

April 30, 2002

Mr. R. T. Ridenoure
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SUBJECT: SITE-SPECIFIC WORKSHEETS FOR USE IN THE NUCLEAR REGULATORY
COMMISSION'S SIGNIFICANCE DETERMINATION PROCESS
(TAC NO. MA6544)

Dear Mr. Ridenoure:

Enclosed please find the Risk-Informed Inspection Notebook which incorporates the updated Significance Determination Process (SDP) Phase 2 Worksheets that inspectors will be using to characterize and risk-inform inspection findings. This document is one of the key implementation tools of the reactor safety SDP in the reactor oversight process.

Following initial implementation of the revised reactor oversight process (ROP), site visits were conducted by the NRC to verify and update plant equipment configuration data and to collect site-specific risk information from your staff. The enclosed document reflects the results of this visit.

The enclosed Phase 2 Worksheets have incorporated much of the information we obtained during our site visits. The staff encourages further licensee comments where it is identified that the Worksheets give inaccurately low significance determinations. Any comments should be provided to the Document Control Desk, with a copy to the Chief, Probabilistic Safety Assessment Branch, Office of Nuclear Reactor Regulation. We will continue to assess SDP accuracy and update the document based on continuing experience.

While the enclosed Phase 2 Worksheets have been verified by our staff to include the site specific data we will continue to assess its accuracy throughout implementation and update the document based on comments by our inspectors and your staff.

Sincerely,
/RA/

Alan B. Wang, Project Manager, Section 2
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-285

Enclosure: Risk-Informed Inspection Notebook

cc w/encl: See next page

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**RISK-INFORMED INSPECTION NOTEBOOK FOR
FORT CALHOUN POWER STATION**

PWR, COMBUSTION ENGINEERING, TWO-LOOP PLANT WITH LARGE DRY CONTAINMENT

Prepared by

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NOTICE

This notebook was developed for the NRC's inspection teams to support risk-informed inspections. The activities involved in these inspections are discussed in "Reactor Oversight Process Improvement," SECY-99-007A, March 1999. The user of this notebook is assumed to be an inspector with an extensive understanding of plant-specific design features and operation. Therefore, the notebook is not a stand-alone document, and may not be suitable for use by non-specialists. This notebook will be periodically updated with new or replacement pages incorporating additional information on this plant. All recommendations for improvement of this document should be forwarded to the Chief, Probabilistic Safety Assessment Branch, NRR, with a copy to the Chief, Inspection Program Branch, NRR.

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ABSTRACT

This notebook contains summary information to support the Significance Determination Process (SDP) in risk-informed inspections for the Fort Calhoun Power Station.

The information includes the following: Categories of Initiating Events Table, Initiators and System Dependency Table, SDP Worksheets, and SDP Event Trees. This information is used by the NRC's inspectors to identify the significance of their findings, i.e., in screening risk-significant findings, consistent with Phase 2 screening in SECY-99-007A. The Categories of Initiating Event Table is used to determine the likelihood rating for the applicable initiating events. The SDP worksheets are used to assess the remaining mitigation capability rating for the applicable initiating event likelihood ratings in identifying the significance of the inspector's findings. The Initiators and System Dependency Table and the SDP Event Trees (the simplified event trees developed in preparing the SDP worksheets) provide additional information supporting the use of SDP worksheets.

The information contained herein is based on the licensee's Individual Plant Examination (IPE) submittal, the updated Probabilistic Risk Assessment (PRA), and system information obtained from the licensee during site visits as part of the review of earlier versions of this notebook. Approaches used to maintain consistency within the SDP, specifically within similar plant types, resulted in sacrificing some plant-specific modeling approaches and details. Such generic considerations, along with changes made in response to plant-specific comments, are summarized.

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1. INFORMATION SUPPORTING SIGNIFICANCE DETERMINATION PROCESS (SDP)

SECY-99-007A (NRC, March 1999) describes the process for making a Phase 2 evaluation of the inspection findings. The first step in this is to identify the pertinent core damage scenarios that require further evaluation consistent with the specifics of the inspection findings. To aid in this process, this notebook provides the following information:

1. Estimated Likelihood Rating for Initiating Event Categories
2. Initiators and System Dependency Table
3. Significance Determination Process (SDP) Worksheets
4. SDP Event Trees.

Table 1, Categories of Initiating Events, is used to estimate the likelihood rating for different initiating events for a given degraded condition and the associated exposure time at the plant. This Table follows the format of Table 1 in SECY-99-007A. Initiating events are grouped in frequency bins that are one order of magnitude apart. The Table includes the initiating events that should be considered for the plant and for which SDP worksheets are provided. The following initiating events are categorized by industry-average frequency: transients (Reactor Trip) (TRANS); transients without power conversion system (TPCS); large, medium, and small loss of coolant accidents (LLOCA, MLOCA, and SLOCA); inadvertent or stuck open relief valve (IORV or SORV); main steam line break (MSLB), anticipated transients without scram (ATWS), and interfacing system LOCA (ISLOCA). The frequency of the remaining initiating events vary significantly from plant to plant, and accordingly, they are categorized by plant-specific frequency obtained from the licensee. They include loss of offsite power (LOOP) and special initiators caused by loss of support systems.

The Initiators and System Dependency Table shows the major dependencies between frontline- and support-systems, and identifies their involvement in different types of initiators. This table identifies the most risk-significant systems; it is not an exhaustive nor comprehensive compilation of the dependency matrix, as known in Probabilistic Risk Assessments (PRAs). For pressurized water reactors (PWRs), the support systems/success criteria for Reactor Coolant Pump (RCP) seals are explicitly denoted to assure that the inspection findings on them are properly accounted for. This Table is used to identify the SDP worksheets to be evaluated, corresponding to the inspection's findings on systems and components.

To evaluate the impact of the inspection's findings on the core-damage scenarios, SDP worksheets are provided. There are two sets of SDP worksheets; one for those initiators that can be mitigated by redundant trains of safety systems, and the other for those initiators that cannot be mitigated; however, their occurrence is prevented by several levels of redundant barriers.

The first set of SDP worksheets contain two parts. The first identifies the functions, the systems, or combinations thereof that have mitigating functions, the number of trains in each system, and

the number of trains required (success criteria) for the initiator. It also characterizes the mitigation capability in terms of the available hardware (e.g., 1 train, 1 multi-train system) and the operator action involved. The second part of the SDP worksheet contains the core-damage accident sequences associated with each initiator; these sequences are based on SDP event trees. In the parenthesis next to each sequence, the corresponding event-tree branch number(s) representing the sequence is given. Multiple branch numbers indicate that the different accident sequences identified by the event tree have been merged into one through Boolean reduction. The SDP worksheets are developed for each of the initiating event categories, including the "Special Initiators", the exception being those which directly lead to a core damage (the inspections of these initiators are assessed differently; see SECY-99-007A). The special initiators are those that are caused by complete or partial loss of support systems. A special initiator typically leads to a reactor scram and degrades some frontline or support systems (e.g., Loss of CCW in PWRs).

In considering the special initiators, we defined a set of criteria for including them to maintain some consistency across the plants. These conditions are as follows:

1. The special initiator should degrade at least one of the mitigating safety functions thereby changing its mitigation capability in the worksheet. For example, when a safety function with two redundant trains, classified as a multi-train system, degrades to a one-train system, it is classified as 1 Train, due to the loss of one of the trains as a result of the special initiator.
2. The special initiators which degrade the mitigation capability of the systems/functions associated with the initiator from comparable transient sequences by two and higher orders of magnitude must be considered.

From the above considerations, the following classes of initiators are considered in this notebook:

1. Transients with power conversion system (PCS) available, called Transients (Reactor trip) (TRANS),
2. Transients without PCS available, called Transients w/o PCS (TPCS),
3. Small Loss of Coolant Accident (SLOCA),
4. Stuck-open Power Operated Relief Valve (SORV),
5. Medium LOCA (MLOCA),
6. Large LOCA (LLOCA),
7. Steam Generator Tube Rupture (SGTR),
8. Anticipated Transients Without Scram (ATWS), and
9. Main Steam Line Break (MSLB).

Examples of special initiators included in the notebook are as follows:

1. Loss of Offsite Power (LOOP),
2. LOOP with failure of 1 Emergency AC bus or associated EDG (LEAC),
3. Loss of 1 DC Bus (LDC),
4. Loss of component cooling water (LCCW),
5. Loss of instrument air (LIA),

6. Loss of service water (LSW).

The worksheet for the LOOP includes LOOP with emergency AC power (EAC) available and LOOP without EAC, i.e., Station Blackout (SBO). LOOP with partial availability of EAC, i.e., LOOP with loss of a bus of EAC, is covered in a separate worksheet to avoid making the LOOP worksheet too large. In some plants, LOOP with failure of 1 EAC bus is a large contributor to the plant's core damage frequency (CDF).

The second set of SDP worksheets addresses those initiators that cannot be mitigated, i.e., can directly lead to core-damage. It currently includes the Interfacing System LOCA (ISLOCA) initiator. ISLOCAs are those initiators that could result in a loss of RCS inventory outside the containment, sometimes referred to as a "V" sequence. In PWRs, this event effectively bypasses the capability to utilize the containment sump recirculation once the RWST has emptied. Also, through bypassing the containment, the radiological consequences may be significant. In PWRs, this typically includes loss of RCS inventory through high- and low-pressure interfaces, such as RHR connections, RCP thermal barrier heat-exchanger, high-pressure injection piping if the design pressure (pump head) is much lower than RCS pressure, and, potentially, through excess letdown heat exchanger. RCS inventory loss through ISLOCA could vary significantly depending on the size of the leak path; some may be recoverable with minimal impact. The SDP worksheet for ISLOCA, therefore, identifies the major consequential leak paths, and the barriers that should fail, allowing the initiator to occur.

Following the SDP worksheets, the SDP event trees corresponding to each of the worksheets are presented. The SDP event trees are simplified event trees developed to define the accident sequences identified in the SDP worksheets. For special initiators whose event tree closely corresponds to another event tree (typically, the Transient (Reactor trip) or Transients w/o PCS event tree) with one or more functions eliminated or degraded, a separate event tree may not be drawn.

The following items were considered in establishing the SDP event trees and the core-damage sequences in the SDP worksheets:

1. Event trees and sequences were developed such that the worksheet contains all the major accident sequences identified by the plant-specific IPEs/PRA. The special initiators modeled for a plant is based on a review of the special initiators included in the plant IPE/PRA and the information provided by the licensee.
2. The event trees and sequences for each plant take into account the IPE/PRA models and event trees for all similar plants. For modeling the response to an initiating event, any major deviations in one plant from similar plants may be noted at the end of the worksheet.
3. The event trees and the sequences were designed to capture core-damage scenarios, without including containment-failure probabilities and consequences. Therefore, branches of event trees that are developed only for the purpose of a Level II PRA analysis are not considered. The resulting sequences are merged, using Boolean logic.

