UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

April 24, 2001

Mr. Randall K. Edington
Vice President - Operations
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SUBJECT: RIVER BEND STATION - RE: SITE-SPECIFIC WORKSHEETS FOR USE IN THE NUCLEAR REGULATORY COMMISSION'S SIGNIFICANCE DETERMINATION PROCESS (TAC NO. MA6544)

Dear Mr. Edington:

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 and is also publically available through the Nuclear Regulatory Commission (NRC) external website at http://www.nrc.gov/NRC/IM/index.html.

The 1999 Pilot Plant review effort clearly indicated that significant site-specific design and risk information was not captured in the Phase 2 worksheets forwarded to you last spring. Subsequently, a site visit was 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 Phase 2 Worksheets incorporate 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 forwarded to the Chief, Probabilistic Safety Assessment Branch, Nuclear Reactor Regulation. We will continue to assess SDP accuracy and update the document based on continuing experience.

While the 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.

We will coordinate our efforts through Mr. Robert L. Biggs, Coordinator, Safety and Regulatory Affairs, in the licensing organization. If you have any questions, please contact me at 301-415-1737

Sincerely,

Robert E. Moody, Project Manager
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Docket No. 50-458

Enclosure: As stated

cc w/encl: See next page

River Bend Station

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RISK-INFORMED INSPECTION NOTEBOOK FOR

RIVER BEND STATION

UNIT 1

BWR-6, GE, WITH MARK III CONTAINMENT

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NOTICE

This notebook was developed for the NRC's inspection teams to support risk-informed inspections. The "Reactor Oversight Process Improvement," SECY-99-007A, March 1999 discusses the activities involved in these inspections. 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. It 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 River Bend Station, Unit 1 .

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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TABLES

FIGURES

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. In Phase 2, the first step 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 Events Categories
2. Initiator and System Dependency Table
3. Significance Determination Process (SDP) Worksheets
4. SDP Event Trees.

Table 1, Categories of Initiating Events, is used to obtain the estimated likelihood rating for applicable initiating events for the plant for different exposures times for degraded conditions. This Table follows the format of the Table 1 contained in SECY-99-007A. Initiating events are grouped in frequency bins covering one order of magnitude. The table includes the initiating events that should be considered for the plant and for which SDP worksheets are provided. Categorization of the following initiating events is based on 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); anticipated transients without scram (ATWS); interfacing systems LOCA (ISLOCA) and LOCA outside containment (LOC). The frequency of the remaining initiating events vary significantly from plant to plant, and accordingly, they are categorized using the plant-specific frequency obtained from the licensee. These initiating events include loss of offsite power (LOOP) and special initiators caused by loss of support systems.

The Initiator 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 shown in Probabilistic Risk Assessments (PRAs). This table is used to identify the SDP worksheets to be evaluated, corresponding to inspection findings on systems and components.

To evaluate the impact of an inspection finding on the core-damage scenarios, we developed the SDP worksheets. They contain two parts. The first part identifies the functions, the systems, and the combinations thereof that can perform mitigating functions, the number of trains in each system, and the number of trains required (success criteria) for each 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 parentheses next to each of the sequences the corresponding event tree branch number(s) representing the sequence is included. Multiple branch numbers indicate that the different accident sequences identified by the event tree are merged into one through the Boolean reduction.

SDP worksheets are developed for each initiating event, including "Special Initiators," which are typically caused by complete or partial loss of support systems. A special initiator typically leads to a reactor scram and degrades some front-line or support systems (e.g., Loss of Service water in BWRs). The SDP worksheets for initiating events that directly lead to core damage are different. Of this type of initiating events, only the interfacing system LOCA (ISLOCA) and LOCA outside containment (LOC) are included. This worksheet identifies the major consequential leak paths and the number of barriers that may fail to cause the initiator to occur.

For the special initiators, we considered those plant-specific initiators whose contribution to the plant's core damage frequency (CDF) is non-negligible and/or have the potential to be a significant contributor to CDF given an inspection finding on system trains and components. We defined a set of criteria for their inclusion 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 changing its mitigation capability in the worksheet. For example, a safety function with two redundant trains, classified as a multi-train system, degrades to an one-train system, to be 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 accident sequences associated with the initiator from comparable transient sequences by two and higher orders of magnitude, must be considered.

Following the above considerations, the classes of initiators that we consider in this notebook are:

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. Inadvertent or Stuck-open Power Operated Relief Valve (IORV or SORV),
5. Medium LOCA (MLOCA),
6. Large LOCA (LLOCA),
7. Loss of Offsite Power (LOOP)
8. Anticipated Transients Without Scram (ATWS).

Section 1.3 lists the plant-specific special initiators addressed in this notebook. Examples of special initiators are as follows:

1. LOOP with failure of 1 Emergency AC (LEAC) bus or associated EDG (LEAC),
2. LOOP with stuck open SORV (LORV),

3. Loss of 1 DC Bus (LDC),
4. Loss of component cooling water (LCCW),
5. Loss of instrument air (LOIA),
6. Loss of service water (LSW).

The worksheet for the LOOP may include 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. LOOP with stuck open SORV is also covered in a separate worksheet, when applicable. In some plants, LOOP with failure of 1 EAC bus and LOOP with stuck-open SORV are large contributors to the plant's core damage frequency (CDF).

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.

