Exercise 1

Scenario

Use the Generic BWR Risk-Informed Inspection Notebook for this exercise. During a monthly surveillance to verify the boron concentration in the standby liquid control storage tank, the licensee identified that the boron concentration was substantially less than that required for the system to fulfill its safety function during an anticipated transients without scram (ATWS) event. It was subsequently determined that the cause of the low boron concentration in the tank was the failure to establish the required boron concentration following maintenance on the tank, which had been performed 28 days earlier. If an ATWS had occurred and standby liquid control (SLC) was ineffective in reducing power due to the low boron concentration, the emergency operating procedures would have directed the operators to perform alternate boron injection to reduce reactor power. The operators were trained on the emergency operating procedures, sufficient time was available to perform alternate boron injection before core damage occurred, the equipment was available to perform alternate boron injection and the reactor building environmental conditions would not have been degraded at that point in the event. The Generic BWR Nuclear Plant has a Mark I containment.

CAUTION: You must have completed the Phase 2 evaluation for this exercise before answering the questions below.

Questions

1. (True/False) For this scenario, all of the initiating event worksheets must be evaluated.

   A) False
   B) True

2. The initiating event likelihood that should be used when evaluating the anticipated transients without scram (ATWS) worksheet is:

   A) 4
   B) 5
   C) 6
   D) 7

3. (True/False) All of the sequences on the ATWS worksheet are required to be solved.

   A) False
   B) True

4. (True/False) It is appropriate to give credit for operator recovery actions.

   A) False
   B) True

5. (True/False) The finding is required to be evaluated using Inspection Manual Chapter 0609, Appendix H, "Containment Integrity Significance Determination Process," for its potential risk contribution to large early release frequency (LERF).

A-9

A) False
B) True

X

IMC 0609 App A Att 1

step 2.6

why don't I get a 2 for operator action

instead of 1 for recovery of failed ~~sep~~ flow

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.

CAUTION: You must have completed the Phase 2 evaluation for this exercise before answering the questions below.

Questions

6. For this scenario, which of the initiating event worksheets must be evaluated?

   A) All
   B) All except ATWS, LCCW, LODC
   C) LOOP, SGTR, SORV, SLOCA, MLOCA, LEAC
   D) All except LLOCA, ATWS, LODC

7. The initiating event likelihood that should be used when evaluating the loss of offsite power with loss of one class 1E 4.16-kV bus (LEAC) worksheet is:

   A) 2
   B) 3
   C) 4 ←
   D) 5

   X should be 4 or

8. What is the result for Sequence 3 on the SLOCA worksheet?

   A) 6
   B) 7 ←
   C) 8
   D) 9

   X giving credit as multi train system 1/2 needed + recovery of failed system ?

9. What is the result for Sequence 3 on the MLOCA worksheet?

   A) 7
   B) 8
   C) 9
   D) 10

   giving credit for single train of mitigation = 2

10. (True/False) A Phase 3 analysis of this finding is not required because the risk significance of the finding is Green.

    phase 3 req'd for seq 7 or less

A) False
B) True

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.

increase IE by one order of magnitude

CAUTION: You must have completed the Phase 2 evaluation for this exercise before answering the questions below.

Questions

11. For this scenario, which of the initiating event worksheets must be evaluated?

    A) All
    B) All except LLOCA
    C) TRAN, TPCS, SLOCA, IORV, LOOP, ATWS
    D) LOIA

12. The initiating event likelihood that should be used when evaluating the loss of instrument air (LOIA) worksheet is:

    A) 1
    B) 2
    C) 3
    D) 4

13. (True/False) All of the sequences on the LOIA worksheet are required to be solved.

    A) False
    B) True

14. What is the result for Sequence 3 on the LOIA worksheet?

    A) 5
    B) 6
    C) 7
    D) 8

15. (True/False) The risk significance of this finding due to internal initiating events is White.

    A) False
    B) True

Exercise 4

Scenario

Use the Generic BWR Risk-Informed Inspection Notebook for this exercise. During a quarterly surveillance test, the "A" residual heat removal service water (RHRSW) pump failed to start. It was subsequently determined that the breaker failed to close because the licensee had not performed the specified preventive maintenance on the breaker and had not overhauled the breaker in 30 years. The breaker had been inadvertently omitted from the preventive maintenance program. Operation of the RHRSW pump was last successfully demonstrated 91 days prior. The RHRSW system is a split train support system. The inspectors determined that the criteria for crediting operator recovery (i.e., replacement of the breaker) of the "A" RHRSW pump were satisfied and that credit for recovery of the pump was appropriate.

$t = \frac{91}{2} = 45 > 30$ days
normally in Standby
increase Likelyhood by
2 orders of magnitude

CAUTION: You must have completed the Phase 2 evaluation for this exercise before answering the questions below.

Questions

16. For this scenario, which of the initiating event worksheets must be evaluated?

A) All
B) SLOCA, IORV, MLOCA, LLOCA
C) All except LLOCA
D) MLOCA, LLOCA

17. The initiating event likelihood that should be used when evaluating the medium loss of coolant accident (MLOCA) worksheet is:

A) 2
B) 3
C) 4
D) 5

18. (True/False) The result for Sequence 1 on the MLOCA worksheet is 9.

A) False
B) True

X

19. What is the dominant accident sequence associated with this finding?

A) TPCS - CHR - LI 6
B) LOIA - CHR 5
C) LOSW - CHR 4 ✓
D) LOOP - CHR - CV 7

X

what above dealing for splittrain support system

20. What is the risk significance of this finding due to internal initiating events?

A) Green
B) White

X

C) Yellow
D) Red

Loop

Loop w/ LEAC

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.

t > 30 days

CAUTION: You must have completed the Phase 2 evaluation for this exercise before answering the questions below.