4. The simplified event trees focus on classes of initiators, as defined above. In so doing, many separate event trees in the IPEs/PRA often are represented by a single tree. For example, some IPEs/PRA define four classes of LOCAs rather than the three classes considered here. The sizes of LOCAs for which high-pressure injection is not required are sometimes divided into two classes, the only difference between them being the need for reactor scram in the smaller break size. There may be some consolidation of transient event trees besides defining the special initiators following the criteria defined above.
5. Major actions by the operator during accident scenarios are credited using four categories of Human Error Probabilities (HEPs). They are termed operator action=1 (representing an error probability of $5E-2$ to 0.5), operator action=2 (error probability of $5E-3$ to $5E-2$), operator action=3 (error probability of $5E-4$ to $5E-3$), and operator action=4 (error probability of $5E-5$ to $5E-4$). An human action is assigned to a category bin, based on a generic grouping of similar actions among a class of plants. This approach resulted in designation of some actions to a higher bin, even though the IPE/PRA HEP value may have been indicative of a lower category. In such cases, it is noted at the end of the worksheet. On the other hand, if the IPE/PRA HEP value suggests a higher category than that generically assumed, the HEP is assigned to a bin consistent with the IPE/PRA value in recognition of potential plant-specific design; a note is also given in these situations. Operator's actions belonging to category 4, i.e., operator action=4, may only be noted at the bottom of worksheet because, in those cases, equipment failures may have the dominating influence in determining the significance of the findings.

The four sections that follow include Categories for Initiating Events Table, Initiators and Dependency Table, SDP worksheets, and the SDP event trees for Fort Calhoun Power Station.

1.1 INITIATING EVENT LIKELIHOOD RATINGS

Table 1 presents the applicable initiating events for this plant and their estimated likelihood ratings corresponding to the exposure time for degraded conditions. The initiating events are grouped into rows based on their frequency. As mentioned earlier, loss of offsite power (LOOP) and special initiators are assigned to rows using the plant-specific frequency obtained from individual licensees. For other initiating events, industry-average values are used.

Table 1 Categories of Initiating Events for Fort Calhoun Power Station

Row	Approximate Frequency	Example Event Type	Estimated Likelihood Rating		
			A	B	C
I	> 1 per 1-10 yr	Reactor Trip (Trans), Loss of Power Conversion System (TPCS)	A	B	C
II	1 per 10-10 ² yr	Loss of offsite power (LOOP), Loss of Component Cooling Water (LCCW), Loss of Raw Water (LRW), Loss of Instrument Air (LIA)	B	C	D
III	1 per 10 ² - 10 ³ yr	SGTR, Stuck open PORV/SRV (SORV), Small LOCA including RCP seal failures (SLOCA), Main Steam Line Break Outside Containment(MSLB), Loss of DC Bus 1, (LDCBUS1), Loss of DC Bus 2 (LDCBUS2), Loss of HVAC to Room 56 (LHVAC56)	C	D	E
IV	1 per 10 ³ - 10 ⁴ yr	Medium LOCA (MLOCA), LOOP with loss of one division of emergency AC (LOOP1EDG), Loss of 4KV Bus 1A3 (L4KV1A3), Loss of 4KV Bus 1A4 (L4KV1A4)	D	E	F
V	1 per 10 ⁴ - 10 ⁵ yr	Large LOCA (LLOCA)	E	F	G
VI	less than 1 per 10 ⁵ yr	ATWS, ISLOCA	F	G	H
			> 30 days	3-30 days	< 3 days
			Exposure Time for Degraded Condition		

Note:

- 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

1.2 INITIATORS AND SYSTEM DEPENDENCY

Table 2 lists the systems included in the SDP worksheets, the major components in the systems, and the support system dependencies. The systems' involvements in different initiating events are noted in the last column.

Table 2 Initiators and System Dependency for Fort Calhoun Power Station

Affected System	Major Components	Support Systems	Initiating Event Scenarios
AC Power	Two 4KV Buses, 480V Buses	DC	All
DC Power	3 Battery Chargers, 2 125VDC buses, 2 batteries	AC	All
AFWS	TDAFWP, Emergency Feedwater Storage Tank (EFWST)	125 V-DC, 120 V-AC, HVAC, EFWST makeup (condensate, demin. Water, fire water, raw water, or potable water)	All except MLOCA and LLOCA
	DDAFWP(FW-54), Condensate Storage Tank (CST)	None	
	MDAFWP, EFWST	4 KV, 125 V-DC, 120 V-AC, EFWST makeup (condensate, demin. Water, fire water, raw water, or potable water)	
CVCS	3 Positive displacement charging pumps, 2 boric acid transfer pumps , 2 boric acid storage tanks (BASTs)	AC, DC	ATWS
HPSI	Two Trains (3 Pumps), Valves, Safety Injection and Refueling Water Tank (SIRWT)	4.16 KV, 480 V-AC, 120 V-AC, and 125 V- DC	All except LRW

Table 2 (Continued)

HPSI (Recirc.)	Two Trains (3 Pumps), Valves	4.16 KV, 480 V-AC, 120 V-AC and 125 V-DC CCW, RW	All except LRW, ATWS, and SGTR
LPSI	Two Trains (2 Pumps), Valves, SIRWT	4.16 KV, 480 V-AC, 120 V-AC, and 125 V- DC, CCW, RW	LLOCA
SIRWT Makeup	Boric Acid Tanks, Boric Acid Pumps, Demineralized Water, Demineralized Water Booster Pumps	AC, DC	SGTR
CS (Recirc.)	2Trains of Pumps, Shutdown Down Cooling (SDC) Heat Exchangers, Valves	4.16 KV, 480 V-AC, 125 V-DC, 120 V-AC, CCW, RW	All except LRW, ATWS, and STGR
Containment Air Recirculation Cooling (CARC) System	Two Containment Filtering and Cooling Unit (CFCU) trains each with a Containment Cooling and Filtering Unit (CFU) and a Containment Cooling (CU) unit	AC, DC, CCW, RW	All except LRW, ATWS, and STGR
Main Feedwater/Condens ate System	3 MFW Pumps, 3 Condensate Pumps, Condenser	AC, DC, IA, CW, TPCW	TRANS, SLOCA, SORV
Main Steam	4 bypass valves, 1 pressure control valves	IA, 120V-AC, DC (fail closed)	All except MLOCA and LLOCA

Table 2 (Continued)

	1 atmospheric dump valve (down stream of MSIVs)	IA (fail closed), 120V-AC (remote operation)	
	2 steam lines each with one MSIV	IA, DC (fail closed)	
	2 steam lines each with 4 safety valves	None	
	2 steam lines each with 1 solenoid operated safety valve	IA, DC (fails closed and remains operable as a safety valve)	
Circulating Water (CW)	Three Pumps and valves	AC, DC	TRANS, SLOCA, SORV, LIA
Turbine Plant Cooling Water	Pumps and Valves	AC, DC, CW	TRANS, SLOCA, SORV, LIA
Instrument Air (IA)	Compressors	AC, DC, TPCW	LIA
Safety Injection Tanks (SITs)	4 SITs	None	LLOCA
EDG	2 EDGs with fuel tank and fuel transfer pumps	125 V-DC, HVAC	LOOP, LOOP1EDG
CCW	3 Pumps, Valves, Heat Exch.	41.6 KV, 480 V-AC, 120 V-AC, 125 V-DC, RW	LCCW
Raw Water (RW)	4 Pumps, Valves	4.16 KV, 480 V-AC, 120 V-AC, and 125 V-DC	LRW

Table 2 (Continued)

Primary Pressure Relief	2 Safety Relief Valves, 2 PORVs with Block Valves	480 V-AC	All except MLOCA, LLOCA and LRW
RCP Seals	Byron Jackson Seals	CCW	SLOCA

Notes:

- (1) Based on the IPE, the core damage frequency is 1.36E-5 per year including floods.
- (2) Loss of CCW flow (1/3 pumps) for RCP seal cooling **and** failure to trip RCP in 30 minutes (the procedure calls for 5 minutes) is assumed to lead to a seal LOCA.
- (3) The IPE's dependency table shows that CCW, AFW, CS, CARC, HPSI, and LPSI all depend on instrument air. It is assumed that the dependency of CCW, CS, and CARC are backed by accumulators, and the dependency of HPSI and LPSI is through the dependency of CCW.

1.3 SDP WORKSHEETS

This section presents the SDP worksheets to be used in the Phase 2 evaluation of the inspection findings for the Fort Calhoun Power Station . The SDP worksheets are presented for the following initiating event categories:

1. Transients (Reactor Trip) (TRANS)
2. Transients w/o PCS (TPCS)
3. Small LOCA (SLOCA)
4. Stuck-open PORV (SORV)
5. Medium LOCA (MLOCA)
6. Large LOCA (LLOCA)
7. Loss of Offsite Power (LOOP)
8. Steam Generator Tube Rupture (SGTR)
9. Main Steam Line Break (MSLB)
10. Anticipated Transients Without Scram (ATWS)
11. Loss of 4kv Bus 1A3 (L4KV1A3)
12. Loss of 4kv Bus 1A4 (L4KV1A4)
13. Loss of 125v DC Bus 1 (LDCBUS1)
14. Loss of 125v DC Bus 2 (LDCBUS2)
15. LOOP with Loss of 1 EDG (LOOP1EDG)
16. Loss of Component Cooling Water (LCCW)
17. Loss of Raw Water (LRW)
18. Loss of Instrument Air (LIA)
19. Interfacing System LOCA (ISLOCA)

Table 3.1 SDP Worksheet for Fort Calhoun Power Station — Transients (Reactor Trip) (TRANS)

Estimated Frequency (Table 1 Row) _____ Exposure Time _____ Table 1 Result (circle): A B C D E F G H			
Safety Functions Needed: Power Conversion System (PCS) Secondary Heat Removal (AFW) Feed/Bleed (FB) High Pressure Safety Injection (EIHP) High Pressure Recirc (HPR) Containment Press/Temp Control (CNT)		Full Creditable Mitigation Capability for Each Safety Function: 1/3 Main Feedwater pumps and 1/3 Condensate pumps through 1/2 SG (operator action = 3) ⁽¹⁾ 1/1 MDAFW trains (1 train) or 1/1 TDAFW train (1 ASD train) or 1/1 Diesel Driven train (FW-54) (operator action = 2) ⁽²⁾ 1/2 PORVs open for Feed/Bleed (operator action = 2) ⁽³⁾ 1/2 HPSI trains (3 pumps) taking suction from SIRWT (1 multi-train system) 1/2 HPSI trains (3 pumps) taking suction from sump (1 multi-train system) 1/2 CS Train (3 pumps) in Recirc. mode through the SDC HXs. (1 multi-train system) or 1/2 CFCU trains (1 multi train system)	
<u>Circle Affected Functions</u>	<u>Recovery of Failed Train</u>	<u>Remaining Mitigation Capability Rating for Each Affected Sequence</u>	<u>Sequence Color</u>
1 TRANS - AFW - PCS - HPR (4)			
2 TRANS - AFW - PCS - CNT (5)			
3 TRANS - AFW - EIHP (6)			
4 TRANS - AFW - PCS - FB (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 IPE does not document the HEP associated with maintaining PCS in operation. A generic credit of 3 based on the HEPs of CE plants is used.
- (2) The diesel driven AFW pump requires operator to start and align. The HEP is $3.2E-4$ (Event OPER-40 on page 3.3-18) which is lower than the generic credit of 2 based on the HEPs of CE plants. In this worksheet, the generic credit is used. Makeup is needed if FW-54 is not available. The HEP for operator failure to provide makeup is $3.E-3$ (Event AHFFEFWST on page 3.3-17.)
- (3) The HEP for operator failure to initiate feed and bleed, is $2.3E-3$ (Event OPER-41 on page 3.3-18) which is lower than the generic credit of 2 based on the HEPs of CE plants. In this worksheet, the generic credit is used.