We considered the following items in establishing the SDP event trees and the core-damage sequences in the SDP worksheets; Section 2.1 gives additional guidelines and assumptions.

1. Event trees and sequences were developed such that the worksheet contains all the major accident sequences identified by the plant-specific IPEs or PRAs. 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 took into account the IPE/PRA models and event trees for all similar plants. Any major deviations in one plant from similar plants typically are 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 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 often are represented by a single tree. For example, some IPEs define four or more classes of LOCAs rather than the three classes considered here. The sizes of LOCAs for which high-pressure injection is not required are some times divided into two classes; the only difference between them being the need for reactor scram in the smaller

break size. Some consolidation of transient event tree may also be done 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 the Categories of Initiating Events Table, Initiators and System Dependency Table, SDP Worksheets, and the SDP Event Trees for the River Bend Station, Unit 1.

1.1 RATINGS OF INITIATING EVENT LIKELIHOOD

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 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, as per SECY-99-007A.

Table 1 Categories of Initiating Events for River Bend Station, Unit 1

Row	Approximate Frequency	Example Event Type	Estimated Likelihood Rating		
I	> 1 per 1-10 yr	Reactor Trip, Loss of Power Conversion System (Loss of condenser, Closure of MSIVs, Loss of feedwater)	A	B	C
II	1 per 10-10^2 yr	Loss of offsite power (LOOP), Inadvertent or stuck open SRVs (SORV)	B	C	D
III	1 per 10^2 - 10^3 yr	Loss of Normal Service Water (TNSW), Loss of 120 VDC Division I (TDCI), Loss of 120 VDC Division II (TDCII), Loss of Reactor Plant Component Cooling Water (TCCP)	C	D	E
IV	1 per 10^3 - 10^4 yr	Small LOCA (RCS rupture), Medium LOCA (RCS rupture),	D	E	F
V	1 per 10^4 - 10^5 yr	Large LOCA (RCS rupture), ATWS	E	F	G
VI	less than 1 per 10^5 yr	ISLOCA	F	G	H
			> 30 days	3-30 days	< 3 days
			Exposure Time for Degraded Condition		

Note:

1. The SDP worksheets for ATWS core damage sequences assume that the ATWS is not recoverable by manual actuation of the reactor trip function or by ARI (for BWRs). Thus, the ATWS frequency to be used by these worksheets must represent the ATWS condition that can only be mitigated by the systems shown in the worksheet (e.g., boration).

1.2 INITIATORS AND SYSTEM DEPENDENCY

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

Table 2 Initiators and System Dependency Table for River Bend Station, Unit 1[1]

Affected System		Major Components	Support Systems	Initiating Event Scenarios
Code	System			
ADS/SRVs	Reactor Depressurization System	7 Automatic Depressurization System (ADS) valves; 9 safety relief valves (SRVs) from Main Steam system	Air accumulator[2], ESF Class 1E Div I and Div II 125 VDC	All except Large LOCA
PCS	Power Conversion System	MSIVs, MSSVs, Reactor Feedwater Pumps, Condensate pumps, Main condenser	Main Steam Isolation Valves (MSIVs): IAS and air accumulators, non-safety DC electric power	TRANS, SORV, SLOCA TCCP, TDCI, TDCII
	Main Steam		Main Steam Shutoff Valves (MSSVs):non-safety 480 VAC	
	Feedwater FW		Reactor FW Pump A (B and C): Div 1 (2) 13.8 kV bus, Non-ESF AC power, NSW, CCS, IAS, 125 VDC normal bus A (B) to restart the pump, Control power from 125 VDC Normal Buses A and B	
	Condensate		CDS Pumps A and C: Non-ESF AC Power, Div 1 13.8 kV Bus, NSW, CCS , CDS Pump B: Div 2 13.8 kV Bus, Control power from 125 VDC Normal Buses A and B, CDS Pump Discharge Valves: Non-ESF AC Power, NSW, CCS, Non-safety 480 VAC MCCs, CDS makeup, reject, recirculation, and filter/demineralizer control valves: IAS, CST	
			Main Condenser: Non-ESF AC Power, Circulating Water System	

Table 2 (Continued)

Affected System		Major Components	Support Systems	Initiating Event Scenarios
Code	System			
RPT	Recirculation Pump Trip	ATWS RPT logic and End of Cycle (EOC) RPT logic	125 VDC (trip logic), 120 VAC (instrumentation)	ATWS
LPCI Train A	Low Pressure Coolant Injection	1 MD RHR pump, MOVs	Div. I - Emergency AC Power, Div I Class 1E 125 V DC control power, LPCI actuation logic, Emergency Ventilation Room Cooling	All
LPCI Train B		1 MD RHR pump, MOVs	Div. II - Emergency AC Power, Div II Class 1E 125 V DC control power, LPCI actuation logic, Emergency Ventilation Room Cooling	
LPCI Train C		1 MD RHR pump, MOVs	Div. II - Emergency AC Power, Div II Class 1E 125 V DC control power, LPCI actuation logic, Emergency Ventilation Room Cooling	
RHR/SDC Trains A and B	Shutdown Cooling	2 MD RHR pumps, 2 RHR heat exchangers in series per train, MOVs	Div I (Div II) Emergency AC Power, Div I (Div II) Class 1E 125 V DC, Room Cooling HVR-UC6 (HVR-UC9), CCP or SSW train A (B) for RHR pump seals, NSW or SSW train A (B) for RHR HXs.	TRANS, TPCS, SLOCA, SORV, LOOP, ATWS, TCCP, TNSW, TDCI (Train A), TDCII (Train B)
RHR/SPC Trains A and B	Suppression Pool Cooling	2 MD RHR pumps, 2 RHR heat exchangers in series per train, MOVs	Div I (Div II) Emergency AC, Div I (Div II) class 1E 125 VDC, Room cooling HVR-UC6 (HVR-UC9) , NSW or SSW train A (B) for HXs.	All
SPCC[3]	Suppression Pool Cooling and Clean up	2 MD Pumps, Valves, and 2 Heat Exchangers	NSW, SSW, IAS (air for AOVs), non-safety 480 VAC (for pumps),non-safety 125 VDC (for control power),safety -related 120 VAC (control of SPCC suction and discharge isolation valves)	TRANS, TPCS, SLOCA, SORV