Loop w/ LEAC

IE -> -2 increase

Questions

21. For this scenario, which of the initiating event worksheets must be evaluated?

A) All
B) All except LLOCA
C) LOOP
D) LOOP, LEAC ←

22. The initiating event likelihood that should be used when evaluating the loss of offsite power with loss of one class 1E 4.16-kV bus (LEAC) worksheet is:

A) 2
B) 3
C) 4
D) 5

23. (True/False) Sequence 2 on the LOOP worksheet (LOOP - AFW - FB) should not be solved when evaluating the LOOP worksheet.

A) False
B) True

24. What is the result for Sequence 5 on the LOOP worksheet?

A) 10
B) 9
C) 8 ←
D) 6

25. What is the risk significance of this finding due to internal initiating events?

A) Green
B) White,
C) Yellow
D) Red

X

9s	4
8s	6
7s	4
6s	–

EXERCISE 1, EXERCISE 3, EXERCISE 4

RISK-INFORMED INSPECTION NOTEBOOK FOR

GENERIC BWR NUCLEAR POWER PLANT

GE, BWR–3 WITH MARK I CONTAINMENT

Prepared by
Brookhaven National Laboratory
Energy Sciences and Technology Department

Prepared for

U. S. Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Division of Systems Analysis and Regulatory Effectiveness

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		

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 or by ARI (for BWRs). 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).

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

Affected System		Major Components	Support Systems	Initiating Event Scenarios
Code	Name			
ADS	Reactor Vessel Pressure Control and Automatic Depressurization System	5 relief Valves (ADS) & 8 safety valves	IA/nitrogen, 125 V-DC	All except LLOCA
PCS	Power Conversion System	3 reactor feed pumps, 4 condensate pumps,4 condensate booster pumps	4160 V-AC, 125 V-DC, TBCCW, IA (1)	TRAN, IORV, SLOCA, ATWS
RHR	Residual Heat Removal	2 Loops, each with 2 RHR pumps & 1 RHR HX, MOVs	4160 V-AC, 125 V-DC, 480V AC, RHRSW, Pump Room HVAC	All
SBCS	Standby Coolant Supply System	2 Valves	Non-emergency ESF AC Buses, SW	LLOCA, MLOCA
AC	AC Power (non-EDG)	4160V AC, 480V AC	125V DC	All
DC	DC Power	125V DC (2 batteries & 4 battery charger), 250V DC (2 batteries & 3 battery charger) (shared between two units)	480V AC	All
EDGs	Emergency Diesel Generators	1 dedicated EDG, 1 shared EDG, & 1 SBO DG	125 V-DC, DGCW, EDG HVAC	LOOP
RHRSW	RHR Service Water	2 Loops, 2 pump-motor set per loop	HVAC, 4160 V-AC, 480 V-AC, 125 V-DC	All
DGCW	Diesel generator Cooling Water	Pumps	480 V-AC	LOOP
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

Notes:

1. IA supplies all AOVs in the FW&C system. Regulating valves fail as is on loss of IA or control signals. RFP regulating valves fail open on loss of IA and the makeup and emergency makeup valves fail closed.

2. The internal event CDF is estimated as 4.6E-6/yr (PSA Model 99A).

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 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)
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	1	3 + 3 + 2		9
2 TRAN - PCS - CHR - LI (4, 8) 1 + 3 + 3 + 2	9	1	3 + 3 + 2		9
3 TRAN - PCS - HPI - DEP (11) 1 + 3 + 2 + 2	8				
4 TRAN - PCS - HPI - LPI (10) 1 + 3 + 2 + 6	12	1	3 + 2 + 6		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 available and ready for use.

Notes:

1. A credit of 3 for operator action to use feed pumps is assigned based on data from other BWR plants.
2. The HEP for DEP is 7E-04. A credit of 2 is assigned based on a survey of similar BWR plants.
3. The HEP for failure to initiate SPC is 2.0E-04. This function is defined as a multi-train system, because the hardware failure dominates.
4. The HEP for initiating containment venting is 3.2E-03. A credit of 2 is assigned based on a survey of similar BWR plants.

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 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)
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**	1	3 + 2		6
2 TPCS - CHR - LI (3, 7) **1 + 3 + 2**	**6**	1	3 + 2		6
3 TPCS - HPI - DEP (10) **1 + 2 + 2**	**5**	1			
4 TPCS - HPI - LPI (9) **1 + 2 + 6**	**9**	1	2 + 6		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 available and ready for use.

Notes:

1. The HEP for DEP is 7E-04. A credit of 2 is assigned based on a survey of similar BWR plants.
2. The HEP for failure to initiate SPC is 2.0E-04. This function is defined as a multi-train system, because the hardware failure dominates.
3. The HEP for initiating containment venting is 3.2E-03. A credit of 2 is assigned based on a survey of similar BWR plants.

Table 3.3 SDP Worksheet for Generic BWR — Transients with Loss of Service Water (LOSW)[1]

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
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)
Containment Heat Removal (CHR)	1/4 RHR pumps in 1/2 trains with heat exchangers and 1/4 RHRSW pumps in 1/2 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 LOSW - CHR (2) 3 + 3	6	1	3		4
2 LOSW - LPI (3) 3 + 3	6	1	3		4
3 LOSW - DEP (4) 3 + 2	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 available and ready for use.