Table 3.2 SDP Worksheet for Fort Calhoun Power Station — Transients without PCS (TPCS)

Estimated Frequency (Table 1 Row) _____ Exposure Time _____ Table 1 Result (circle): A B C D E F G H			
Safety Functions Needed: Secondary Heat Removal (AFW) Feed/Bleed (FB) High Pressure Safety Injection (EIHP) High Pressure Recirc (HPR) Containment Press/Temp Control (CNT)		Full Creditable Mitigation Capability for Each Safety Function: 1/1 MDAFW trains (1 train) or 1/1 TDAFW train (1 ASD train) or 1/1 Diesel Driven train (FW-54) (operator action = 2) ⁽¹⁾ and steam relief through 1/8 safety valves or 1/2 solenoid operated safety valves 1/2 PORVs open for Feed/Bleed (operator action = 2) ⁽²⁾ 1/2 HPSI trains (3 pumps) taking suction from SIRWT (1 multi-train system) 1/2 HPSI trains (3 pumps) taking suction from sump (1 multi-train system) 1/2 CS Train (3 pumps) in Recirc. mode through the SDC HXs. (1 multi-train system) or 1/2 CFCU trains (1 multi train system)	
<u>Circle Affected Functions</u>	<u>Recovery of Failed Train</u>	<u>Remaining Mitigation Capability Rating for Each Affected Sequence</u>	<u>Sequence Color</u>
1 TPCS - AFW - HPR (3)			
2 TPCS - AFW - CNT (4)			
3 TPCS - AFW - EIHP (5)			
4 TPCS - AFW - FB (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 diesel driven AFW pump requires operator to start and align. The HEP is 3.2E-4 (Event OPER-40 on page 3.3-18) which is lower than the generic credit of 2 based on the HEPs of CE plants. In this worksheet, the generic credit is used. Makeup is needed if FW-54 is not available. The HEP for operator failure to provide makeup is 3.E-3 (Event AHFFFEFWST on page 3.3-17.)
- (2) The HEP for operator failure to initiate feed and bleed, is 2.3E-3 (Event OPER-41 on page 3.3-18) which is lower than the generic credit of 2 based on the HEPs of CE plants. In this worksheet, the generic credit is used.

Table 3.3 SDP Worksheet for Fort Calhoun Power Station — Small LOCA (SLOCA)

Estimated Frequency (Table 1 Row) _____ Exposure Time _____ Table 1 Result (circle): A B C D E F G H			
Safety Functions Needed: Power Conversion System (PCS) Secondary Heat Removal (AFW) Feed/Bleed (FB) High Pressure Safety Injection (EIHP) High Pressure Recirc (HPR) Containment Press/Temp Control (CNT)		Full Creditable Mitigation Capability for Each Safety Function: 1/3 Main Feedwater pumps and 1/3 Condensate pumps through 1/2 SG (operator action = 3) ⁽¹⁾ 1/1 MDAFW trains (1 train) or 1/1 TDAFW train (1 ASD train) or 1/1 Diesel Driven train (FW-54) (operator action = 2) ⁽²⁾ and steam relief through 1/8 safety valves or 1/2 solenoid operated safety valves 1/2 PORVs open for Feed/Bleed (operator action = 2) ⁽³⁾ 1/2 HPSI trains (3 pumps) taking suction from SIRWT (1 multi-train system) 1/2 HPSI trains (3 pumps) taking suction from sump (1 multi-train system) 1/2 CS Train (3 pumps) in Recirc. mode through the SDC HXs. (1 multi-train system) or 1/2 CFCU trains (1 multi train system)	
<u>Circle Affected Functions</u>	<u>Recovery of Failed Train</u>	<u>Remaining Mitigation Capability Rating for Each Affected Sequence</u>	<u>Sequence Color</u>
1 SLOCA - CNT (2,6,10)			
2 SLOCA - HPR (3,7,11)			
3 SLOCA - EIHP (4,8,12)			
4 SLOCA - PCS- AFW - FB (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 IPE does not document the HEP associated with maintaining PCS in operation. A generic credit of 3 based on the HEPs of CE plants is used.
- (2) The diesel driven AFW pump requires operator to start and align. The HEP is $3.2E-4$ (Event OPER-40 on page 3.3-18) which is lower than the generic credit of 2 based on the HEPs of CE plants. In this worksheet, the generic credit is used. Makeup is needed if FW-54 is not available. The HEP for operator failure to provide makeup is $3.E-3$ (Event AHFFEFWST on page 3.3-17.)
- (3) The HEP for operator failure to initiate feed and bleed, is $9.1E-6$ (Event OPER-8 on page 3.3-18) which is lower than the generic credit of 2 based on the HEPs of CE plants. In this worksheet, the generic credit is used.

Table 3.4 SDP Worksheet for Fort Calhoun Power Station — Stuck Open PORV (SORV)

Estimated Frequency (Table 1 Row) _____ Exposure Time _____ Table 1 Result (circle): A B C D E F G H			
Safety Functions Needed: Isolation of Small LOCA (BLK) Power Conversion System (PCS) Secondary Heat Removal (AFW) Feed/Bleed (FB) High Pressure Safety Injection (EIHP) High Pressure Recirc (HPR) Containment Press/Temp Control (CNT)		Full Creditable Mitigation Capability for Each Safety Function: Operator close the block valve associated with stuck open PORV (operator action = 3) ⁽¹⁾ 1/3 Main Feedwater pumps and 1/3 Condensate pumps through 1/2 SG (operator action = 3) ⁽²⁾ 1/1 MDAFW trains (1 train) or 1/1 TDAFW train (1 ASD train) or 1/1 Diesel Driven train (FW-54) (operator action = 2) ⁽³⁾ and steam relief through 1/8 safety valves or 1/2 solenoid operated safety valves (operator action = 2) ⁽⁴⁾ 1/2 HPSI trains (3 pumps) taking suction from SIRWT (1 multi-train system) 1/2 HPSI trains (3 pumps) taking suction from sump (1 multi-train system) 1/2 CS Train (3 pumps) in Recirc. mode through the SDC HXs. (1 multi-train system) or 1/2 CFCU trains (1 multi train system)	
Circle Affected Functions	Recovery of Failed Train	Remaining Mitigation Capability Rating for Each Affected Sequence	Sequence Color
1 SORV - BLK - CNT (3,7,11)			
2 SORV - BLK - HPR (4,8,12)			
3 SORV - BLK - EIHP (5,9,13)			
4 SORV - BLK - PCS- AFW - FB (14)			

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 is 2.1E-4 (Event OP-23 on page 3.3-18) which is lower than the generic credit of 3. In this worksheet, the generic credit is used.
- (2) The IPE does not document the HEP associated with maintaining PCS in operation. A generic credit of 3 based on the HEPs of CE plants is used.
- (3) The diesel driven AFW pump requires operator to start and align. The HEP is 3.2E-4 (Event OPER-40 on page 3.3-18) which is lower than the generic credit of 2 based on the HEPs of CE plants. In this worksheet, the generic credit is used. Makeup is needed if FW-54 is not available. The HEP for operator failure to provide makeup is 3.E-3 (Event AHFFFEFWST on page 3.3-17.)
- (4) The HEP for operator failure to initiate feed and bleed, is 9.1E-6 (Event OPER-8 on page 3.3-18) which is lower than the generic credit of 2 based on the HEPs of CE plants. In this worksheet, the generic credit is used.

Table 3.5 SDP Worksheet for Fort Calhoun Power Station — Medium LOCA (MLOCA)

Estimated Frequency (Table 1 Row) _____ Exposure Time _____ Table 1 Result (circle): A B C D E F G H			
Safety Functions Needed: High Pressure Safety Injection (EIHP) High Pressure Recirc (HPR) Containment Press/Temp Control (CNT)		Full Creditable Mitigation Capability for Each Safety Function: 1/2 HPSI trains (3 pumps) taking suction from SIRWT (1 multi-train system) 1/2 HPSI trains (3 pumps) taking suction from sump (1 multi-train system) 1/2 CS Train (3 pumps) in Recirc. mode through the SDC HXs. (1 multi-train system) or 2/2 CFCU trains (1 train)	
<u>Circle Affected Functions</u>	<u>Recovery of Failed Train</u>	<u>Remaining Mitigation Capability Rating for Each Affected Sequence</u>	<u>Sequence Color</u>
1 MLOCA - CNT (2)			
2 MLOCA - HPR (3)			
3 MLOCA - EIHP (4)			
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 3.6 SDP Worksheet for Fort Calhoun Power Station — Large LOCA (LLOCA)

Estimated Frequency (Table 1 Row) _____ Exposure Time _____ Table 1 Result (circle): A B C D E F G H			
Safety Functions Needed: Safety Injection Tanks (SIT) Early Inventory, LP Injection (EILP) High Pressure Safety Injection (EIHP) High Pressure Recirc (HPR) Containment Press/Temp Control (CNT)		Full Creditable Mitigation Capability for Each Safety Function: 3/3 remaining SITs (1 train) 1/2 LPSI trains (1 multi-train system) 1/2 HPSI trains (3 pumps) taking suction from SIRWT (1 multi-train system) 1/2 HPSI trains (3 pumps) taking suction from sump (1 multi-train system) 1/2 CS Train (3 pumps) in Recirc. mode through the SDC HXs. (1 multi-train system) or 2/2 CFCU trains (1 train)	
<u>Circle Affected Functions</u>	<u>Recovery of Failed Train</u>	<u>Remaining Mitigation Capability Rating for Each Affected Sequence</u>	<u>Sequence Color</u>
1 LLOCA - CNT (2,5)			
2 LLOCA -HPR (3,6)			
3 LLOCA- EIHP - EILP (7)			
4 LLOCA - SIT (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.