Table 2 (Continued)

Affected System		Major Components	Support Systems	Initiating Event Scenarios
Code	**System**			
ESFAS	Engineering Safety Features Actuation System	ECCS, RCIC sensors, logic power monitors, master relays, actuation control circuits, Reactor level sensors and transmitters, Drywell pressure sensors and transmitters	HPCS: Div III DC power RCIC: Div II DC Power LPCS, LPCIA: Div I DC Power LPCI B and C: Div II DC Power Safety related 120 VAC Power	All
FPW to RPV thru LPCI lines	Fire Protection Water	1 MD pump, 2 DD pumps, yard mains, valves, piping	(FP1A and FP1B diesel driven - dedicated batteries) : Non-ESF AC power for motor-driven FP2, Div II 480 VAC power to RHR LPCI MOVs, Div I and Div II 480 VAC power to SSW isolation valves	TRANS, TPCS, SORV, SLOCA, LOOP, TCCP, TNSW, TDCI, TDCII
HPCS	High Pressure Core Spray	1 MD pump, 1 dedicated EDG, MOVs	Actuation logic, Div III Emergency AC Power, Div III Class 1E 125 V DC control power, Emergency Ventilation Room Cooling (HVR-UC5), CST or suppression pool	TRANS, TPCS, SORV, SLOCA, MLOCA, LLOCA, LOOP, TCCP, TNSW, TDCI, TDCII
RCIC	Reactor Core Isolation Cooling	1 TD pump, MOVs	Actuation logic, Div I Class 1E 125 V DC control power, Emergency Ventilation Room Cooling, Main steam tunnel cooling, MCC area cooling, CST or suppression pool	TRANS, TPCS, SORV, SLOCA, LOOP, ATWS, TCCP, TNSW, TDCI
LPCS	Low Pressure Core Spray	1 MD pump, MOVs	Actuation logic, Div I Emergency AC Power, Div I Class 1E 125 V DC control power, Emergency Ventilation Room Cooling (HVR-UC6)	TRANS, TPCS, SORV, SLOCA, LOOP, ATWS, TCCP, TNSW, TDCII

Table 2 (Continued)

Affected System		Major Components	Support Systems	Initiating Event Scenarios
Code	System			
CRD	Control Rod Drive System Trains A and B	2 MD pumps, hydraulic control units, instrumentation and control circuits	Non-ESF AC Power, Normal 4160 VAC, Normal DC Power, manual actuation, Instrument Air, RPCCW (Reactor Plant Component Cooling Water) to CRD pumps, SW (Service Water) Instrument Air	TRANS, TPCS, TNSW, TDCI, TDCII
CVS	Containment Venting	Hydrogen purge outlets to annulus MOV; air-operated valves and dampers; Standby Gas Treatment System if available, Annulus Mixing	Non-ESF AC Power, Div I and Div II Emergency AC Power, Instrument Air	N/A (Containment Venting is not credited in the IPE due to the small size of 3 in. diameter piping of the vent path)
SLC	Standby Liquid Control	2 MD pumps, explosive valves, logic and control circuits	Emergency 480 VAC Div 1 to SLC A, Emergency 480 VAC Div 2 to SLC B, manual actuation	ATWS
EDGs	Electric Power System	Emergency diesel generators, output breakers, busses		LOOP
EAC Div A	Emergency AC Div A		Division I AC (ENS-SWG1A) SSW train A, Emergency Ventilation (for DG), Div I DC power to start Diesel	
EAC Div B	Emergency AC Div B		Division II AC (ENS-SWG1B) SSW train B, Emergency Ventilation (for DG), Div II DC power to start Diesel	
EAC Div C	Emergency AC Div C		Division III AC (E22-S004) SSW train A or B, Emergency Ventilation (for DG), Div III DC power to start Diesel	

Table 2 (Continued)

