW, 24V Nickel-cadmium batteries	LOSW, LOIA
CRD	Control Rod Drive Hydraulic System	2 MDP, MOV	Non-emergency ESF AC Buses, TBCCW	TRAN, TPCS, SLOCA, IORV, LOOP, ATWS
IA	Instrument Air	2 compressors for each unit plus a shared compressor supplying both units	SW, 480V AC	LOIA
SLC	Standby Liquid Control	2 MDP, 2 explosive valves	480 V-AC, 125 V-DC	ATWS
Room HVAC			DGCW	All
APCV	Augmented Primary Containment Vent	Valves, Dampers	Essential Service Bus, IA backed up by accumulators for each valve operator	All

The second step in performing a Phase 2 analysis of this finding is to determine the initiating event likelihood for each of the worksheets that must be evaluated. (See IMC 0609, Appendix A, Attachment 1, Step 2.2)

- Enter Table 1, "Categories of Initiating Events for Generic BWR Nuclear Power Plant." The exposure time associated with this finding is 28 days. Therefore, the column for an exposure time between 3 and 30 days should be entered. (Note: This finding does not increase the likelihood of any initiating events.)
    - The transient (TRAN) and loss of power conversion system (TPCS) initiating events are located in Row I. Therefore, an initiating event likelihood of 2 should be used when solving these initiating event worksheets.
    - The loss of offsite power (LOOP), inadvertent or stuck open SRVs (IORV), and loss of instrument air (LOIA) initiating events are located in Row II. Therefore, an initiating event likelihood of 3 should be used when solving these initiating event worksheets.
    - The loss of an AC bus (LOAC) initiating event is located in Row III. Therefore, an initiating event likelihood of 4 should be used when solving this initiating event worksheet.
    - The small loss of coolant accident (SLOCA) initiating event is located in Row IV. Therefore, an initiating event likelihood of 5 should be used when solving this initiating event worksheet.
- Table 1 is shown below.

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

Row	Approximate Frequency	Example Event Type	Initiating Event Likelihood (IEL)		
I	> 1 per 1-10 yr	**Transient (Reactor Trip) (TRAN), Loss of Power Conversion System (Loss of condenser, Closure of MSIVs, Loss of feedwater) (TPCS)**	1	2	3
II	1 per 10-10^2 yr	**Loss of offsite power (LOOP), Inadvertent or stuck open SRVs (IORV), Loss of Instrument Air (LOIA)**	2	3	4
III	1 per 10^2 - 10^3 yr	Loss of Service Water (LOSW), **Loss of an AC Bus (LOAC)**	3	4	5
IV	1 per 10^3 - 10^4 yr	**Small LOCA (RCS rupture) (SLOCA)**, Medium LOCA (RCS rupture) (MLOCA)	4	5	6
V	1 per 10^4 - 10^5 yr	Large LOCA (RCS rupture) (LLOCA), ATWS	5	6	7
VI	less than 1 per 10^5 yr	ISLOCA, Vessel rupture	6	7	8
			> 30 days	3-30 days	< 3 days
			Exposure Time for Degraded Condition		

The third step in performing a Phase 2 analysis of this finding is to determine which safety functions are impacted on each of the worksheets for this finding. (See IMC 0609, Appendix A, Attachment 1, Step 2.3.1)

- The RCIC pump is needed for the high pressure injection (HPI) safety function on each of the worksheets that are required to be evaluated.

The fourth step in performing a Phase 2 analysis of this finding is to determine which sequences contain the affected safety functions on these worksheets. These sequences need to be solved. (See IMC 0609, Appendix A, Attachment 1, Step 2.3.2). Therefore, the following sequences need to be solved.

- Sequences 3 and 4 on the TRAN worksheet
- Sequences 3 and 4 on the TPCS worksheet
- Sequences 2 and 3 on the LOIA worksheet
- Sequences 3 and 4 on the LOAC worksheet
- Sequences 3 and 4 on the SLOCA worksheet
- Sequences 4 and 5 on the IORV worksheet
- Sequences 1, 3 and 4 on the LOOP worksheet

The fifth step in performing a Phase 2 analysis of this finding is to determine the remaining mitigation capability credit for each of these sequences. (See IMC 0609, Appendix A, Attachment 1, Step 2.3.3).

- The success criteria for the HPI function on each of these worksheets is: HPCI (1 ASD train) or RCIC (1 ASD train). Therefore, the full credit mitigation capability for the HPI function is 2 (HPCI = 1 + RCIC = 1). (See Table 5, "Remaining Mitigation Capability Credit.")
- Because the RCIC system is not available, the remaining mitigation capability of the HPI function is HPCI (1 ASD train). Therefore, the remaining mitigation capability for the HPI function is 1.
- All of the other safety functions in these sequences are not impacted by this finding. Therefore, full mitigation credit is given for each of them.