Notes:

1. Service Water (SW) system provides cooling water to major components like HPCI/RCIC, and CS room coolers, instrument air compressors, and turbine-generator. It acts as the ultimate heat sink for the TBCCW and RBCCW systems. It also supplies makeup to the fire water system and main condenser hotwell. Accordingly, in a loss of SW, HPCI, RCIC, and CS are assumed to be lost. CRD is not available as a late injection source. LOSW frequency in the PRA is 2.35E-3.

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)
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**	~~0~~ 2 4-1	3 3	0	~~8~~ 5 6
2 LOIA - HPI - LPI (5) **2 + 2 + 6**	**10**	~~0~~ 2 4-1	2+6 2+6	0	~~8~~ 10 11
3 LOIA - HPI - DEP (6) **2 + 2 + 2**	**6**	4-1	2+2	0	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 available and ready for use.

Notes:

1. Loss of instrument air (LOIA) results in closure of the MSIV and loss of control of the feedwater regulating valves. This is similar to transients without the PCS. In addition, at Generic BWR Nuclear Power Plant, the HPCI and RCIC steamline drain valves require IA, but they reposition for HPCI/RCIC initiation on loss of IA. The valves in the APCV system are all air-operated supplied from IA, but accumulators on each valve is assumed to allow actuations on LOIA. CRD is assumed to be lost due to loss of TBCCW as the cooling source. With HPCI/RCIC injection, failure of SPC leads to core damage since CRD is not available as a late injection source.

2. LOIA initiating frequency is estimated as 1.75E-2.

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)	1/2 RHR pumps in 1/1 train in LPCI Mode (1 train) or 1/1 LPCS train (1 train)
Containment Heat Removal (CHR)	1/2 RHR pumps in 1/1 train with heat exchangers and 1/2 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)	1/2 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	3	2+2		7
2 LOAC - CHR - LI (3,7) **3 + 2 + 2**	7	3	2+2		7
3 LOAC - HPI - DEP (10) **3 + 2 + 2**	7				
4 LOAC - HPI - LPI (9) **3 + 2 + 4**	9	3	2+4		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 available and ready for use.

Notes:

1. Loss of an AC Bus (Bus 13, 14, 18, 19) results in loss of one loop RHR and one loop of CS systems. The IE frequency for each of Bus 13 and 18 is 1.2E-3. The IE frequency for other buses is estimated at 1.2E-4.

2. No separate event tree is provided. Please refer to the TPCS tree.

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 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)
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	4	3 + 3 + 2		12
2 SLOCA - PCS - CHR - LI (4, 8) 4 + 3 + 3 + 2	12	4	3+3+2		12
3 SLOCA - PCS - HPI - LPI (10) 4 + 3 + 2 + 6	15	4	3+2+6		15
4 SLOCA - PCS - HPI - DEP (11) 4 + 3 + 2 + 2	11				
5 SLOCA - EC (12) 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 available and ready for use.

Notes:

1. A credit of 3 for operator action to use feed pumps is assigned based on data from other BWR plants.
2. The HEP for DEP is 7E-04. A credit of 2 is assigned based on a survey of similar BWR plants.
3. The HEP for failure to initiate SPC is 2.0E-04. This function is defined as a multi-train system, because the hardware failure dominates.
4. The HEP for initiating containment venting is 3.2E-03. A credit of 2 is assigned based on a survey of similar BWR plants.

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 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 1/2 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	02	3+3+2		10
2 IORV - PCS - CRD - CHR (6) 2 + 3 + 2 + 3	10	02	3+2+3		10
3 IORV - PCS - CRD - LPI (7) 2 + 3 + 2 + 6	13	02	3+2+6		13
4 IORV - PCS - HPI - CHR (9) 2 + 3 + 2 + 3	10	02	3+2+3		10
5 IORV - PCS - HPI - LPI (10) 2 + 3 + 2 + 6	13	02	3+2+6		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 available and ready for use.

Notes:

1. One relief valve can relieve about 558,000 lbm/hr at 1135 psig. It will result in depressurization of the reactor vessel pressure due to the initiating event. Accordingly, depressurization is not a safety function in this worksheet. IORV frequency in the PRA is 3.3E-2.
2. The HEP for DEP is 7E-04. A credit of 2 is assigned based on a survey of similar BWR plants.
3. The HEP for failure to initiate SPC is 2.0E-04. This function is defined as a multi-train system, because the hardware failure dominates.
4. The HEP for initiating containment venting is 3.2E-03. A credit of 2 is assigned based on a survey of similar BWR plants.

Table 3.8 SDP Worksheet for Generic BWR — Medium LOCA (MLOCA)

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Early Inventory (EI)	HPCI (1 ASD train)
Early Containment Control (EC)	Passive operation of SP, 7/8 vacuum breakers remain closed and 1/8 open, when needed (1 multi-train system)
Depressurization (DEP)	Operator opens 1/ 5 ADS valves (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 with heat exchangers and 1/4 RHRSW pumps in 1/2 trains in SPC mode (1 multi-train system)
Containment Venting (CV)	Venting through 8" drywell or wetwell APCV (operator action = 2)
Late Inventory (LI)	Operator action to add water using SBCS and feedwater system (operator action = 2)

Circle Affected Sequences:		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 MLOCA - CHR - LI (3, 8) 4 + 3 + 2	9	4 ✓	3 + 2	1	9
2 MLOCA - CHR - CV (4, 9) 4 + 3 + 2	9	4	3 + 2	1	9
3 MLOCA - LPI (5, 10) 4 + 6	10	4	6	1	10
4 MLOCA - EI - DEP (11) 4 + 1 + 2	7				
5 MLOCA - EC (12) 4 + 3	7				

chr = 3 multi train RHR SW

recovery is credited → 10

4 + 3 + 2 + 1

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 available and ready for use.