Affected System		Major Components	Support Systems	Initiating Event Scenarios
Code	System			
ESF Class 1E DC Power	Electric Power System/ Emergency DC Div A, Div B, Div C	Busses, breakers, batteries, DC Chargers	Division I, II, III EDC Div I, II, III AC Power Batteries (4 hours life)	TDCI, TDCII
EPS non-1E DC Div A, Div B	Electric Power System/ Non Class 1E DC Power	Busses, breakers, batteries, DC Chargers	Normal DC A (BYS-SWG1A) Div I AC Power (Isolate on LOCA signal) Batteries (2 hour life) Normal DC B (BYS-SWG1B) Div II AC Power (Isolate on LOCA signal) Batteries (2 hour life) Normal DC for NSW (BYS-SWG06) Normal AC power (NHS-MCC9K) Normal AC for SWC (BYS-PNL04) Normal AC Power (NHS-MCC103A) Swing Charger (BYS-SWG1D) NJS-SWG1U1 or BYS-EG1 (SBO diesel) acts as back up charger to ENB-SWG01A, ENB-SWG01B, ENB-SWG1A, or ENB-SWG1B	LOOP, TCCP, TNSW, TDCI, TDCII

Table 2 (Continued)

Affected System		Major Components	Support Systems	Initiating Event Scenarios
Code	System			
SSW	Standby Service Water	4 MD pumps, MOVs, cooling tower		All
	Train A: Pump A or C		Div I Emergency AC, Div I Class 1E DC Power, Div III emergency AC, Div III Class 1E DC Power	
	Train B: Pumps B or D		Div II Emergency AC, Div II Class 1E DC Power	
	SSW cross-tie	SSW Loop B to RHR connection, MOVs, SSW pumps B and D	Div II Emergency AC, Div II DC, SSW Train B, SSW to RHR isolation valves	
NSW	Normal Service Water	NSW: 3 MD pumps, MOVs, supply headers	NSW: SWC heat exchangers, Non- class 1E 4.16KV and 125 VDC	TCCP, TNSW
TPCCW	Turbine Plant Component Cooling Water	TPCCW: 3 MD pumps, 3 heat exchangers, MOVs, supply headers	TPCCW: NSW, Non- class 1E 4.16KV and 125 VDC	
SWC	Service Water Cooling	SWC: 3 MD pumps, 8 heat exchangers, 1 cooling tower	SWC: Non- class 1E 4.16KV and 125 VDC	

Table 2 (Continued)

Affected System		Major Components	Support Systems	Initiating Event Scenarios
Code	System			
RPCCW	Reactor Plant Component Cooling Water	3 MD pumps, 3 heat exchangers, piping headers, expansion tank, valves	Normal Bus 480 VAC load centers, RPCCW Pumps A and C - 480 VAC Switchgear A, RPCCW Pump B - 480 VAC Switchgear B, NSW or SSW train B	TCCP
PAS IAS SAS	Plant Air System Instrument Air System Service Air System	3 100% IAS MD compressors, 1 DD compressors, air dryers, air filters, SAS to IAS cross tie, 3 SAS MD compressors	Motor-driven IAS and SAS compressors/ IAS dryers: 480 VAC normal AC power,	All

Table 2 (Continued)

Affected System		Major Components	Support Systems	Initiating Event Scenarios
Code	System			
HVAC	Heating, Ventilating, and Air Conditioning			All
	Emergency Diesel Generator Rooms	1 exhaust fan per DG control room (HVP-FN2A,2B,3A),1 supply fan per DG room (HVP-FN6A-C), logic and control circuits	Emergency Diesel Generator Rooms fans and dampers: respective Div 1, Div 2 or Div 3 AC power	
ECCS Pump Rooms RHR, RCIC, LPCS	Emergency Core Cooling System (ECCS) Pump Rooms (RHR, RCIC, LPCS)	HPCS:HVR-UC5, RCIC, LPCS,RHRA:HVR-UC6, RHR B,C: HVR-UC9, MST: HVR-UC8, MCC Area: HVR-UC7,UC10	HVR-UC5: Div III AC, NSW, SSW train A or SSW train B. HVR-UC6: Div I AC, NSW or SSW train A HVR-UC9: Div II AC, NSW or SSW train B HVR-UC8: Div I AC, NSW or SSW Train A HVR-UC7: Div I AC, NSW or SSW train A HVR-UC10: Div II AC, NSW or SSW train B	
CFS(4)	Containment Fan System	3 unit coolers with MD fans, dampers, controls	HVR-UC1A: Div I AC power, NSW or SSW Train A, Div I DC power HVR-UC1B: Div II AC power, NSW or SSW Train B, Div II DC power HVR-UC1C: Div II AC power, Turbine Building Chilled Water (HVN), Div II DC power (Not Credited in PRA)	SORV, SLOCA, LOOP

Notes:

1. The above information is based upon the River Bend Response to Generic Letter 88-20, "Individual Plant Examination for Severe Accident Vulnerabilities" submitted to the NRC by letter dated February 1, 1993 and Licensee comments obtained during site visit based on PRA update of July 1999. The overall core damage frequency for internal events and flooding is 3.16 E-6 per reactor-year based on July 1999 PSA update.

2. The primary air for 16 safety relief valve is the air accumulators. The accumulator air is sufficient for 4-5 SRV lifts, and 1-2 lifts per valve for non-ADS valves. The primary source of air in addition to accumulators is from S-V-V air compressors, with back up from PVLCS (Penetration Valve Leakage Control System as backup air supply).

3. This system was added based on the licensee's comment. It was not in the original IPE.

4. The CFS is not directly credited in the SDP worksheet. However, based on the licensee's comment has been included in the footnote for the appropriate initiators as a means of Containment temperature control (e.g. see the related footnote in SLOCA worksheet).