The sixth step in performing a Phase 2 analysis of this finding is to determine if the nature of the degradation is such that an operator could recover the unavailable equipment or function in time to mitigate the assumed initiating event. (See IMC 0609, Appendix A, Attachment 1, Step 2.3.4). For this example, assume that recovery credit should be given.

The seventh step in performing a Phase 2 analysis of this finding is to determine the sequence risk significance for each of the affected sequences. (See IMC 0609, Appendix A, Attachment 1, Step 2.4.1). Each of the solved worksheets are shown below.

Table 3.1 SDP Worksheet for Generic BWR — Transients (Reactor Trip) (TRAN)

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:

Power Conversion System (PCS)	1/3 Feedpumps and 1/4 condensate/condensate booster pumps (operator action = 3)
High Pressure Injection (HPI)	HPCI (1 ASD train) or **RCIC (1 ASD train)**
Depressurization (DEP)	1/5 ADS valves (RVs) manually opened (operator action = 2)
Low Pressure Injection (LPI)	1/4 RHR pumps in ½ trains in LPCI Mode (1 multi-train system) or ½ LPCS trains (1 multi-train system)
Containment Heat Removal (CHR)	1/4 RHR pumps in ½ trains with heat exchangers and 1/4 RHRSW pumps in SPC (1 multi-train system)
Containment Venting (CV)	Venting through 8" drywell or wetwell APCV (operator action = 2)
Late Inventory Makeup (LI)	2/2 CRD pumps (operator action = 2)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 TRAN - PCS - CHR - CV (5, 9) 1 + 3 + 3 + 2	9				
2 TRAN - PCS -CHR - LI (4, 8) 1 + 3 + 3 + 2	9				
3 TRAN - PCS - **HPI** - DEP (11) 1 + 3 + 2 + 2	8	2	3 + 1 + 2	1	9
4 TRAN - PCS - **HPI** - LPI (10) 1 + 3 + 2 + 6	12	2	3 + 1 + 6	1	13

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

Operator recovery was assumed for this example. The specific actions credited would be documented here.

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 available and ready for use.

Table 3.2 SDP Worksheet for Generic BWR — Transients without PCS (TPCS)

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
High Pressure Injection (HPI)	HPCI (1 ASD train) or **RCIC (1 ASD train)**
Depressurization (DEP)	1/5 ADS valves (RVs) manually opened (operator action = 2)
Low Pressure Injection (LPI)	1/4 RHR pumps in ½ trains in LPCI Mode (1 multi-train system) or ½ LPCS trains (1 multi-train system)
Containment Heat Removal (CHR)	1/4 RHR pumps in ½ trains with heat exchangers and 1/4 RHRSW pumps in SPC (1 multi-train system)
Containment Venting (CV)	Venting through 8" drywell or wetwell APCV (operator action = 2)
Late Inventory Makeup (LI)	2/2 CRD pumps (operator action = 2)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 TPCS - CHR - CV (4, 8) 1 + 3 + 2	6				
2 TPCS - CHR - LI (3, 7) 1 + 3 + 2	6				
3 TPCS - **HPI** - DEP (10) 1 + 2 + 2	5	2	1 + 2	1	6
4 TPCS - **HPI** - LPI (9) 1 + 2 + 6	9	2	1 + 6	1	10

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

Operator recovery was assumed for this example. The specific actions credited would be documented here.

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 available and ready for use.

Table 3.4 SDP Worksheet for Generic BWR — Loss of Instrument Air (LOIA)[1,2]

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
High Pressure Injection (HPI)	HPCI (1 ASD train) or **RCIC (1 ASD train)**
Depressurization (DEP)	1/5 ADS valves (RVs) manually opened (operator action = 2)
Low Pressure Injection (LPI)	1/4 RHR pumps in ½ trains in LPCI Mode (1 multi-train system) or ½ LPCS trains (1 multi-train system)
Containment Heat Removal (CHR)	1/4 RHR pumps in ½ trains with heat exchangers and 1/4 RHRSW pumps in SPC (1 multi-train system)
Containment Venting (CV)	Venting through 8" drywell or wetwell APCV (operator action = 2)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 LOIA - CHR (2,4) 2 + 3	5				
2 LOIA - **HPI** - LPI (5) 2 + 2 + 6	10	3	1 + 6	1	11
3 LOIA - **HPI** - DEP (6) 2 + 2 + 2	6	3	1 + 2	1	7

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

Operator recovery was assumed for this example. The specific actions credited would be documented here.

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 available and ready for use.