Notes:

1. Operator action to initiate standby coolant supply (SBCS) is assigned a credit of 2. PRA assigns a failure probability of 1.6 E-2.
2. Containment venting (CV) is assigned a credit of 2, based on survey of other BWR plant. PRA assigns a failure probability of 3.2E-3.

Table 3.9 SDP Worksheet for Generic BWR — Large LOCA (LLOCA)

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Early Inventory (EI)	1/4 RHR pumps in 1/2 trains in LPCI mode (1 multi-train system) or 1/2 LPCS trains (1 multi-train system)
Early Containment Control (EC)	Passive operation of SP, 7/8 vacuum breakers remain closed and 1/8 open, when needed (1 multi-train system)
Containment Heat Removal (CHR)	1/4 RHR pump with heat exchangers and 1/4 RHRSW pumps in 1/2 trains in SPC mode (1 multi-train system)
Containment Venting (CV)	Venting through 8" drywell or wetwell APCV (operator action = 2)
Late Inventory (LI)	Operator action to add water using SBCS and feedwater system (operator action = 2)

Circle Affected Functions:		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 LLOCA - CHR - LI (3) **5 + 3 + 2**	**10**	5	3+2		10
2 LLOCA - CHR- CV (4) **5 + 3 + 2**	**10**	5	3+2		10
3 LLOCA - EI (5) **5 + 6**	**11**				
4 LLOCA - EC (6) **5 + 3**	**8**				

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

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

Notes:

1. Operator action to initiate standby coolant supply (SBCS) is assigned a credit of 2. PRA assigns a failure probability of 1.6 E-2.
2. Containment venting (CV) is assigned a credit of 2, based on survey of other BWR plant. PRA assigns a failure probability of 3.2E-3.

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 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 with heat exchangers and 1/4 RHRSW pumps in 1/2 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**	0			
2 LOOP - EAC - RLOOP 4 HR (26) **2 + 3 + 1**	**6**	0			
3 LOOP - HPI - DEP (10, 20) **2 + 2 + 2**	**6**	0			
4 LOOP - HPI - LPI (9, 19) **2 + 2 + 6**	**10**	2	2+6		1P
5 LOOP - CHR - CV (4, 8, 14, 18, 24) **2 + 3 + 2**	**7**	2	3+2		7
6 LOOP - CHR - LI (3, 7, 13, 17, 23) **2 + 3 + 2**	**7**	2	3+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 available and ready for use.

Notes:

1. A dual unit LOOP is assumed. Each unit has a dedicated EDG. It is conservatively assumed that the shared diesel is aligned to the other unit. A operator action credit of 1 is assigned for use of the shared or SBO diesel.

2. PRA defines battery depletion at 4 hrs.

3. In sequences 3 and 4, either EAC or recovery of LOOP in 45 mins is successful. Failure to recover offsite power in 45 mins is assigned an operator action credit of 1.

4. In sequences 5 and 6, either EAC or recovery of LOOP in 4 hrs is successful. In PRA, failure to recover offsite power in 4 hrs in estimated at 1.6E-01. An operator action credit of 1 is assigned.

Table 3.11 SDP Worksheet for Generic BWR — Anticipated Transients without Scram (ATWS)

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Over Pressure Protection (OVERP)	11/13 RVs/SRVs (1 multi-train system)
Reactivity Control (SLC)	1/2 SLC train (operator action = 2)
Recirculation Pump Trip (RPT)	Manual or automatic trip of recirculation pumps (1 multi-train system)
High Pressure Injection (HPI)	HPCI (1 ASD train) or 1/3 Feedwater pumps (1 multi-train system)
Depressurization (DEP)	1/5 ADS valves 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 train (1 multi-train system)
Inhibit ADS and LVI Control (INH)	Operator inhibits ADS and controls RPV level (operator action = 2)
Containment Heat Removal (CHR)	1/4 RHR pumps with heat exchangers and 1/4 RHRSW pump in 1/2 trains in SPC (1 multi-train system)
Containment Venting (CV)	containment 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 ATWS - OVERP (14) **5 + 3**	**8**				
2 ATWS - SLC (11) **5 + 2**	**7**	6	0	2	8
3 ATWS - RPT (13) **5 + 3**	**8**				
4 ATWS - HPI - DEP (10) **5 + 4 + 2**	**11**				
5 ATWS - HPI - LPI (9) **5 + 4 + 6**	**15**	5	4+6		15

6 ATWS - INH (12) 5 + 2	7				
7 ATWS - CHR - CV (4,8) 5 + 3 + 2	10	5	3+2		10
8 ATWS - CHR - LI (3, 7) 5 + 3 + 2	10	5	3+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 available and ready for use.

Notes:

1. The standby liquid control system (SLC) is manually operated. PRA assigns a human error probability of 4.7 E-2. A credit of 2 is assigned.