Table 3.7 SDP Worksheet for Fort Calhoun Power Station — Loss of Offsite Power (LOOP) ⁽¹⁾

Estimated Frequency (Table 1 Row) _____		Exposure Time _____		Table 1 Result (circle): A B C D E F G H	
Safety Functions Needed: Emergency AC Power (EAC) Turbine Driven AFW (TDAFW) Recovery of AC Power in < 1 hrs (REC1) Recovery of AC Power in < 8 hrs (REC8) Secondary Heat Removal (AFW) Feed/Bleed (FB) High Pressure Safety Injection (EIHP) High Pressure Recirc (HPR) Containment Press/Temp Control (CNT)		Full Creditable Mitigation Capability for Each Safety Function: 1/2 Emergency Diesel Generators (1 multi-train system) [1/1 TDAFW train (1 ASD train) or 1/1 Diesel driven Pump (FW-54)] (operator action = 2) ⁽²⁾ and steam relief through 1/8 safety valves or 1/2 solenoid operated safety valves Recovery of off site power in less than 1 hours (operator action = 1) ⁽³⁾ Recovery of off site power in less than 8 hours (operator action = 2) ⁽⁴⁾ 1/1 MDAFW trains (1 train) or 1/1 TDAFW train (1 ASD train) or 1/1 Diesel Driven train (FW-54) (operator action = 2) ⁽⁵⁾ and steam relief through 1/8 safety valves or 1/2 solenoid operated safety valves 1/2 PORVs open for Feed/Bleed (operator action = 2) ⁽⁶⁾ 1/2 HPSI trains (3 pumps) taking suction from SIRWT (1 multi-train system) 1/2 HPSI trains (3 pumps) taking suction from sump (1 multi-train system) 1/2 CS Train (3 pumps) in Recirc. mode through the SDC HXs. (1 multi-train system) or 1/2 CFCU trains (1 multi train system)			
Circle Affected Functions	Recovery of Failed Train	Remaining Mitigation Capability Rating for Each Affected Sequence		Sequence Color	
1 LOOP - AFW - CNT (3)					
2 LOOP - AFW - HPR (4)					
3 LOOP - AFW - EIHP (5)					

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4 LOOP - AFW - FB (6)			
5 LOOP - EAC -CNT (8,14) (AC power recovered)			
6 LOOP - EAC -HPR (9,15) (AC power recovered)			
7 LOOP - EAC - EIHP (10,16) (AC power recovered)			
8 LOOP - EAC - FB (11,17) (AC power recovered)			
9 LOOP - EAC - REC8 (12) (Extended SBO sequence)			
10 LOOP-EAC-TDAFW - REC1 (18)			

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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 0.217 per year.
- (2) In a SBO, the operator has to manually control AFW due to failure open of the flow control valves. The HEP is 1.E-3 (Event AHFCONTROL on page 3.3-17.) The diesel driven AFW pump requires operator to start and align. The HEP is 3.2E-4 (Event OPER-40 on page 3.3-18) which is lower than the generic credit of 2 based on the HEPs of CE plants. In this worksheet, the generic credit should be used.
- (3) The IPE does not document the HEP associated with recovery of offsite power. A generic credit of 1 is used.
- (4) The IPE does not document the HEP associated with recovery of offsite power. A generic credit of 2 is used.
- (5) The diesel driven AFW pump requires operator to start and align. The HEP is 3.2E-4 (Event OPER-40 on page 3.3-18) which is lower than the generic credit of 2 based on the HEPs of CE plants. In this worksheet, the generic credit is used.
- (6) The HEP for operator failure to initiate feed and bleed, is 2.3E-3 (Event OPER-41 on page 3.3-18) which is lower than the generic credit of 2 based on the HEPs of CE plants. In this worksheet, the generic credit is used.

Table 3.8 SDP Worksheet for Fort Calhoun Power Station — Steam Generator Tube Rupture (SGTR)

Estimated Frequency (Table 1 Row) _____ Exposure Time _____ Table 1 Result (circle): A B C D E F G H			
Safety Functions Needed: Secondary Heat Removal (AFW) Feed/Bleed (FB) High Pressure Safety Injection (EIHP) Primary/Secondary Pressure Equalization (EQ) Makeup SIRWT (SIRWT) Shutdown Cooling (SDC)		Full Creditable Mitigation Capability for Each Safety Function: 1/1 MDAFW trains (1 train) or 1/1 TDAFW train (1 ASD train) or 1/1 Diesel Driven train (FW-54) (operator action = 2) ⁽¹⁾ and steam relief through 1/4 safety valves or 1/1 solenoid operated safety valves 1/2 PORVs open for Feed/Bleed (operator action = 2) ⁽²⁾ 1/2 HPSI trains (3 pumps) taking suction from SIRWT (1 multi-train system) Isolation of faulted SG and depressurization below SG safety set points (operator action = 3) ⁽³⁾ Operator alignment of borated water sources to SIRWT and preventing the RAS switch over (operator action = 2) ⁽⁴⁾ Operator depressurizes using secondary and establishes shutdown cooling (operator action=2) ⁽⁵⁾	
<u>Circle Affected Functions</u>	<u>Recovery of Failed Train</u>	<u>Remaining Mitigation Capability Rating for Each Affected Sequence</u>	<u>Sequence Color</u>
1 SGTR - EQ - SIRWT - SDC (4)			
2 SGTR - EQ - EIHP (5)			
3 SGTR - AFW - SIRWT (7)			
4 SGTR - AFW - FB (8)			

(6)

Table 3.9 SDP Worksheet for Fort Calhoun Power Station — Main Steam Line Break (MSLB)

Estimated Frequency (Table 1 Row) _____ Exposure Time _____ Table 1 Result (circle): A B C D E F G H			
Safety Functions Needed: Isolation of MSLB (ISOB) Isolation of MSLB (ISO) Secondary Heat Removal (AFW)		Full Creditable Mitigation Capability for Each Safety Function: Closure of both MSIVs (1 train) ⁽¹⁾ Closure of one MSIV (1 train) ⁽¹⁾ 1/1 MDAFW trains (1 train) or 1/1 TDAFW train with one steam supply (1 ASD train) or 1/1 Diesel Driven train (FW-54) (operator action = 2) ⁽²⁾ and steam relief through 1/4 safety valves or 1/1 solenoid operated safety valves 1/2 PORVs open for Feed/Bleed (operator action = 2) ⁽³⁾ 1/2 HPSI trains (3 pumps) taking suction from SIRWT (1 multi-train system) 1/2 HPSI trains (3 pumps) taking suction from sump (1 multi-train system) 1/2 CS Train (3 pumps) in Recirc. mode through the SDC HXs. (1 multi-train system) or 1/2 CFCU trains (1 multi train system)	
Feed/Bleed (FB) High Pressure Safety Injection (EIHP) High Pressure Recirc (HPR) Containment Press/Temp Control (CNT)			
<u>Circle Affected Functions</u>	<u>Recovery of Failed Train</u>	<u>Remaining Mitigation Capability Rating for Each Affected Sequence</u>	<u>Sequence Color</u>
1 MSLB - ISOB - AFW - EIHP(6)			
2 MSLB - ISOB - AFW - FB (5)			
3 MSLB - ISOB- AFW- HPR (4)			
5 MSLB - ISOB - ISO (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) Failure of a MSIV to close would lead to a blow down of the associated SG and loss of one source of steam supply to TDAFW pump. Failure of both MSIV to close is assumed to lead to core damage.
- (2) The diesel driven AFW pump requires operator to start and align. The HEP is $3.2E-4$ (Event OPER-40 on page 3.3-18) which is lower than the generic credit of 2 based on the HEPs of CE plants. In this worksheet, the generic credit is used. Makeup is needed if FW-54 is not available. The HEP for operator failure to provide makeup is $3.E-3$ (Event AHFFFEFWST on page 3.3-17.)
- (3) The HEP for operator failure to initiate feed and bleed, is $2.3E-3$ (Event OPER-41 on page 3.3-18) which is lower than the generic credit of 2 based on the HEPs of CE plants. In this worksheet, the generic credit is used.

Table 3.10 SDP Worksheet for Fort Calhoun Power Station — Anticipated Transients Without Scram (ATWS)

Estimated Frequency (Table 1 Row) _____ Exposure Time _____ Table 1 Result (circle): A B C D E F G H			
<u>Safety Functions Needed:</u> Turbine Trip (TTP) Primary Safety Relief Valves (SRV) Secondary Heat Removal (AFW)		<u>Full Creditable Mitigation Capability for Each Safety Function:</u> Operator manually trip the turbine (1 multi-train system) 1/2 SRVs and 1/2 PORVs (1 multi-train system) 1/1 MDAFW trains (1 train) or 1/1 TDAFW train (1 ASD train) or 1/1 Diesel Driven train (FW-54) (operator action = 2) ⁽¹⁾ and steam relief through 1/8 safety valves or 1/2 solenoid operated safety valves 1/3 charging pumps from 1/2 BASTs (operator action = 3) ⁽²⁾	
Emergency Boration (BORATE)			
<u>Circle Affected Functions</u>	<u>Recovery of Failed Train</u>	<u>Remaining Mitigation Capability Rating for Each Affected Sequence</u>	<u>Sequence Color</u>
1 ATWS - AFW (2)			
2 ATWS - BORATE (3)			
3 ATWS - SRV (4)			
4 ATWS - TTP (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.

Notes:

- (1) The diesel driven AFW pump requires operator to start and align. The HEP is $3.2E-4$ (Event OPER-40 on page 3.3-18) which is lower than the generic credit of 2 based on the HEPs of CE plants. In this worksheet, the generic credit is used.
- (2) The HEP for operator failure to emergency borate is $3E-3$ (Event OPER-50 on page 3.3-18.)

Table 3.11 SDP Worksheet for Fort Calhoun Power Station — Loss of 4kv bus 1A3 (L4KV1A3)

Estimated Frequency (Table 1 Row) _____ Exposure Time _____ Table 1 Result (circle): A B C D E F G H			
<u>Safety Functions Needed:</u> Secondary Heat Removal (AFW) Feed/Bleed (FB) High Pressure Safety Injection (EIHP) High Pressure Recirc (HPR) Containment Press/Temp Control (CNT)		<u>Full Creditable Mitigation Capability for Each Safety Function:</u> 1 TDAFW train (1 ASD train) or 1/1 Diesel Driven train (FW-54) (operator action = 2) ⁽²⁾ and steam relief through 1/8 safety valves or 1/2 solenoid operated safety valves 1/1 PORVs open for Feed/Bleed (operator action = 2) ⁽³⁾ 1/1 HPSI train (1 pump) taking suction from SIRWT (1 train) 1/1 HPSI train (1 pump) taking suction from sump (1 train) 1/1 CS Train (2 pumps) in Recirc. mode through the 1/1 SDC HX. (1 train) or 1/1 CFCU train (1 train)	
<u>Circle Affected Functions</u>	<u>Recovery of Failed Train</u>	<u>Remaining Mitigation Capability Rating for Each Affected Sequence</u>	<u>Sequence Color</u>
1 L4KV1A3 - AFW - HPR (3)			
2 L4KV1A3 - AFW - CNT (4)			
3 L4KV1A3 - AFW - EIHP (5)			
4 L4KV1A3 - AFW - FB (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 frequency of loss AC bus 1A3 is $2.94E-4$ per year. It leads to loss of PCS and the equipment on the bus, a PORV, CS pump 3A, CFCU train A, LPSI pump 1A, HPSI pumps 2A and 2C, CCW pumps 3A and 3C, RW pumps 10A and 10C, and AFW pump FW-6. The TPCS event tree is used for this initiating event.
2. The diesel driven AFW pump requires operator to start and align. The HEP is $3.2E-4$ (Event OPER-40 on page 3.3-18) which is lower than the generic credit of 2 based on the HEPs of CE plants. In this worksheet, the generic credit is used. Makeup is needed if FW-54 is not available. The HEP for operator failure to provide makeup is $3.E-3$ (Event AHFFFEFWST on page 3.3-17.)
3. The HEP for operator failure to initiate feed and bleed, is $2.3E-3$ (Event OPER-41 on page 3.3-18) which is lower than the generic credit of 2 based on the HEPs of CE plants. In this worksheet, the generic credit is used.