1.3 SDP WORKSHEETS

This section presents the SDP worksheets to be used in the Phase 2 evaluation of the inspection findings for the River Bend Station, Unit 1. The SDP worksheets are presented for the following initiating event categories:

1. Transients (Reactor Trip) (TRANS)
2. Transients (without PCS) (TPCS)
3. Small LOCA (SLOCA)
4. Stuck Open Relief Valve (SORV)
5. Medium LOCA (MLOCA)
6. Large LOCA (LLOCA)
7. Loss of Offsite Power (LOOP)
8. Anticipated Transients Without Scram (ATWS)
9. Loss of Reactor Plant Component Cooling Water (TCCP)
10. Loss of Normal Service Water (LNSW)
11. Loss of 120 V Emergency Division I DC Power (TDCI)
12. Loss of 120 V Emergency Division II DC Power (TDCII)
13. Interfacing System LOCA (ISLOCA)

Table 3.1 SDP Worksheet for River Bend Station, Unit 1 — 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:	Full Creditable Mitigation Capability for Each Safety Function:
Power Conversion System (PCS)	1/3 Feedwater pumps with operable condenser and CST (operator action = 2) [(1)]
High Pressure Core Spray (HPCS)	HPCS (1 train)
Reactor Core Isolation Cooling (RCIC)	RCIC (1 ASD train)
Early Inventory Control CRD Pumps (EICRD)	2/2 CRD pumps (operator action = 2) [(2)]
Depressurization (DEP)	4/16 SRVs/ADS manually opened [7 ADS relief valves (auto ADS is inhibited) and 9 SRVs] (operator action = 3) [(3)]
Low Press Injection (LPI)	1/3 RHR trains in LPCI Mode (1 multi-train system) or 1/1 LPCS pumps (1 diverse train) or 1/2 SPCC pumps aligned for injection (operator action = 1)
Containment Heat Removal (CHR)	1/2 RHR pumps and corresponding 1/2 RHR heat exchangers in suppression pool cooling (SPC) mode or shutdown cooling mode (SDC) or 1/2 SPCC Pumps and the corresponding heat exchanger aligned for SPC mode (operator action = 3) [(4)]
Late Inventory CRD (LICRD)	1/2 CRD pumps (operator action = 2) [(2)]
Late Depressurization (LDEP)	{4/16 SRVs manually opened and [1/3 Condensate Injection if RX pressure < 435 psi or 1/1 SSW cross-tie or (1/1 MD FPW Pump or 1/2 DD FPW Pump, with RX pressure <= 150 psi)]} (operator action = 2) [(5)]

Circle Affected Functions	Recovery of Failed Train	Remaining Mitigation Capability Rating for Each Affected Sequence	Sequence Color
1 TRANS - PCS- CHR - LICRD - LDEP (5)[(6)]			
2 TRANS - PCS - RCIC - CHR - LICRD (8,11)[(7)]			

3 TRANS - PCS - RCIC - HPCS - LPI (12)			
4 TRANS - PCS - RCIC - HPCS - DEP - EICRD (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 operator action in the updated PRA for use of PCS is 5E-3 therefore a credit of 2 is given.

2. The RIVB IPE event trees show enhanced CRD (2 pump operation) as a high pressure injection source only if depressurization fails. According to RIVB IPE Table 3.1-17, two control rod drive (CRD) pump operation is considered to be required for success if CRD is the only injection source to the reactor. This is based on a flow of ~175 to 200 gpm, at high vessel pressure, needed to initially maintain core coverage. One CRD pump is sufficient if CRD is only used in the long term, i.e. when coolant makeup has been provided for a long time. The HEP credit is assigned based on generic values.

3. Depressurization (DEP) using SRVs is considered an operator action; RIVB IPE Table 3.3.-4 assigns a failure probability for failure to depressurize (DEP) of 2.0E-3. The updated PRA estimates a HEP value of 1.7E-4. An operator action credit of 3 is given based on generic HEP values.

4. The updated IPE also credits use of 1/2 containment fans as a means for CHR. The operator action credit of 3 is assigned generically for CHR function.

5. The operator actions associated with LDEP is combined and a credit of 2 is given based on generic HEP values for BWRs.

6. When PCS and HPCS fail and RCIC is available, but CHR function is failed, RCIC is assumed to fail when the pool water temperature reaches ~173°F due to loss of NPSH. In this case, the IPE credits the LDEP function as a part of late inventory makeup.

7. When PCS and RCIC fail but HPCS is operating with CHR function not available, the containment would fail due to overpressurization (venting assumed not to be of sufficient capacity). Steam would be released into the 141 ft level of the Aux. Bldg., assuming to cause the following:

   1. Failure of the MCC for the room cooler for LPCS, RHRA, and RCIC.
   2. Loss of power to SDC suction valve.
   3. Failure of the MOV to open allowing a flow path for SW and FW to the reactor vessel.
   4. Loss of capability to open SRVs except for the relief mode operation.