2. Operator failure to inhibit ADS is estimated at 1.4E-02. An operator action credit of 2 is assigned.

EXERCISE 2 EXERCISE 5

RISK-INFORMED INSPECTION NOTEBOOK FOR

GENERIC PWR NUCLEAR POWER PLANT

Westinghouse PWR, Four-Loop Plant with Large Dry Containment

Prepared by
Brookhaven National Laboratory
Energy Sciences and Technology Department

Prepared for

U. S. Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Division of Systems Analysis and Regulatory Effectiveness

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 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 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 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 2	5	6
V	1 per 10^4 - 10^5 yr	Large LOCA (LLOCA), Loss of Component Cooling Water (LCCW)	5 5	6	7
VI	less than 1 per 10^5 yr	ATWS[1]	6 6	7	8
			> 30 days	3-30 days	< 3 days
			Exposure Time for Degraded Condition		

Notes:

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

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

Affected Systems	Major Components	Support Systems	Initiating Event Scenarios
Auxiliary Feedwater (AFW)	Three MDPs[1,2]	4.16-kV, DC, ESFAS, dedicated room cooling	All except MLOCA, LLOCA
	One TDP[2]	DC, ESFAS	All except MLOCA, LLOCA, SGTR, MSLB
	Feedwater isolation valves for MDPs	480V	SGTR, MSLB
	Feedwater isolation valve for TDP	DC	
Chemical and Volume Control System (CVCS)	Two centrifugal charging pumps (CCP)[3], 160 gpm @ 2575 psi	4.16-kV, 480V, DC, CCW, room cooling [3]	SGTR, ATWS
	Two boric acid transfer pumps[3]		ATWS
Component Cooling Water System (CCW)	Three trains, each with one pump	4.16-kV, DC, ECW, ESFAS	LCCW
Electric Power System	Three Class 1E 4.16-kV buses	EAB HVAC, DC	All
	Three Standby Diesel Generators [4]	DC, ESFAS, ECW	LOOP, LEAC
	Three trains of Class 1E 480V load centers and motor control centers	4.16kV, DC, EAB HVAC	All
	Class 1E vital 120V AC (4 trains)	DC, 480V, EAB HVAC	All
	Four Class 1E 125V DC distribution buses, each supplied by two chargers and one battery. The duration of the batteries is 6 to 8 hours.	480V, EAB HVAC	All
Engineered Safeguards Features Actuation System (ESFAS)	Three actuation trains, each with a load sequencer	120V vital AC, DC	All
Essential Cooling Water System (ECWS)	Three trains, each with one pump	4.16-kV, 480V (for MOVs), DC, ESFAS	All

High Head Safety Injection (HHSI) System	Three pumps (800 gpm @1275 psi, shutoff head = 1650 psid)	4.16-kV, 480V, DC, ESFAS, SI pump room cooling[8]	All except LLOCA, ATWS, LODC
Instrument Air (IA)	Two IA compressors (per unit). Back up is two station air compressors	Offsite power, BOP diesel[5]	LOIA
Low Head Safety Injection (LHSI) System	Three pumps	4.16-kV, 480V, DC, ESFAS, SI pump room cooling[8]	All except ATWS, LCCW, LODC
Main Steam Isolation System	For each steam generator: one MSIV [FW isolation and Control Valves [10]]	Offsite power and IA, DC, ESFAS	SGTR, MSLB
	For each steam generator: one PORV	480V, DC, 120V vital AC	All except LLOCA, and MLOCA
	For each steam generator: five safety relief valves	None	TPCS, LOOP, ATWS, LEAC
Primary Relief System	Two PORVs	DC [9]	TPCS, SLOCA, SORV, LOOP, SGTR, ATWS, MSLB, LEAC
	Two block valves	480V [9]	SORV
	Pressurizer normal spray	DC (for valves). RCPs 1A and 1D for two spray valves, IA	SGTR
	Pressurizer auxiliary spray	DC (for valve), CVCS (CCP) flow, IA	
	Three safety relief valves	None	ATWS
Reactor Containment Fan Coolers (RCFCs)	Three trains, each with two cooler units	480V, DC, ESFAS, CCW	TPCS, SLOCA, SORV, MLOCA, LLOCA, LOOP, SGTR, MSLB, LEAC
Reactor Coolant Pump Seal Cooling (RCP)	Seals and thermal barriers of four Reactor Coolant Pumps (RCP)	CCW, CVCS. The success criteria is 1 / 3 CCW pumps to the RCP thermal barriers (1 multi-train system) or 1 / 2 centrifugal charging pumps for RCP seal injection (1 multi-train system)	SLOCA

Residual Heat Removal System (RHRS)	Three trains; pumps, valves, and heat exchangers	480V, DC, CCW	TPCS, SLOCA, SORV, MLOCA, LLOCA, LOOP, SGTR, MSLB, LEAC
SI Pump Room Cooling[8]	Supplemental coolers and three manual valves in the chilled water line	480V, ECW	TPCS, SLOCA, SORV, MLOCA, LLOCA, LOOP, SGTR, MSLB, LEAC

Notes:

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

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

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

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

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

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

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

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

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

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

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

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

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 TPCS - AFW - LPR (3) 1 + 4 + 3	8	1	3 + 2	0	6
2 TPCS - AFW - FB (4) 1 + 4 + 2	7	1	3 + 2	0	6
3 TPCS - AFW - EIHP (5) 1 + 4 + 3	8	1 1	3 + 2 4 + 2	0 1	6 8

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

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

Notes:

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

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

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

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

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

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

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

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

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

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

Notes:

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

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

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

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

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

Circle Affected Functions		**IEL**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Recovery Credit**	**Results**
1 MLOCA - LPR (2) 4 + 3	7	4	2		6
2 MLOCA - LPI (3) 4 + 3	7	4	2		6
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:

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

Note:

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

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

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

Safety Functions Needed: **Early Inventory, LP Injection (EILP)** **Low Pressure Recirculation (LPR)**		**Full Creditable Mitigation Capability for Each Safety Function:** ½ LHSI pumps (1 multi-train system) ½ LHSI pumps with associated 1/3 RHR heat exchangers or 2/6 RCFCs with cooling flow from CCW (1 multi-train system)			
Circle Affected Functions		**IEL**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Recovery Credit**	**Results**
1 LLOCA - LPR (2) 5 + 3	8	5	2		7
2 LLOCA - EILP (3) 5 + 3	8	5 ~~5~~	2 ~~2~~	1	8 ~~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. IPE indicates that mitigation of a large LOCA does not require accumulators. Furthermore, one loop and the associated ECCS injection is assumed not to be available due to the location of the break.