Table 3.5 SDP Worksheet for Generic BWR — Loss of an AC Bus (LOAC)

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
High Pressure Injection (HPI)	HPCI (1 ASD train) or **RCIC (1 ASD train)**
Depressurization (DEP)	1/5 ADS valves (RVs) manually opened (operator action = 2)
Low Pressure Injection (LPI)	½ RHR pumps in 1/1 train in LPCI Mode (1 train) or 1/1 LPCS train (1 train)
Containment Heat Removal (CHR)	½ RHR pumps in 1/1 train with heat exchangers and ½ RHRSW pumps in 1/1 train in SPC (1 train)
Containment Venting (CV)	Venting through 8" drywell or wetwell APCV (operator action = 2)
Late Inventory Makeup (LI)	½ condensate (operator action = 2)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 LOAC - CHR - CV (4,8) 3 + 2 + 2	7				
2 LOAC - CHR - LI (3,7) 3 + 2 + 2	7				
3 LOAC - **HPI** - DEP (10) 3 + 2 + 2	7	4	1 + 2	1	8
4 LOAC - **HPI** - LPI (9) 3 + 2 + 4	9	4	1 + 4	1	10

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

Operator recovery was assumed for this example. The specific actions credited would be documented here.

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 available and ready for use.

Table 3.6 SDP Worksheet for Generic BWR — Small LOCA (SLOCA)

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Early Containment Control (EC)	Passive operation of SP, 7/8 vacuum breakers remain closed and 1/8 open, when needed (1 multi-train system)
Power Conversion System (PCS)	1/3 Feedwater pumps and 1/4 condensate/ condensate booster pumps (operator action = 3)
High Pressure Injection (HPI)	HPCI (1 ASD train) or **RCIC (1 ASD train)**
Depressurization (DEP)	1/5 ADS valves manually opened (operator action = 2)
Low Pressure Injection (LPI)	1/4 RHR pumps in ½ trains in LPCI Mode (1 multi-train system) or ½ LPCS trains (1 multi-train system)
Containment Heat Removal (CHR)	1/4 RHR pumps in ½ trains with heat exchangers and 1/4 RHRSW pumps in SPC (1 multi-train system)
Containment Venting (CV)	Venting through 8" drywell or wetwell APCV (operator action = 2)
Late Inventory Makeup (LI)	1/4 Condensate or 2/2 CRD pumps (operator action = 2)

Circle Affected Functions:		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 SLOCA - PCS - CHR- CV (5,9) 4 + 3 + 3 + 2	12				
2 SLOCA - PCS - CHR - LI (4, 8) 4 + 3 + 3 + 2	12				
3 SLOCA - PCS - **HPI** - LPI (10) 4 + 3 + 2 + 6	15	5	3 + 1 + 6	1	16
4 SLOCA - PCS - **HPI** - DEP (11) 4 + 3 + 2 + 2	11	5	3 + 1 + 2	1	12
5 SLOCA - EC (12) 4 + 3	7				

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

Operator recovery was assumed for this example. The specific actions credited would be documented here.

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 available and ready for use.

Table 3.7 SDP Worksheet for Generic BWR — Inadvertent Opening of Relief Valve (IORV)

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Power Conversion System (PCS)	1/3 Feedwater pumps and 1/4 condensate / condensate booster pumps (operator action = 3)
High Pressure Injection (HPI)	HPCI (1 ASD train) or **RCIC (1 ASD train)**
Control Rod Drive (CRD)	Operator initiates 2/2 CRD pumps (operator action = 2)
Low Pressure Injection (LPI)	1/4 RHR pumps in ½ trains in LPCI Mode (1 multi-train system) or ½ LPCS trains (1 multi-train system)
Containment Heat Removal (CHR)	1/4 RHR pumps in ½ trains with heat exchangers and 1/4 RHRSW pumps in ½ trains in SPC (1 multi-train system)
Containment Venting (CV)	Venting through 8" drywell or wetwell APCV (operator action = 2)

Circle Affected Functions:		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 IORV - PCS - CHR - CV (4) 2 + 3 + 3 + 2	10				
2 IORV - PCS - CRD - CHR (6) 2 + 3 + 2 + 3	10				
3 IORV - PCS - CRD - LPI (7) 2 + 3 + 2 + 6	13				
4 IORV - PCS - **HPI** - CHR (9) 2 + 3 + 2 + 3	10	3	3 + 1 + 3	1	11
5 IORV - PCS - **HPI** - LPI (10) 2 + 3 + 2 + 6	13	3	3 + 1 + 6	1	14

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

Operator recovery was assumed for this example. The specific actions credited would be documented here.

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 available and ready for use.