Table 3.2 SDP Worksheet for River Bend Station, Unit 1 — Transients (without PCS) TPCS [1]

Estimated Frequency (Table 1 Row) ________ **Exposure Time** ________ **Table 1 Result (circle): A B C D E F G H**

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
High Pressure Core Spray (HPCS)	HPCS (1 train)
Reactor Core Isolation Cooling (RCIC)	RCIC (1 ASD train)
Early Inventory Control CRD Pumps (EICRD)	2/2 CRD pumps (operator action = 2) [2]
Depressurization (DEP)	4/16 SRVs manually opened [7 ADS relief valves (auto ADS is inhibited) and 9 SRVs] (operator action = 3) [3]
Low Pressure Injection (LPI)	1/3 RHR trains in LPCI Mode (1 multi-train system) or 1/1 LPCS pumps (1 train) or 1/2 SPCC pumps aligned for injection (operator action = 1)
Containment Heat Removal (CHR)	1/2 RHR pumps and corresponding 1/2 RHR heat exchangers in suppression pool cooling (SPC) mode or shutdown cooling mode (SDC) or 1/2 SPCC Pumps and the corresponding heat exchanger aligned for SPC mode (operator action = 3) [4]
Late Inventory CRD (LI)	1/2 CRD pumps (operator action = 2) [5]
Late Depressurization (LDEP)	{4/16 SRVs manually opened and [1/3 Condensate Injection if RX pressure < 435 psi or 1/1 SSW cross-tie or (1/1 MD FPW Pump or 1/ 2 DD FPW Pump, with RX pressure <= 150 psi)]} (operator action = 2) [6]

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 TPCS- CHR - LICRD - LDEP (5)			
2 TPCS - RCIC - CHR - LICRD (8,11)			

3 TPCS - RCIC - HPCS - LPI (12)			
4 TPCS -RCIC - HPCS - DEP - EICRD (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 transient tree is used for this worksheet.

2. The operator action in the updated PRA for use of PCS is 5E-3, therefore a credit of 2 is given.

3. The RIVB IPE event trees show enhanced CRD (2 pump operation) as a high pressure injection source only if depressurization fails. According to RIVB IPE Table 3.1-17, two control rod drive (CRD) pump operation is considered to be required for success if CRD is the only injection source to the reactor. This is based on a flow of ~175 to 200 gpm, at high vessel pressure, needed to initially maintain core coverage. One CRD pump is sufficient if CRD is only used in the long term, i.e., when coolant makeup has been provided for a long time.

4. Depressurization (DEP) using SRVs is considered an operator action; RIVB IPE Table 3.3.-4 assigns a failure probability for failure to depressurize (DEP) of 2.0E-3. The updated PRA estimates a HEP value of 1.7E-4. An operator action credit of 3 is given based on generic HEP values.

5. The updated IPE also credit use of 1/2 containment fans as a means for CHR. The operator action credit of 3 is assigned generically for CHR function.

6. The operator actions associated with LDEP is combined and a credit of 2 is given based on generic HEP values for BWRs.

Table 3.3 SDP Worksheet for River Bend Station, Unit 1 — Small LOCA (SLOCA)

Estimated Frequency (Table 1 Row) _________ Exposure Time _________ Table 1 Result (circle): A B C D E F G H

<u>Safety Functions Needed</u>:	<u>Full Creditable Mitigation Capability for Each Safety Function:</u>
Power Conversion System (PCS)	1/3 Feedwater pumps if Rx pressure > 435 psi with operable condenser and CST (operator action = 2) [(1)]
High Pressure Core Spray (HPCS)	HPCS (1 train)
Reactor Core Isolation Cooling (RCIC)	RCIC (1 ASD train)
Depressurization (DEP)	3/16 SRVs manually opened [7 ADS relief valves (auto ADS is inhibited) and 9 SRVs] (operator action = 3) [(2)]
Low Pressure Injection (LPI)	1/3 RHR trains in LPCI Mode (1 multi-train system) or 1/1 LPCS pumps (1 train) or 1/2 SPCC pumps aligned for injection (operator action = 1)
Containment Heat Removal (CHR)	1/2 RHR pumps and corresponding 1/2 RHR heat exchangers in suppression pool cooling (SPC) mode or shutdown cooling mode (SDC) or 1/2 SPCC Pumps and the corresponding heat exchanger aligned for SPC mode (operator action = 3) [(3)]
Late Depressurization (LDEP)	{3/16 SRVs manually opened and [1/3 Condensate Injection if RX pressure < 435 psi or 1/1 SSW cross-tie or (1/1 MD FPW Pump or 1/2 DD FPW Pump, with RX pressure <= 150 psi)]} (operator action = 2)

<u>Circle Affected Functions</u>	<u>Recovery or Failed Train</u>	<u>Remaining Mitigation Capability Rating for Each Affected Sequence</u>	<u>Sequence Color</u>
1 SLOCA - PCS - CHR - LDEP (4)			

2 SLOCA -PCS - RCIC - CHR (6,8)			
3 SLOCA - PCS - RCIC - HPCS - LPI (9)			
4 SLOCA - PCS - RCIC - HPCS - DEP (10)			
Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event: If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use.			

Notes:

1. The operator action in the updated PRA for use of PCS is 5E-3 therefore a credit of 2 is given.

2. Depressurization (DEP) using SRVs is considered an operator action; RIVB IPE Table 3.3.-4 assigns a probability for failure to depressurize (DEP) of 2.0E-3.

3. Containment venting is not modeled in the IPE due to the limited capacity of the line, i.e., 3 inches. (See RIVB IPE page 271). The containment fan system (CFS) maintains design ambient conditions and removes heat generated during normal and loss of offsite power conditions. During a LOCA, the CFS assists in removing heat from the containment. (See RIVB IPE page 287.)