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

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Emergency AC Power (EAC)	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 Credit	Results	
1 LOOP - AFW - LPR (3) 2 + 4 + 3	9	2	3 + 2 4 + 3	0	7 9	9
2 LOOP - AFW - FB (4) 2 + 4 + 2	8	2	3 + 2	0	7	8
3 LOOP - AFW - EIHP (5) 2 + 4 + 3	9	2 2	3 + 2 4 + 2	1	8 7	9
4 LOOP - EAC - LPR (7, 11) 2 + 3 + 3 (AC Recovered)	8	2	2 + 2		6	8
5 LOOP - EAC - EIHP (8, 13) 2 + 3 + 3 (AC Recovered)	8	2 2	2 + 2 3 + 2	1	8 6	8
6 LOOP - EAC - REC5 (9) 2 + 3 + 2	7	2	2 + 2		6	7
7 LOOP - EAC - TDAFW - FB (12) 2 + 3 + 1 + 2 (AC Recovered)	8	2	2 + 1 + 0	0	5	8

8 LOOP - EAC - TDAFW - REC2 (14) 2 + 3 + 1 + 1	7	2	2 A1 AD	0	5	7

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

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

Notes:

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

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

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

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

7 SGTR - AFW - FB (11) 3 + 3 + 2	8	3	2 + 2		7
8 SGTR - AFW - EIHP (12) 3 + 3 + 3	9	3 3	3 + 2 2 + 2	1	7 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 IPE states that long-term RWST makeup and AFWST makeup are not addressed in current plant procedures or training. The licensee also stated that such long-term makeup is not required or modeled in the licensee's event trees. If both pressure equalization and isolation of faulted SG failed, the loss of primary inventory through the faulted SG will increase. Hence, we assumed that the RWST would be eventually depleted, with subsequent core damage.

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

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

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

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

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

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

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

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 MSLB - FWVC - STIN (3) 3 + 2 + 1	6	3			
2 MSLB - AFW - LPR (5) 3 + 3 + 3	9	3	2+2		7
3 MSLB - AFW - FB (6) 3 + 3 + 2	8	3	2+2		7
4 MSLB - EIHP - FWVC (8) 3 + 3 + 2	8	33	2 + 2 2 + 2	1	78
5 MSLB - EIHP - AFW (9) 3 + 3 + 3	9	33	2 + 3 2+2	1	79
6 MSLB - MSIV (10) 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. When safety function MSIV fails, a major concern is pressurized thermal shock (PTS). We assumed if two MSIVs fail to close it leads to core damage. If one MSIV fail to close, the sequences provides mitigation capabilities. If all MSIVs close then the event is covered under TPCS.

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

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

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

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
RCP Trip (RCP)	Operator trips the RCPs to prevent a seal LOCA (operator action = 2) [2]
High Pressure Injection (EIHP)	1/3 HHSI trains (1 multi-train system)
Secondary Heat Removal (AFW)	1/3 MDAFW trains (1 multi-train system) or 1/1 TDAFW train (1 ASD train)

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results
1 LCCW - AFW (2) 5 + 4	9	5	3		8
2 LCCW - EIHP (3) 5 + 3	8	5 5	2 2	1	8 7
3 LCCW - RCP (4) 5 + 2	7				

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

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

Notes:

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

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

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

Safety Functions Needed: Secondary Heat Removal (AFW)		Full Creditable Mitigation Capability for Each Safety Function: ½ MDAFW train (1 multi-train system) or 1/1 TDAFW train (1 ASD train)			
Circle Affected Functions		**IEL**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Recovery Credit**	**Results**
1 LODC AFW (2) 2 + 4	6	2	3		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. There are 4 DC buses at the plant. Loss of 125V DC Class 1E channel I (bus E1A11) or channel III (bus E1B11) will result in the closure of all MSIVs. It will also cause the closure of all main feedwater isolation and control valves. For bus E1B11, no charging pumps are affected. The systems that are affected by bus E1A11 are: EDG 11, breakers on the 4.16-kV AC bus E1A are disabled (local, manual actions are required to open or close the breakers), train A of ECW (DC power required to start, but not to run), train A of essential chilled water(ECH) (DC power required to start, but not to run), train A of CCW (DC power required to start, but not to run), component cooling supply and return for the CCPs is split, all MSIVs close, turbine bypass is inoperable , MDAFW pump 11, charging pump 1B , HP SI pump 1A , pressurizer PORV PCV655A (fails closed), LPSI pump 1A , containment spray pump A, RHR pump A, and two fan coolers. Feed/Bleed cannot be implemented because 2 / 2 pressurizer PORVs are required to open, but one is closed. The frequency of loss of DC bus E1A11 is 5E-3per year, and of DC bus E1B11 is 5E-3 per year. Hence, the frequency of the loss of any of these two buses is 1.0E-2 per year.