Table 3.10 SDP Worksheet for Generic BWR — Loss of Offsite Power (LOOP)

Safety Functions Needed:	Full Creditable Mitigation Capability for each Safety Function:
Emergency Power (EAC)	1/1 EDGs (1train) or 1/1 SBO or cross-tie DG (operator action = 1)
Recovery of LOOP in 45 min (RLOOP 45 M)	Recovery of LOOP (operator action = 1)
Recovery of LOOP in 4 hrs (RLOOP 4 HR)	Recovery of LOOP in 4 hrs (operator action = 1)
High Pressure Injection (HPI)	HPCI (1 ASD train) or **RCIC (1 ASD train)**
Depressurization (DEP)	1/5 ADS valves manually opened (operator action = 2)
Low Pressure Injection (LPI)	1/4 RHR trains in ½ trains in LPCI Mode (1 multi-train system) or ½ LPCS trains (1 multi-train system)
Containment Heat Removal (CHR)	1/4 RHR pumps with heat exchangers and 1/4 RHRSW pumps in ½ trains in SPC (1 multi-train system)
Containment Venting (CV)	Venting through 8" drywell or wetwell APCV (operator action = 2)
Late Inventory (LI)	2/2 CRD pumps (operator action = 2)

Circle Affected Functions:		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 LOOP - EAC - **HPI** - RLOOP 45 M (25) 2 + 3 + 2 + 1	8	3	3 + 1 + 1	1	9
2 LOOP - EAC - RLOOP 4 HR (26) 2 + 3 + 1	6				
3 LOOP - **HPI** - DEP (10, 20) 2 + 2 + 2	6	3	1 + 2	1	7
4 LOOP - **HPI** - LPI (9, 19) 2 + 2 + 6	10	3	1 + 6	1	11
5 LOOP - CHR - CV (4, 8, 14, 18, 24) 2 + 3 + 2	7				
6 LOOP - CHR - LI (3, 7, 13, 17, 23) 2 + 3 + 2	7				

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

Operator recovery was assumed for this example. The specific actions credited would be documented here.

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 available and ready for use.

The eighth step in performing a Phase 2 analysis of this finding is to determine the risk significance of the inspection finding due to internal initiating events. (See IMC 0609, Appendix A, Attachment 1, Step 2.4.2).

- Complete Table 6, "Counting Rule Worksheet." These worksheets contain 15 sequences that are required to be solved. Nine have sequence results greater than 9, two have sequence results of 9, one has a sequence result of 8, two have sequence results of 7 and one has a sequence result of 6. Therefore, the risk significance of the inspection finding due to internal initiating events is 6 or White.

  The completed Table 6 is shown below.

Counting Rule Worksheet			
Step	**Instructions**		
(1)	Enter the number of sequences with a risk significance equal to 9.	(1)	**2**
(2)	Divide the result of Step (1) by 3 and round down.	(2)	**0**
(3)	Enter the number of sequences with a risk significance equal to 8.	(3)	**1**
(4)	Add the result of Step (3) to the result of Step (2).	(4)	**1**
(5)	Divide the result of Step (4) by 3 and round down.	(5)	**0**
(6)	Enter the number of sequences with a risk significance equal to 7.	(6)	**2**
(7)	Add the result of Step (6) to the result of Step (5).	(7)	**2**
(8)	Divide the result of Step (7) by 3 and round down.	(8)	**0**
(9)	Enter the number of sequences with a risk significance equal to 6.	(9)	**1**
(10)	Add the result of Step (9) to the result of Step (8).	(10)	**1**
(11)	Divide the result of Step (10) by 3 and round down.	(11)	**0**
(12)	Enter the number of sequences with a risk significance equal to 5.	(12)	**0**
(13)	Add the result of Step (12) to the result of Step (11).	(13)	**0**
(14)	Divide the result of Step (13) by 3 and round down.	(14)	**0**
(15)	Enter the number of sequences with a risk significance equal to 4.	(15)	**0**
(16)	Add the result of Step (15) to the result of Step (14).	(16)	**0**

- If the result of Step 16 is greater than zero, then the risk significance of the inspection finding is of high safety significance (RED).
- If the result of Step 13 is greater than zero, then the risk significance of the inspection finding is at least of substantial safety significance (YELLOW).
- If the result of Step 10 is greater than zero, then the risk significance of the inspection finding is at least of low to moderate safety significance (WHITE).
- If the result of Steps 10, 13, and 16 are zero, then the risk significance of the inspection finding is of very low safety significance (GREEN).

Phase 2 Result: ☐ **GREEN** ■ **WHITE** ☐ **YELLOW** ☐ **RED**

Table 6 - Counting Rule Worksheet