Table 3.12 SDP Worksheet for Fort Calhoun Power Station — Loss of 4kv bus 1A4 (L4KV1A4)

Estimated Frequency (Table 1 Row) _____ Exposure Time _____ Table 1 Result (circle): A B C D E F G H			
Safety Functions Needed: Secondary Heat Removal (AFW) Feed/Bleed (FB) High Pressure Safety Injection (EIHP) High Pressure Recirc (HPR) Containment Press/Temp Control (CNT)		Full Creditable Mitigation Capability for Each Safety Function: 1/1 MDAFW trains (1 train) or 1/1 TDAFW train (1 ASD train) or 1/1 Diesel Driven train (FW-54) (operator action = 2) ⁽²⁾ and steam relief through 1/8 safety valves or 1/2 solenoid operated safety valves 1/1 PORVs open for Feed/Bleed (operator action = 2) ⁽³⁾ 1/1 HPSI train (2 pumps) taking suction from SIRWT (1 train) 1/1 HPSI train (2 pumps) taking suction from sump (1 train) 1/1 CS Train (1 pump) in Recirc. mode through 1/2 SDC HXs. (1 train) or 1/1 CFCU train (1 train)	
<u>Circle Affected Functions</u>	<u>Recovery of Failed Train</u>	<u>Remaining Mitigation Capability Rating for Each Affected Sequence</u>	<u>Sequence Color</u>
1 L4KV1A4 - AFW - HPR (3)			
2 L4KV1A4 - AFW - CNT (4)			
3 L4KV1A4 - AFW - EIHP (5)			
4 L4KV1A4 - AFW - FB (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 frequency of loss AC bus 1A4 is $2.94E-4$ per year. It leads to loss of PCS and the equipment on the bus, a PORV, CS pump 3B and 3C, CFCU train B, LPSI pump 1B, HPSI pump 2B, CCW pumps 3B, and RW pumps 10B and 10D. The TPCS event tree is used for this initiating event.
2. The diesel driven AFW pump requires operator to start and align. The HEP is $3.2E-4$ (Event OPER-40 on page 3.3-18) which is lower than the generic credit of 2 based on the HEPs of CE plants. In this worksheet, the generic credit is used. Makeup is needed if FW-54 is not available. The HEP for operator failure to provide makeup is $3.E-3$ (Event AHFFFEWST on page 3.3-17.)
3. The HEP for operator failure to initiate feed and bleed, is $2.3E-3$ (Event OPER-41 on page 3.3-18) which is lower than the generic credit of 2 based on the HEPs of CE plants. In this worksheet, the generic credit is used.

Table 3.13 SDP Worksheet for Fort Calhoun Power Station — Loss of 125v DC Bus 1 (LDCBUS1)

Estimated Frequency (Table 1 Row) _____		Exposure Time _____		Table 1 Result (circle): A B C D E F G H							
<u>Safety Functions Needed:</u> Secondary Heat Removal (AFW) Feed/Bleed (FB) High Pressure Safety Injection (EIHP) High Pressure Recirc (HPR) Containment Press/Temp Control (CNT)				<u>Full Creditable Mitigation Capability for Each Safety Function:</u> 1 TDAFW train (1 ASD train) or 1/1 Diesel Driven train (FW-54) (operator action = 2) ⁽²⁾ and steam relief through 1/8 safety valves or 1/2 solenoid operated safety valves 1/2 PORVs open for Feed/Bleed (operator action = 2) ⁽³⁾ 1/1 HPSI train (1 pump) taking suction from SIRWT (1 train) 1/1 HPSI train (1 pump) taking suction from sump (1 train) 1/1 CS Train (2 pumps) in Recirc. mode through the 1/1 SDC HXs. (1 train) or 1/1 CFCU train (1 train)							
<u>Circle Affected Functions</u>	<u>Recovery of Failed Train</u>	<u>Remaining Mitigation Capability Rating for Each Affected Sequence</u>						<u>Sequence Color</u>			
1 LDCBUS1 - AFW - HPR (3)											
2 LDCBUS1 - AFW - CNT (4)											
3 LDCBUS1 - AFW - EIHP (5)											
4 LDCBUS1 - AFW - FB (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 frequency of loss DC bus 1 is $3.E-3$ per year. It has the same impacts as those of a loss of AC bus 1A3. It leads to loss of PCS and the equipment on the bus, CS pump 3A, CFCU train A, LPSI pump 1A, HPSI pumps 2A and 2C, CCW pumps 3A and 3C, RW pumps 10A and 10C, and AFW pump FW-6. The TPCS event tree is used for this initiating event.
2. The diesel driven AFW pump requires operator to start and align. The HEP is $3.2E-4$ (Event OPER-40 on page 3.3-18) which is lower than the generic credit of 2 based on the HEPs of CE plants. In this worksheet, the generic credit is used. Makeup is needed if FW-54 is not available. The HEP for operator failure to provide makeup is $3.E-3$ (Event AHFFFEWST on page 3.3-17.)
3. The HEP for operator failure to initiate feed and bleed, is $2.3E-3$ (Event OPER-41 on page 3.3-18) which is lower than the generic credit of 2 based on the HEPs of CE plants. In this worksheet, the generic credit is used.

Table 3.14 SDP Worksheet for Fort Calhoun Power Station — Loss of 125v DC Bus 2 (LDCBUS2)

Estimated Frequency (Table 1 Row) _____ Exposure Time _____ Table 1 Result (circle): A B C D E F G H			
<u>Safety Functions Needed:</u> Secondary Heat Removal (AFW) Feed/Bleed (FB) High Pressure Safety Injection (EIHP) High Pressure Recirc (HPR) Containment Press/Temp Control (CNT)		<u>Full Creditable Mitigation Capability for Each Safety Function:</u> 1/1 MDAFW trains (1 train) or 1/1 TDAFW train (1 ASD train) or 1/1 Diesel Driven train (FW-54) (operator action = 2) ⁽²⁾ and steam relief through 1/8 safety valves or 1/2 solenoid operated safety valves 1/2 PORVs open for Feed/Bleed (operator action = 2) ⁽³⁾ 1/1 HPSI trains (2 pumps) taking suction from SIRWT (1 train) 1/1 HPSI trains (2 pumps) taking suction from sump (1 train) 1/1 CS Train (1 pump) in Recirc. mode through 1/2 SDC HXs. (1 train) or 1/1 CFCU train (1 train)	
<u>Circle Affected Functions</u>	<u>Recovery of Failed Train</u>	<u>Remaining Mitigation Capability Rating for Each Affected Sequence</u>	<u>Sequence Color</u>
1 LDCBUS2 - AFW - HPR (3)			
2 LDCBUS2 - AFW - CNT (4)			
3 LDCBUS2 - AFW - EIHP (5)			
4 LDCBUS2 - AFW - FB (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 frequency of loss DC bus 24 is $3E-3$ per year. Its impacts are the same as those of a loss of 4kv bus 1A4. It leads to loss of PCS and the equipment on the bus, CS pump 3B and 3C, CFCU train B, LPSI pump 1B, HPSI pump 2B, CCW pumps 3B, and RW pumps 10B and 10D. The TPCS event tree is used for this initiating event.
2. The diesel driven AFW pump requires operator to start and align. The HEP is $3.2E-4$ (Event OPER-40 on page 3.3-18) which is lower than the generic credit of 2 based on the HEPs of CE plants. In this worksheet, the generic credit is used. Makeup is needed if FW-54 is not available. The HEP for operator failure to provide makeup is $3.E-3$ (Event AHFFFEWST on page 3.3-17.)
3. The HEP for operator failure to initiate feed and bleed, is $2.3E-3$ (Event OPER-41 on page 3.3-18) which is lower than the generic credit of 2 based on the HEPs of CE plants. In this worksheet, the generic credit is used.

Table 3.15 SDP Worksheet for Fort Calhoun Power Station — LOOP with Loss of 1 EDG (LOOP1EDG)⁽¹⁾

Estimated Frequency (Table 1 Row) _____ Exposure Time _____ Table 1 Result (circle): A B C D E F G H			
Safety Functions Needed: Stuck Open PORV (SORV) Secondary Heat Removal (AFW) Feed/Bleed (FB) High Pressure Safety Injection (EIHP) High Pressure Recirc (HPR) Containment Press/Temp Control (CNT)		Full Creditable Mitigation Capability for Each Safety Function: 1/1 PORV re-close (1 train) 1 TDAFW train (1 ASD train) or 1/1 Diesel Driven train (FW-54) (operator action = 2) ⁽²⁾ and steam relief through 1/8 safety valves or 1/2 solenoid operated safety valves 1/1 PORVs open for Feed/Bleed (operator action = 2) ⁽³⁾ 1/1 HPSI train (1 pump) taking suction from SIRWT (1 train) 1/1 HPSI train (1 pump) taking suction from sump (1 train) 1/1 CS Trains (2 pumps) in Recirc. mode through the 1/1 SDC HXs. (1 train) or 1/1 CFCU train (1 train)	
<u>Circle Affected Functions</u>	<u>Recovery of Failed Train</u>	<u>Remaining Mitigation Capability Rating for Each Affected Sequence</u>	<u>Sequence Color</u>
1 LOOP1EDG - AFW - HPR (3)			
2 LOOP1EDG - AFW - CNT (4)			
3 LOOP1EDG - AFW - EIHP (5)			
4 LOOP1EDG - AFW - FB (6)			

5 LOOP1EDG - SORV - HPR (8)			
6 LOOP1EDG - SORV - CNT (9)			
7 LOOP1EDG - SORV - EIHP (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. This worksheet was developed to supplement the LOOP worksheet in modeling the condition in which only one EDG is available. Depending on which EDG is available, the impacts on the plant vary, as can be seen in the differences between the worksheets for L4KV1A3 and L4KV1A4. This worksheet assumes that EDG D1, i.e, bus 1A3, is lost. The loss of EDG leads to loss of the equipment on the bus, a PORV, CS pump 3A, CFCU train A. LPSI pump 1A, HPSI pumps 2A and 2C, CCW pumps 3A and 3C, RW pumps 10A and 10C, and AFW pump FW-6.
2. The diesel driven AFW pump requires operator to start and align. The HEP is $3.2E-4$ (Event OPER-40 on page 3.3-18) which is lower than the generic credit of 2 based on the HEPs of CE plants. In this worksheet, the generic credit is used. Makeup is needed if FW-54 is not available. The HEP for operator failure to provide makeup is $3.E-3$ (Event AHFFFEFWST on page 3.3-17.)
3. The HEP for operator failure to initiate feed and bleed, is $2.3E-3$ (Event OPER-41 on page 3.3-18) which is lower than the generic credit of 2 based on the HEPs of CE plants. In this worksheet, the generic credit is used.