Table 3.4 SDP Worksheet for River Bend Station, Unit 1 — Stuck Open Relief Valve (SORV)[1]

Estimated Frequency (Table 1 Row) ________ **Exposure Time** ________ **Table 1 Result (circle): A B C D E F G H**

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Power Conversion System (PCS)	1/3 Feedwater pumps if Rx pressure > 435 psi and 1/3 Condensate Injection if RX Pressure <= 435 psi with operable condenser and CST (operator action = 2) [2]
High Pressure Core Spray (HPCS)	HPCS (1 train)
Reactor Core Isolation Cooling (RCIC)	RCIC (1 ASD train)
Depressurization (DEP)	3/16 SRVs manually opened [7 ADS relief valves (auto ADS is inhibited) and 9 SRVs] (operator action = 3) [3]
Low Pressure Injection (LPI)	1/3 RHR trains in LPCI Mode (1 multi-train system) or 1/1 LPCS pumps (1 train) or 1/2 SPCC pumps aligned for injection (operator action = 1)
Containment Heat Removal (CHR)	1/2 RHR pumps and corresponding 1/2 RHR heat exchangers in suppression pool cooling (SPC) mode or shutdown cooling mode (SDC) or 1/2 SPCC Pumps and the corresponding heat exchanger aligned for SPC mode (operator action = 3) [4]
Late Depressurization (LDEP)	{3/16 SRVs manually opened and [1/3 Condensate Injection if RX pressure < 435 psi or 1/1 SSW cross-tie or (1/1 MD FPW Pump or 1/2 DD FPW Pump, with RX pressure <= 150 psi)]}(operator action = 2)

Circle Affected Functions	**Recovery or Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 SORV - PCS - CHR - LDEP (4)			
2 SORV - PCS - RCIC - CHR (6,8)			

3 SORV - PCS - RCIC - HPCS - LPI (9)			
4 SORV - PCS - RCIC - HPCS - DEP (10)			
Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event: If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use.			

Notes:

1. The SLOCA event tree is used for this worksheet.

2. The operator action in the updated PRA for use of PCS is 5E-3 therefore a credit of 2 is given.

3. Depressurization (DEP) using SRVs is considered an operator action; RIVB IPE Table 3.3.-4 assigns a probability for failure to depressurize (DEP) of 2.0E-3.

4. Containment venting is not modeled in the IPE due to the limited capacity of the line, i.e., 3 inches. (See RIVB IPE page 271). The containment fan system (CFS) maintains design ambient conditions and removes heat generated during normal and loss of offsite power conditions. During a LOCA, the CFS assists in removing heat from the containment. (See RIVB IPE page 287.)

Table 3.5 SDP Worksheet for River Bend Station, Unit 1 — 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:	**Full Creditable Mitigation Capability for Each Safety Function:**
High Pressure Core Spray (HPCS)	HPCS (1 train) (1)
Depressurization (DEP)	3/16 SRVs [7 ADS relief valves (auto ADS is inhibited) or 9 SRVs manually opened] (operator action = 3) (2)
Low Pressure Injection 1(LPI1)	1/3 RHR trains in LPCI mode (1 multi-train system) or 1/1 LPCS (1 train)
Low Pressure Injection 2 (LPI2)	1/1 SSW train B cross tie to RHR injection (operator action = 1) (3)
Suppression Pool Cooling (SPC)	1/2 RHR trains in SPC mode (operator action = 2) (4)

Circle Affected Functions	**Recovery or Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 MLOCA - HPCS - LPI1 - LPI2 (4)			
2 MLOCA - HPCS - DEP (5)			
3 MLOCA - SPC - LPI2 (7)			
4 MLOCA - SPC - DEP (8)			

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

Notes:

1. Feedwater/condensate could initially provide makeup but the condenser hotwell inventory is considered likely to reach low levels because of insufficient condenser hotwell makeup. (See RIVB IPE Table 3.1-16, page 174.)

2. Depressurization (DEP) using SRVs is considered as a operator action; RIVB IPE Table 3.3.-4 assigns a probability for failure to depressurize (DEP) of 2.0E-3. The updated PRA assigns a value of 1.7E-4.

3. Suppression pool strainers are assumed to experience some clogging during Large and Medium LOCAs due to insulation material falling into the suppression pool and mixing with the particulate matter, which can not be removed by the SPCC system. NRC Bulletin 93-02 noted that fibrous material combined with particulate matter will lower the NPSH for the ECCS pumps. If suppression pool cooling is not successful, the ECCS pumps taking suction from the suppression pool will fail due to loss of NPSH. It is also assumed that the SPCC system can not remove enough heat to prevent loss of NPSH to the ECCS pumps. The only system credited for Medium and Large LOCAs that does not take suction from the suppression pool is SSW cross-tie to RHR injection.

4. SSW operation is required for the operating RHR heat exchanger. This should be considered in evaluating sequence-3 when inspection finding deals with unavailability of SSW system. (RIVB IPE Table 3.1-15, page 173.)