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

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

Circle Affected Functions		IEL	Remaining Mitigation Capability Rating for Each Affected Sequence	Recovery Credit	Results	
1 LEAC - AFW - LPR (3) 4 + 4 + 3	11	2	3+2		7	9
2 LEAC - AFW - FB (4) 4 + 4 + 2	10	2	3+2		7	8
3 LEAC - AFW - EIHP (5) 4 + 4 + 3	11	4 2	4+2 3+2	1	7 11	9
4 LEAC - PORV - LPR (7) 4 + 2 + 3	9	2	2+2		6	7
5 LEAC - PORV - EIHP (8) 4 + 2 + 3	9	2 4	2+2 2+2	1	6 9	7
6 LEAC - PORV - AFW (9) 4 + 2 + 4	10	2	2+3		7	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 plant has three Class 1E 4.16-kV buses. The dominant impact is the loss of Class 1E 4.16-kV bus E1A because bus E1B does not support a charging pump, and bus E1C does not support a pressurizer PORV. Loss of Class 1E 4.16-kV bus E1A has the following impact: EDG11 lost; the battery charger of the Class 1E 125V DC buses E1A11 and E1D11 lose power, and the batteries will eventually fail due to depletion; channels I and II of Class 1E Vital 120V AC fail and as a result, SSPS train R is lost (reactor is tripped) and ESFAS train A is lost; MDAFW pump 11 is lost; SG PORVs SGA and SGD are modeled by the licensee as failing to operate on loss of AC power; charging pump 1B is lost; HP SI pump 1A is lost; block valve of pressurizer PORV PCV655A loses power; LP SI pump 1A; containment spray pump A is lost; SI recirculation pump A is lost; it appears that each RHR pump can be powered from two Class 1E 4.16-kV buses, and hence no RHR pump is lost; and reactor coolant fan coolers 11A and 12A are lost. We assume that one train of ECW and CCW will also be unavailable. When Vital 4.16 kV AC Bus E1A is lost, there is not motive power available to close the block valve of a stuck open PORV.

EXERCISE 2

4s	
5s	
6s	1
7s	1
8s	11111111 = 8
9s	1111 = 4
>9	1

EXERCISE 2

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. 3 as = 1 8(eight)	(2) 1
(3)	Enter the number of sequences with a risk significance equal to 8.	(3) 8
(4)	Add the result of Step (3) to the result of Step (2).	(4) 9
(5)	Divide the result of Step (4) by 3 and round down.	(5) 3
(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) 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 1

SDP PHASE 1 SCREENING WORKSHEET FOR IE, MS, and B CORNERSTONES

Reference/Title (LER #, Inspection Report #, etc):

Performance Deficiency (concise statement clearly stating the deficient licensee performance):

SLC STORAGE TANK BORON CONCENTRATION SUBSTANTIALLY LESS THAN THAT REQUIRED TO FULFILL ITS SAFETY FUNCTION

Factual Description of Identified Condition (statement of facts known about the finding, without hypothetical failures included):

IDENTIFIED 28 DAYS FOLLOWING MAINTENANCE PERFORMED ON TANK

System(s) and train(s) degraded by identified condition:

SLC BOTH TRAINS

Licensing Basis Function of System(s) or Train(s) (as applicable):

REDUCE RX POWER FOLLOWING ATWS

Other Safety Function of System(s) or Train(s) (as applicable):

Maintenance Rule category (check one): ___ risk-significant ___non-risk-significant

Time that identified condition existed or is assumed to have existed: 28 DAYS

Functions and Cornerstones degraded as a result of this identified condition (check ✓)

INITIATING EVENT CORNERSTONE

_____ Transient initiator contributor (e.g., reactor/turbine trip, loss offsite power)

_____ Primary or Secondary system LOCA initiator contributor (e.g., RCS or main steam/feedwater pipe degradations and leaks)

MITIGATION SYSTEMS CORNERSTONE

_____ Core Decay Heat Removal Degraded

_____ Initial Injection Heat Removal Degraded

_____ Primary (e.g., Safety Inj)

____ Low Pressure

____ High Pressure

_____ Secondary - PWR only (e.g., AFW)

_____ Long Term Heat Removal Degraded (e.g., ECCS sump recirculation, suppression pool cooling)

✓ Reactivity Control Degraded

_____ Fire/Flood/Seismic/Weather Protection Degraded

BARRIERS CORNERSTONE

_____ RCS LOCA Mitigation Boundary Degraded (e.g., PORV block valve, PTS issue)

_____ Containment Barrier Degraded

_____ Reactor Containment Degraded

_____ Actual Breach or Bypass

_____ Heat Removal, Hydrogen or Pressure Control Degraded

_____ Control Room, Aux Bldg, or Spent Fuel Bldg Barrier Degraded

_____ Fuel Cladding Barrier Degraded

Page 1 of 3

SDP PHASE 1 SCREENING WORKSHEET FOR IE, MS, and B CORNERSTONES

Check the appropriate boxes ✔

If the finding is assumed to degrade:

1. fire protection defense in depth (DID), detection, suppression, barriers, fire brigade. **STOP. Go to** IMC 0609, Appendix F
2. the safety of a shutdown reactor. **STOP. Go to** IMC 0609, Appendix G
3. the safety of an operating reactor, identify the degraded areas:
   ☐ Initiating Event ☐ Mitigation Systems ☐ RCS Barrier ☐ Fuel Barrier ☐ Containment Barriers
4. **Two or more** of the above areas degraded → **STOP. Go to Phase 2**
5. If **only one** of the above areas is degraded, continue **only** in the **appropriate** column below.