Table 3.16 SDP Worksheet for Fort Calhoun Power Station — Loss of Component Cooling Water (LCCW)

Estimated Frequency (Table 1 Row) _____ Exposure Time _____ Table 1 Result (circle): A B C D E F G H			
Safety Functions Needed: RCP Trip (RCPTRIP) Secondary Heat Removal (AFW) Feed/Bleed (FB) High Pressure Safety Injection (EIHP) Raw Water Backup (RWBU) High Pressure Recirc (HPR) Containment Press/Temp Control (CNT)		Full Creditable Mitigation Capability for Each Safety Function: Operator trips RCPs to prevent a seal (operator action = 3) ⁽¹⁾ 1/1 MDAFW trains (1 train) or 1/1 TDAFW train (1 ASD train) or 1/1 Diesel Driven train (FW-54) (operator action = 2) ⁽²⁾ and steam relief through 1/8 safety valves or 1/2 solenoid operated safety valves 1/2 PORVs open for Feed/Bleed (operator action = 2) ⁽³⁾ 1/2 HPSI trains (3 pumps) taking suction from SIRWT (1 multi-train system) Operator establish raw water back up to CCW (operator action = 3) ⁽⁴⁾ 1/2 HPSI trains (3 pumps) taking suction from sump (1 multi-train system) 1/2 CS Train (3 pumps) in Recirc. mode through the SDC HXs. (1 multi-train system) or 1/2 CFCU trains (1 multi train system)	
<u>Circle Affected Functions</u>	<u>Recovery of Failed Train</u>	<u>Remaining Mitigation Capability Rating for Each Affected Sequence</u>	<u>Sequence Color</u>
2 LCCW - AFW - HPR (3,14)			
3 LCCW - AFW - CNT (4,15)			
4 LCCW - AFW - RWBU (5,16)			
5 LCCW - AFW - EIHP (6,17)			

6 LCCW - AFW - FB (7,18)			
7 LCCW - RCPTRIP - HPR (9)			
8 LCCW - RCPTRIP - CNT (10)			
9 LCCW - RCPTRIP - RWBU (11)			
10 LCCW - RCPTRIP - EIHP (12)			
<p>Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:</p> <p>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.</p>			

Notes:

1. Loss of CCW has a frequency of $1.55E-2$ per year. It requires a manual reactor trip, and causes loss of cooling to containment spray, high pressure injection, low pressure safety injection, CFCUs, control room HVAC, charging pump lube oil coolers, RCP seal/lube oil coolers, and SDC heat exchangers. The operator needs to trip the RCPs if they are not tripped automatically. The Raw water system can be used to provide cooling to all of the above except the charging pump lube oil coolers and RCP seal/lube oil coolers. The IPE does not document the HEP associated with the needed operator actions. A generic credit of 3 for operator failure to trip the RCPs, based on the HEPs of CE plants, is used for all these actions. It is assumed that failure to do so would lead to a seal LOCA with loss of the systems needed to mitigate it.

2. The diesel driven AFW pump requires operator to start and align. The HEP is $3.2E-4$ (Event OPER-40 on page 3.3-18) which is lower than the generic credit of 2 based on the HEPs of CE plants. In this worksheet, the generic credit is used. Makeup is needed if FW-54 is not available. The HEP for operator failure to provide makeup is $3.E-3$ (Event AHFFEFWST on page 3.3-17.)
3. The HEP for operator failure to initiate feed and bleed, is $2.3E-3$ (Event OPER-41 on page 3.3-18) which is lower than the generic credit of 2 based on the HEPs of CE plants. In this worksheet, the generic credit is used.
4. The HEP is $7.2E-4$ (Event WHFRWBKUP on page 3.3-19.)

Table 3.17 SDP Worksheet for Fort Calhoun Power Station — Loss of Raw Water (LRW)

Estimated Frequency (Table 1 Row) _____ Exposure Time _____ Table 1 Result (circle): A B C D E F G H			
Safety Functions Needed: RCP Trip (RCPTRIP) Secondary Heat Removal (AFW)		Full Creditable Mitigation Capability for Each Safety Function: Operator trips RCPs to prevent a seal LOCA (operator action = 3) ⁽¹⁾ 1/1 MDAFW trains (1 train) or 1/1 TDAFW train (1 ASD train) or 1/1 Diesel Driven train (FW-54) (operator action = 2) ⁽²⁾ and steam relief through 1/8 safety valves or 1/2 solenoid operated safety valves	
Circle Affected Functions	Recovery of Failed Train	Remaining Mitigation Capability Rating for Each Affected Sequence	Sequence Color
1 LRW - AFW (2)			
2 LRW - RCPTRIP(3)			
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:

- Loss of Raw Water has a frequency of 1.49E-2 per year. It requires a manual reactor trip, and causes a loss of cooling to CCW heat exchangers. As a result of the loss of CCW, cooling is lost to containment spray, high pressure injection, low pressure safety injection, CFCUs, control room

HVAC, charging pump lube oil coolers, RCP seal/lube oil coolers, and SDC heat exchangers. The operator needs to trip the RCPs if they are not tripped automatically. The IPE does not document the HEP associated with the operator action. A generic credit of 3 based on the HEPs of CE plants is used. Failure to do so would lead to a seal LOCA with loss of the systems needed to mitigate it.

2. The diesel driven AFW pump requires operator to start and align. The HEP is $3.2E-4$ (Event OPER-40 on page 3.3-18) which is lower than the generic credit of 2 based on the HEPs of CE plants. In this worksheet, the generic credit is used. Makeup is needed if FW-54 is not available. The HEP for operator failure to provide makeup is $3.E-3$ (Event AHFFEFWST on page 3.3-17.)

Table 3.18 SDP Worksheet for Fort Calhoun Power Station — Loss of Instrument Air (LIA) ⁽¹⁾

Estimated Frequency (Table 1 Row) _____ Exposure Time _____ Table 1 Result (circle): A B C D E F G H			
Safety Functions Needed: Secondary Heat Removal (AFW) Feed/Bleed (FB) High Pressure Safety Injection (EIHP) High Pressure Recirc (HPR) Containment Press/Temp Control (CNT)		Full Creditable Mitigation Capability for Each Safety Function: [1/1 MDAFW trains or 1/1 TDAFW train or 1/1 Diesel Driven train (FW-54)] (operator action = 2) ⁽²⁾ and steam relief through 1/8 safety valves or 1/2 solenoid operated safety valves 1/2 PORVs open for Feed/Bleed (operator action = 2) ⁽³⁾ 1/2 HPSI trains (3 pumps) taking suction from SIRWT (1 multi-train system) 1/2 HPSI trains (3 pumps) taking suction from sump (1 multi-train system) 1/2 CS Train (3 pumps) in Recirc. mode through the SDC HXs. (1 multi-train system) or 1/2 CFCU trains (1 multi train system)	
<u>Circle Affected Functions</u>	<u>Recovery of Failed Train</u>	<u>Remaining Mitigation Capability Rating for Each Affected Sequence</u>	<u>Sequence Color</u>
1 LIA - AFW - HPR (3)			
2 LIA - AFW - CNT (4)			
3 LIA - AFW - EIHP (5)			
4 LIA - AFW - FB (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) Loss of instrument air has a frequency of $3.13E-2$ per year. It causes loss of main feedwater, atmosphere dump valve, and Raw Water back up to the CCW. The system description states that the air operated valves are designed to fail in the safe position and safety related air operated devices that must remain operable after an accident are equipped with air accumulators. The dependency of AFW is due to the failure open of the flow control valves. The TPCS event tree can be used for this initiating event.
- (2) Due to failure open of the flow control valves, the operator has to manual control the feed flow to the SGs. The HEP is $1.E-3$ (Event AHFCONTROL on page 3.3-17.) A credit of 3 is used for this action. The diesel driven AFW pump requires operator to start and align. The HEP is $3.2E-4$ (Event OPER-40 on page 3.3-18) which is lower than the generic credit of 2 based on the HEPs of CE plants. In this worksheet, the generic credit is used. Makeup is needed if FW-54 is not available. The HEP for operator failure to provide makeup is $3.E-3$ (Event AHFFFEFWST on page 3.3-17.)
- (3) The HEP for operator failure to initiate feed and bleed, is $2.3E-3$ (Event OPER-41 on page 3.3-18) which is lower than the generic credit of 2 based on the HEPs of CE plants. In this worksheet, the generic credit is used.

Table 3.19 SDP Worksheet for Fort Calhoun Power Station — Interfacing System LOCA (ISLOCA)⁽¹⁾

Estimated Frequency (Table 1 Row) _____ Exposure Time _____ Table 1 Result (circle): A B C D E F G H			
Initiating Pathways: LPSI SDC Line (penetration 16) LPSI Injection Lines (penetration 17) 4 RCP Seal Cooler (penetrations 18,19) CVCS letdown line (penetration 2)		Mitigation Capability: Ensure Component Operability for Each Pathway: Two MOVs HCV-347 and HCV-348 with a relief valve, SI-188, in between Four Injection Lines, each with two check valve and one MOV in series (SI-280, SI-194 and HCV-331), (SI-212, SI-197, and HCV-333), (SI-216, SI-200, and HCV-329), and (SI-220, SI-205, and HCV-327) Seal cooler tube rupture can potentially be isolated by depressurizing RCS and closing the MOVs (HCV-438C and D) Letdown control valves LCV-101-1 and 2, relief valve CH-223, letdown stop valves TCV-202 and HCV-204	
<u>Circle Affected Functions</u>	<u>Recovery of Failed Train</u>	<u>Remaining Mitigation Capability Rating for Each Affected Pathway</u>	<u>Sequence Color</u>
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. Information is provided based on licensee's comments and input. Other sources of ISLOCA are not included due to very low likelihood of occurrence.

1.4 SDP EVENT TREES

This section provides the simplified event trees called SDP event trees used to define the accident sequences identified in the SDP worksheets in the previous section. An event tree for the stuck-open PORV is not included since it is similar to the small LOCA event tree. The event tree headings are defined in the corresponding SDP worksheets.

The following event trees are included:

1. Transients (Reactor Trip) (TRANS)
2. Transients without PCS (TPCS)
3. Small LOCA (SLOCA)
4. Stuck-open PORV (SORV)
5. Medium LOCA (MLOCA)
6. Large LOCA (LLOCA)
7. Loss of Offsite Power (LOOP)
8. Steam Generator Tube Rupture (SGTR)
9. Main Line Steam Break (MSLB)
10. Anticipated Transients Without Scram (ATWS)
11. LOOP with Loss of 1 EDG (LOOP1EDG)
12. Loss of Component Cooling Water (LCCW)
13. Loss of Raw Water (LRW)

TRANS	PCS	AFW	FB	EIHP	CNT	HPR	#	STATUS
							1	OK
							2	OK
							3	OK
							4	CD
							5	CD
							6	CD
							7	CD

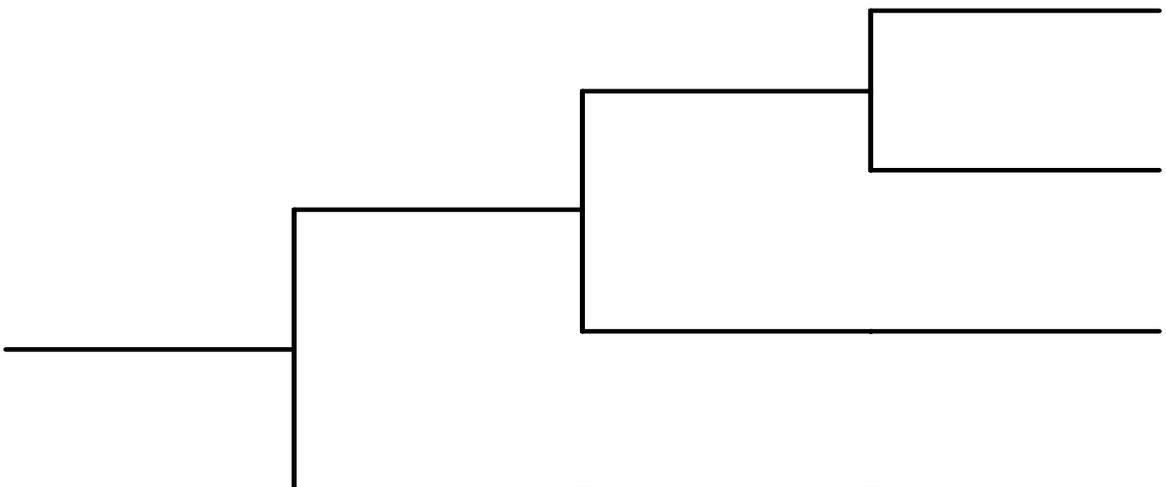
Plant Name Abbrev.: FCAL

SLOCA	PCS	AFW	FB	EIHP	HPR	CNT	#	STATUS
							1	OK
							2	CD
							3	CD
							4	CD
							5	OK
							6	CD
							7	CD
							8	CD
							9	OK
							10	CD
							11	CD
							12	CD
							13	CD

Plant Name Abbrev.: FCAL

SORV	BLK	PCS	AFW	FB	EIHP	HPR	CNT	#	STATUS
								1	TRANS
								2	OK
								3	CD
								4	CD
								5	CD
								6	OK
								7	CD
								8	CD
								9	CD
								10	OK
								11	CD
								12	CD
								13	CD
								14	CD

Plant Name Abbrev.: FCAL

ML OCA	EIHP	HPR	CNT	#	STATUS
 <p data-bbox="756 1218 1470 1282">Plant name e abbrev.: FCAL</p>					1 OK
					2 CD
					3 CD
					4 CD

LLOCA	SIT	EIHP	EILP	HPR	CNT	#	STATUS
						1	OK
						2	CD
						3	CD
						4	OK
						5	CD
						6	CD
						7	CD
						8	CD

Plant Name Abbrev.: FCAL

LOOP	EAC	TDAFW	REC1	REC8	AFW	FB	EIHP	HPR	CNT	#	STATUS
										1	OK
										2	OK
										3	CD
										4	CD
										5	CD
										6	CD
										7	OK
										8	CD
										9	CD
										10	CD
										11	CD
										12	CD
										13	OK
										14	CD
										15	CD
										16	CD
										17	CD
										18	CD

Plant Name Abbrev.: FCAL

SG TR	AFW	EQ	EIHP	FB	SIR WT	SDC	#	STATUS
							1	OK
							2	OK
							3	OK
							4	CD
							5	CD
							6	OK
							7	CD
							8	CD
							9	CD

Plant Name Abbrev.: FCAL

MSLB	ISOB	ISO	AFW	EIHP	FB	HPR	#	STATUS
							1	TPCS
							2	OK
							3	OK
							4	CD
							5	CD
							6	CD
							7	CD

Plant Name Abbrev.: FCAL

ATWS	TTP	SRV	BORATE	AFW	#	STATUS
					1	OK
					2	CD
					3	CD
					4	CD
					5	CD

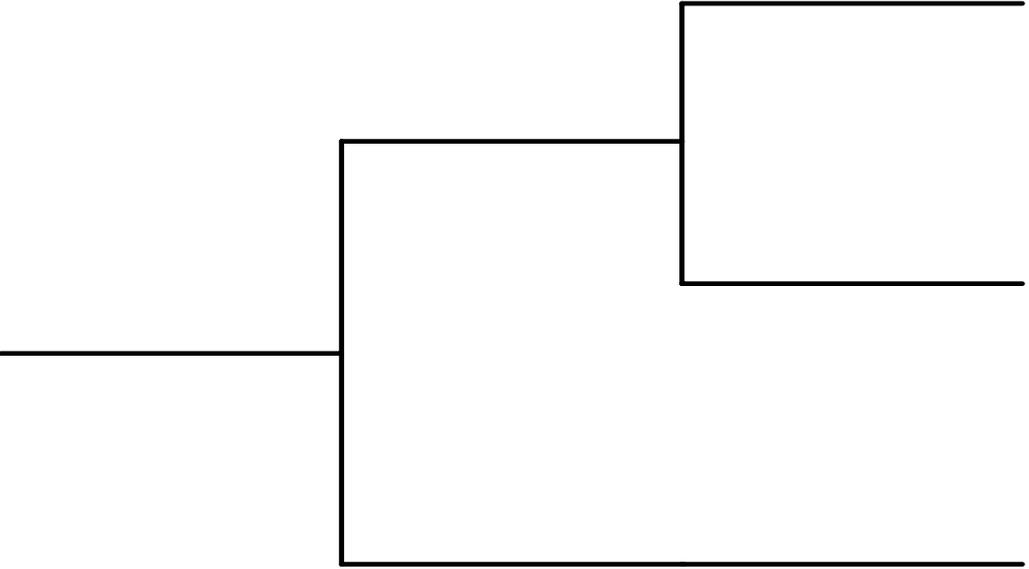
Plant Name Abbrev.: FCAL

LOOPIEDG	SORV	AFW	FB	EIHP	CNT	HPR	#	STATUS
							1	OK
							2	OK
							3	CD
							4	CD
							5	CD
							6	CD
							7	OK
							8	CD
							9	CD
							10	CD

Plant Name Abbrev.: FCAL

LCCW	RCPTRIP	AFW	FB	EIHP	RWBU	CNT	HPR	#	STATUS
								1	OK
								2	OK
								3	CD
								4	CD
								5	CD
								6	CD
								7	CD
								8	OK
								9	CD
								10	CD
								11	CD
								12	CD
								13	OK
								14	CD
								15	CD
								16	CD
								17	CD
								18	CD

Plant Name Abbrev.: FCAL

LRW	RCPTRIP	AFW	#	STATUS
				1 OK
2 CD				
3 CD				

Plant Name Abbrev.: FCAL

2. RESOLUTION AND DISPOSITION OF COMMENTS

This section is composed of two subsections. Subsection 2.1 summarizes the generic assumptions that were used for developing the SDP worksheets for the PWR plants. These guidelines were based on the plant-specific comments provided by the licensee on the draft SDP worksheets and further examination of the applicability of those comments to similar plants. These assumptions which are used as guidelines for developing the SDP worksheets help the reader better understand the worksheets' scope and limitations. The generic guidelines and assumptions for PWRs are given here. Subsection 2.2 documents the plant-specific comments received on the draft version of the material included in this notebook and their resolution.

2.1 GENERIC GUIDELINES AND ASSUMPTIONS (PWRs)

The following generic guidelines and assumptions were used in developing the SDP worksheets for PWRs. These guidelines and assumptions were derived from a review of the licensee's comments, the resolutions of those comments, and the applicability to similar plants.

1. Assignment of plant-specific IEs into frequency rows:

Transient (Reactor trip) (TRANS), transients without PCS (TPCS), small, medium, and large LOCA (SLOCA, MLOCA, LLOCA), inadvertent or stuck-open PORV/SRV (SORV), main steam and feedwater line break (MSLB), anticipated transients without scram (ATWS), and interfacing system LOCAs (ISLOCA) are assigned into rows based on a consideration of the industry-average frequency. Plant-specific frequencies are considered for loss of offsite power (LOOP) and special initiators, and are assigned to the appropriate rows in Table 1.

2. Stuck open PORV/SRV as an IE in PWRs:

This event typically is not modeled in PRAs/IPEs as an initiating event. The failure of the PORVs/SRVs to re-close after opening is typically modeled within the transient event trees subsequent to the initiators. In addition, the intermittent failure or excessive leakage through PORVs as an initiator, albeit with much lower frequency, needed to be considered. To account for such failures and to keep the transient worksheets simple in the SDP, a separate worksheet for the SORV initiator was set up to explicitly model the contribution from such failures. This SDP worksheet, and the associated event tree, is similar to that of SLOCA. The frequency of PORV to re-close depends on the status of pressurizer. If the pressurizer is solid, then the frequency would be higher than the case in which the pressurizer level is maintained. Typically, this depends on early availability of secondary heat removal. However, the frequency for the SORV initiator is generically estimated for all PWR plants in Table 1.

3. Inclusion of special initiators:

The special initiators included in the worksheets are those applicable to this plant. A separate worksheet is included for each of them. The applicable special initiators are primarily based on the plant-specific IPEs/PRAs. In other words, the special initiators included are those modeled in the IPEs/PRAs unless shown to be negligible contributors. In some cases, a particular special initiator may be added for a plant even if it is not included in the IPE/PRA, if it is included in other plants of similar design, and is considered applicable for the plant. However, no attempt is made at this time to have a consistent set of special initiators across similarly designed plants. Except for the interfacing system LOCA (ISLOCA), if the occurrence of the special initiator results in a core damage, i.e., no mitigation capability exists for the initiating event, then a separate worksheet is not developed. For such cases, the inspection's focus is on the initiating event and the risk implication of the finding can be directly assessed. For ISLOCA, a separate worksheet is included noting the pathways that can lead to it.

4. Inclusion of systems under the support system column of the Initiators and System Dependency Table:

This Table shows the support systems for the support- and frontline systems. The intent is to include only the support systems, and not the systems supporting that support system, i.e., those systems whose failure will result in failure of the system being supported. Partial dependency, e.g., a backup system, is not included. If they are, this should be so noted. Sometimes, some subsystems on which inspection findings may be noted were included as a support system, e.g., the EDG fuel oil transfer pump as a support system for EDGs.

5. Coverage of system/components and functions included in the SDP worksheets:

The Initiators and System Dependency Table includes systems and components which are included in the SDP worksheets and those which can affect the performance of these systems and components. One-to-one matching of the event tree headings/functions to that included in the Table was not considered necessary.