Initiating Event	Mitigation Systems	RCS Barrier or Fuel Barrier	Containment Barriers
1. Does the finding contribute to the likelihood of a Primary or Secondary system LOCA initiator? ☐ **If YES → Stop. Go to Phase 2** ☐ If NO, continue 2. Does the finding contribute to both the likelihood of a reactor trip AND the likelihood that mitigation equipment or functions will not be available? ☐ **If YES → Stop. Go to Phase 2** ☐ If NO, continue 3. Does the finding increase the likelihood of a fire or internal/external flood? ☐ **If YES** → Use the IPEEE or other existing plant-specific analyses to identify core damage scenarios of concern and factors that increase the frequency. Provide this input for **Phase 3** analysis. ☐ If NO, screen as Green	1. Is the finding a design or qualification deficiency confirmed not to result in loss of function per GL 91-18 (rev 1)? ☐ **If YES** → screen as Green ☑ If NO, continue 2. Does the finding represent an actual loss of safety function of a System? ☑ **If YES → Stop. Go to Phase 2** ☐ If NO, continue 3. Does the finding represent an actual loss of safety function of a single Train, for > its Tech Spec Allowed Outage Time? ☐ **If YES → Stop. Go to Phase 2** ☐ If NO, continue 4. Does the finding represent an actual loss of safety function of one or more non-Tech Spec Trains of equipment designated as risk-significant per 10CFR50.65, for >24 hrs? ☐ **If YES → Stop. Go to Phase 2** ☐ If NO, continue 5. Does the finding screen as potentially risk significant due to a seismic, fire, flooding, or severe weather initiating event, using the criteria on page 3 of this Worksheet? ☐ **If YES** → Use the IPEEE or other existing plant-specific analyses to identify core damage scenarios of concern and provide this input for **Phase 3** analysis. ☐ If NO, screen as Green	1. RCS Barrier **Stop. Go to Phase 2** 2. Fuel Barrier screen as Green	1. Does the finding only represent a degradation of the radiological barrier function provided for the control room, or auxiliary building, or spent fuel pool, or SBGT system (BWR)? ☐ **If YES** → screen as Green ☐ If NO, continue 2. Does the finding represent a degradation of the barrier function of the control room against smoke or a toxic atmosphere? ☐ **If YES → Stop. Go to Phase 3** ☐ If NO, continue 3. Does the finding represent an actual open pathway in the physical integrity of reactor containment or an actual reduction of the atmospheric pressure control function of the reactor containment? ☐ **If YES → Stop. Go to Appendix H of IMC 0609** ☐ If NO, screen as Green Page 2 of 3

SDP PHASE 1 SCREENING WORKSHEET FOR IE, MS, and B CORNERSTONES

Seismic, Fire, Flooding, and Severe Weather Screening Criteria

1. Does the finding involve the loss or degradation of equipment or function **specifically** designed to mitigate a seismic, flooding, or severe weather initiating event (e.g., seismic snubbers, flooding barriers, tornado doors)? (Equipment and functions for the mitigation or suppression of fire initiating events, such as thermal wrap or sprinkler systems, should be evaluated using IMC 0609 Appendix F and are not evaluated here)

   ☐**If YES** → continue to question 2
   ☐If NO → skip to question 3

2. If the equipment or safety function is assumed to be completely failed or unavailable, are ANY of the following three statements TRUE? The loss of this equipment or function by itself, during the external initiating event it was intended to mitigate

   a) would cause a plant trip or any of the Initiating Events used by Phase 2 for the plant in question;

   b) would degrade **two or more** Trains of a multi-train safety system or function;

   c) would degrade one or more Trains of a system that supports a safety system or function.

   ☐**If YES** → the finding is potentially risk significant due to external initiating event core damage sequences - return to page 2 of this Worksheet
   ☐If NO, screen as Green

3. Does the finding involve the total loss of any safety function, identified by the licensee through a PRA, IPEEE, or similar analysis, that contributes to external event initiated core damage accident sequences (i.e., initiated by a seismic, fire, flooding, or severe weather event)?

   ☐**If YES** → the finding is potentially risk significant due to external initiating event core damage sequences - return to page 2 of this Worksheet
   ☐If NO, screen as Green

Result of Phase 1 screening process:

☐ **Screen as Green** ☐ **Go to Phase 2** ☐ **Go to Phase 3**

Important Assumptions (as applicable):

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EXERCISE 3

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. 3 9s = 1 8(Eight)	(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

4s	II
5s	I
6s	II
7s	II II
8s	I
9s	IIIII II (6)
>9	IIIII +5 I +2 I I +2

EXERCISE 4

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

- 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

Per Answers

Counting Rule Worksheet

Step	Instructions		
(1)	Enter the number of sequences with a risk significance equal to 9.	(1) 0	4 ✓
(2)	Divide the result of Step (1) by 3 and round down. 3 9s = 1 8(eight)	(2) 0	1
(3)	Enter the number of sequences with a risk significance equal to 8.	(3) 2	6 ✓
(4)	Add the result of Step (3) to the result of Step (2).	(4) 2	7
(5)	Divide the result of Step (4) by 3 and round down.	(5) 0	2
(6)	Enter the number of sequences with a risk significance equal to 7.	(6) 24	4 ✓
(7)	Add the result of Step (6) to the result of Step (5).	(7) 24	6
(8)	Divide the result of Step (7) by 3 and round down.	(8) 8	2
(9)	Enter the number of sequences with a risk significance equal to 6.	(9) 12	0
(10)	Add the result of Step (9) to the result of Step (8).	(10) 20	2
(11)	Divide the result of Step (10) by 3 and round down.	(11) 6	0
(12)	Enter the number of sequences with a risk significance equal to 5.	(12) 4	0
(13)	Add the result of Step (12) to the result of Step (11).	(13) 10	0
(14)	Divide the result of Step (13) by 3 and round down.	(14) 3	0
(15)	Enter the number of sequences with a risk significance equal to 4.	(15) 0	0
(16)	Add the result of Step (15) to the result of Step (14).	(16) 3	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

4s										
5s	1	2	1							4
6s	3	1	3	3	2					12
7s	1	2	2	3	5	2	4	1	4	24
8s	1	1								2
9s										
>9	1									