6. Crediting of non-safety related equipment:

SDP worksheets credit or include safety-related equipment and also, non-safety related equipment, as used, in defining the accident sequences leading to core damage. In defining the success criteria for the functions needed, the components included are those covered under the Technical Specifications (TS) and the Maintenance Rule (MR). Credits for other components may have been removed in the SDP worksheets.

7. No credit for certain plant-specific mitigation capability:

The significance determination process (SDP) screens inspection findings for Phase 3 evaluations. Some conservative assumptions are made which result in not crediting some plant-specific features. Such assumptions are usually based on comparisons with plants of similar design, and they help to maintain consistency across the SDP worksheets for similar plant designs.

8. Crediting system trains with high unavailability:

Some system component/trains may have unavailability higher than 1E-2, but they are treated similarly to other trains with lower unavailability in the range of 1E-2. In this screening, this approach is considered adequate to keep the process simple. An exception is made for steam-driven components which are designated as Automatic Steam Driven (ASD) train with a credit of 1E-1.

9. Treating passive components (of high reliability) the same as active components:

Passive components, namely accumulators, are credited similarly to active components, even though they exhibit higher reliability. Considering the potential for common-cause failures, the reliability of a passive system is not expected to differ by more than an order of magnitude from active systems. Pipe failures were excluded, except as part of initiating events where the appropriate frequency is used. Accordingly, a separate designation for passive components was not considered necessary.

10. Crediting accumulators:

SDP worksheets assume the loss of the accumulator unit associated with the failed leg in LOCA scenarios. Accordingly, in defining the mitigation capability for the accumulators, the worksheets refer to the remaining accumulators. For example, in a plant with 4 accumulators with a success criteria of 1 out of 4, for large LOCA the mitigation capability is defined as 1/3 remaining accumulators (1 multi-train system), assuming the loss of the accumulator in the failed leg. For a plant with a success criteria of 2 out of 4 accumulators, the mitigation capability is defined as 2/3 remaining accumulators (1 multi-train system).

The inspection findings are then assessed as follows (using the example of the plant with 4 accumulators and success criteria of 2 out of 4):

4 Acc. Available	Credit=3
3 Acc. Available (1 Acc. is considered unavailable, based on inspection findings)	Credit=2
< 3 Acc. Available (2 or more Acc. are considered unavailable, Based on inspection findings)	Credit=0

11. Crediting operator actions:

The operator's actions modeled in the worksheets are categorized as follows: operator action=1 representing an error probability of 5E-2 to 0.5; operator action=2 representing an error probability of 5E-3 to 5E-2; operator action=3 representing an error probability of 5E-4 to 5E-3; and operator action=4 representing an error probability of 5E-5 to 5E-4. Actions with error probability > 0.5 are not credited. Thus, operator actions are associated with credits of 1, 2, 3, or 4. Since there is large variability in similar actions among different plants, a survey of the error probability across plants of similar design was used to categorize different operator actions. From this survey, similar actions across plants of similar design are assigned the same credit. If a plant uses a lower credit or recommends a lower credit for a particular action compared to our assessment of similar action based on plant survey, then the lower credit is assigned. An operator's action with a credit of 4, i.e., operator action=4, is noted at the bottom of the worksheet; the corresponding hardware failure, e.g., 1 multi-train system, is defined in the mitigating function.

12. Difference between plant-specific values and SDP designated credits for operator actions:

As noted, operator actions are assigned to a particular category based on a review of similar actions for plants with similar design. This results in some differences between plant-specific values and credit for the action in the worksheet. The plant-specific values are usually noted at the bottom of the worksheet.

13. Dependency among multiple operator actions:

IPEs or PRAs, in general, account for dependencies among the multiple operator actions that may be applicable. In the SDP screening approach, if multiple actions are involved in one function, then the credit for the function is designated as one operator action to the extent possible, considering the dependency involved.

14. Crediting the standby high-pressure pump:

The high-pressure injection system in some plants consists of three pumps with two of them auto-aligned and the third spare pump requiring manual action. The mitigating capability then is defined as : 1/2 HPI trains or use of a spare pump (1 multi-train system). Also, a footnote is added to reflect that the use of a spare pump could be given a credit of 1 (i.e., 1E-1) as a recovery action.

15. Emergency AC Power:

The full mitigating capability for emergency AC could include dedicated Emergency Diesel Generators (EDG), Swing EDG, SBO EDG, and finally, nearby fossil-power plants. The following guidelines are used in the SDP modeling of the Emergency AC power capability:

- a) Describe the success criteria and the mitigation capability of dedicated EDGs.
- b) Assign a mitigating capability of "operator action=1" for a swing EDG. The SDP worksheet assumes that the swing EDG is aligned to the other unit at the time of the LOOP (in a sense a dual unit LOOP is assumed). The operator, therefore, should trip, transfer, re-start, and load the swing EDG.
- c) Assign a mitigating capability of "operator action=1" for an SBO EDG similar to the swing EDG. Note, some of the PWRs do not take credit for an SBO EDG for non-fire initiators. In these cases, credit is not given.
- d) Do not credit the nearby power station as a backup to EDGs. The offsite power source from such a station could also be affected by the underlying cause for the LOOP. As an example, overhead cables connecting the station to the nuclear power plant also could have been damaged due to the bad weather which caused the LOOP. This level of detail should be left for a Phase 3 analysis.

(16) Treatment of HPR and LPR:

The operation of both the HPR and LPR rely on the operation of the RHR pumps and the associated heat exchangers. Therefore, failure of LPR could imply failure of both HPR and LPR. A sequence which contains failure of both HPR and LPR as independent events will significantly underestimate the CDF contribution. To properly model this configuration within the SDP worksheets, the following procedure is used. Consider the successful depressurization and use of LPR as the preferred path. HPR is credited when depressurization has failed. In this manner, a sequence containing both HPR and LPR failures together is not generated.

(17) SGTR event tree:

Event trees for SGTR vary from plant to plant depending on the size of primary-to-secondary leak, SG relief capacity, and the rate of rapid depressurization. However, there are several common functional steps that are addressed in the SDP worksheet: early isolation of the affected SG, initiation of primary cool-down and depressurization, and prevention of the SG overfill. These actions also include failure to maintain the secondary pressure below that of Main Steam safety valves which could occur either due to the failure of the relief valves to open or the operator's failure to follow the procedure. Failure to perform this task (sometimes referred to as early isolation and equalization) is assumed to cause continuous leakage of primary outside the containment. The success of this step implies the need for high-pressure makeup for a short period, followed by depressurization and cooldown for RHR entry (note, relief valves are assumed to re-close when primary pressure falls below that of the secondary). If the early makeup is not available or the operator fails to perform early isolation and equalization, rapid depressurization to RHR entry is usually assumed. This would typically require some kind of intermediate- or low-pressure makeup. Finally, depending on the size of the Refueling Water Storage Tank (RWST), sometimes it would be necessary to establish makeup to the RWST to allow sufficient time to enter the RHR mode.

(18) ATWS scenarios:

The ATWS SDP worksheet assumes that these scenarios are not recoverable by operator actions, such as a manual trip. The failure of the scram system, therefore, is not recoverable, neither by the actuation of a back-up system nor through the actuation of manual scram. The initiator frequency, therefore, should only account for non-recoverable scrams, such as mechanical failure of the scram rods.

(19) Recovery of losses of offsite power:

Recovery of losses of offsite power is assigned an operator-action category even though it is usually dominated by a recovery of offsite AC, independent of plant activities. Furthermore, the probability of recovery of offsite power in "X" hours (for example 4 hours) given it is not recovered earlier (for example, in the 1st hour) would be different from recovery in 4 hours with no condition. The SDP worksheet uses a simplified approach for treating recovery of AC by denoting it as an operator action=1 or 2 depending upon the HEP used in the IPE/PRA. A footnote highlighting the actual value used in the IPE/PRA is provided, when available.

(20) RCP seal LOCA in a SBO:

The RCP seal LOCA in a SBO scenario is included in the LOOP worksheet. RCP seal LOCA resulting from loss of support functions is considered only if the loss of support function is a special initiator. The dependencies of RCP seal cooling are identified in Table 2.

(21) RCP Seal LOCA for Westinghouse Plants during SBO Scenarios:

The modeling of the RCP seal failures upon loss of cooling and injection as occurs during SBO scenarios has been the subject of many studies (e.g., BNL Technical report W6211-08/99 and Fort Calhoun

NUREG/CR-4906P). These studies are quite complex and assign probabilities of seal failure as a function of time (duration of SBO) and the associated leak rates. The leak rates, in turn, will determine what would be the safe period for recovery of the AC source and the use of SI pumps before core uncover and damage. On the contrary, the SDP worksheets simplify the analysis of the RCP seal LOCA during the SBO scenarios using the following two assumptions: (1) The probability of catastrophic RCP seal failure is assumed to be 1 if the SBO lasts beyond two hours, and (2) Given a catastrophic seal LOCA, the available time prior to core damage for recovery of offsite power and establishing injection is about two hours. Therefore, in almost all cases, to prevent a core damage, a source of AC should be recovered within 4 hours in SBO scenarios.

(22) Tripping the RCP on loss of CCW:

Upon loss of CCW, the motor cooling will be lost. The operation of RCPs without motor cooling could result in overheating and failure of bearings. Bearing failure, in turn, could cause the shaft to vibrate and thereby result in the potential for seal failure if the RCP is not tripped. In Westinghouse plants, the operator is instructed to trip the RCPs early in the scenario (from 2 to 10 minutes after detecting the loss of cooling). Failure to perform this action is conservatively assumed to result in seal failure and, potentially in a LOCA. This failure mechanism (occurrence of seal LOCA) due to failure to trip the RCPs upon loss of cooling is not considered likely in some plants, whereas it has been modeled explicitly in other plants. To ensure consistency, the trip of the RCP pumps are modeled in the SDP worksheets, and the operator failure to do this is assumed to result in a LOCA. In many cases, the failure to trip RCP following a loss of CCW results in core damage.

23. Hot leg/Cold leg switchover:

The hot leg to cold leg switchover during ECCS recirculation is typically done to avoid boron precipitation. This is typically part of the procedure for PWRs during medium and large LOCA scenarios. Some IPEs/PRAs do not consider the failure of this action as relevant to core damage. For plants needing the hot /cold switchover, it usually can only be accomplished with SI pumps and the ECCS recirculation also uses the SI pumps.

2.2 RESOLUTION OF PLANT-SPECIFIC COMMENTS

The utility comments are on the pilot version of the notebook.

- (1) The success criterion for CARC system in a transient was changed from 2/2 to 1/2. The need of SDC heat exchangers is specified.
- (2) Five ways of providing makeup to EFWST was specified in the worksheets. This is needed only if the DDAFWP, i.e., FW-54, is not available.
- (3) Use of shutdown cooling system is not necessary in a SLOCA.
- (4) "Accumulators" was changed to "Safety Injection Tanks."

REFERENCES

1. NRC SECY-99-007A, Recommendations for Reactor Oversight Process Improvements (Follow-up to SECY-99-007), March 22, 1999.
2. Omaha Public Power District, "Fort Calhoun Station Individual Plant Examination," December 1993.