Table 3.6 SDP Worksheet for River Bend Station, Unit 1 — 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:	**Full Creditable Mitigation Capability for Each Safety Function:**
High Pressure Core Spray (HPCS)	HPCS (1 train) [1]
Low Pressure Injection 1(LPI1)	1/3 RHR trains in LPCI mode (1 multi-train system) or 1/1 LPCS train (1 train)
Low Pressure Injection 2 (LPI2)	1/1 SSW train B cross tie to RHR injection (operator action = 1) [2]
Suppression Pool Cooling (SPC)	1/2 RHR trains in SPC mode (operator action =2) [3] [4]

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 LLOCA - HPCS - LPI1 - LPI2 (4)			
2 LLOCA - SPC - LPI2 (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. Feedwater/condensate could initially provide makeup but the condenser hotwell inventory is considered likely to reach low levels because of insufficient condenser hotwell makeup. (See RIVB IPE Table 3.1-16, page 174.)
2. Suppression pool strainers are assumed to experience some clogging during large and Large LOCAs due to insulation material falling into the suppression pool and mixing with the particulate matter, which can not be removed by the SPCC system. NRC Bulletin 93-02 noted that fibrous material combined with particulate matter will lower the NPSH for the ECCS pumps. If suppression pool cooling is not successful, the ECCS pumps taking suction from the suppression pool will fail due to loss of NPSH. It is also assumed that the SPCC system can not remove enough heat to prevent loss of NPSH to the ECCS pumps. The only system credited for Medium and Large LOCAs that does not take suction from the suppression pool is SSW cross-tie to RHR injection.
3. Service Water cross-tie to RHR is considered a demanding operator action for large LOCA due to the short time frame available to perform the action. The updated PRA assigns a value of 0.24 to this action. The SDP worksheet assigns a credit of 1.
4. SSW operation is required for the operating RHR heat exchanger. (RIVB IPE Table 3.1-15, page 173.)

Table 3.7 SDP Worksheet for River Bend Station, Unit 1 — 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:	**Full Creditable Mitigation Capability for Each Safety Function:**
Emergency Power Div 1 or Div 2 DGs (EAC1&2)	1/2 EDGs (1 multi-train system) [(1)]
Recovery of Offsite Power within 1 Hour (REC1)	Recovery of offsite power or a source of AC in one hour (operator action = 1) [(2)]
High Pressure Core Spray (HPCS)	HPCS pump, the associated EDG and the SSW discharge valve(1 train)
Reactor Core Isolation Cooling (RCIC)	RCIC pump (1 ASD train) [(3)]
DC Charging Diesel (SBODG)	BY-EG1 aligned to emergency DC power (operator action = 1) [(4)]
Recovery of Offsite Power within 4 hours (REC4)	Recovery of offsite power or a source of AC in 4 hours (operator action = 2) [(4)]
Recovery of Offsite Power Within 6 hours (REC6)	Recovery of offsite power or a source of AC in 6 hours (operator action = 2) [(3)]
Fire Water (FPW)	1/2 DD FPW pump with reactor pressure <= 150 psi (operator action = 1) [(7)]
Recovery of Offsite Power within 18 hours (REC18)	Recovery of an AC source in 18 hours and availability of CHR (operator action = 3) [(6)]
Depressurization (DEP)	4/16 SRVs manually opened [7 ADS relief valves (auto ADS is inhibited) and 9 SRVs] (operator action = 3) [(5)]
Low Pressure Injection (LPI)	1/3 RHR trains in LPCI Mode (1 multi-train system) or 1/1 LPCS pumps (1 diverse train) or 1/2 SPCC pumps aligned for injection (operator action = 1)
Containment Heat Removal (CHR)	1/2 RHR pumps and corresponding 1/2 RHR heat exchangers in suppression pool cooling (SPC) mode or shutdown cooling mode (SDC) or 1/2 SPCC Pumps and the corresponding heat exchanger aligned for SPC mode (operator action = 3)
Late Depressurization (LDEP)	{4/16 SRVs manually opened (1/1 MD FPW Pump or 1/2 DD FPW Pump, with RX pressure <= 150 psi)]} (operator action = 1) [(7)]

Circle Affected Functions:	**Recovery or Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 LOOP - CHR - LICRD - LDEP (1,2)			
2 LOOP - RCIC - CHR - LICRD (1,2)			

3 LOOP - RCIC - HPCS - LPI (1,2)			
4 LOOP - RCIC - HPCS - DEP (1,2)			
5 LOOP - EAC1&2 - REC18 (4,7)			
6 LOOP - EAC1&2 - HPCS - REC6 - FPW (8)			
7 LOOP - EAC1&2 - HPCS - REC6 - DEP (9)			
8 LOOP - EAC1&2 - HPCS - SBODG - REC4 (11)			
9 LOOP - EAC1&2 - REC1 - HPCS - RCIC (12)			

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

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

Notes:

1. The EDGs were assumed to fail after only 2 minutes if they are operated without standby service water (SSW). However, the addition of the closed nuclear service water (NSW) has eliminated the need to lock out the SSW pumps to perform NSW testing and pump swap. Therefore, this failure mode is assumed to have been eliminated. (See RIVB IPE page 412.)

2. For LOOP followed by failure of the Div I and Div II EDGs, and then failure of the high pressure injection systems HPCS and RCIC, only one (1) hour is available to recover injection and core cooling before core damage occurs, assuming there are no stuck open relief valves (SORVs). The recovery action most likely to be successful is to regain offsite power, thereby allowing use of a system such as condensate or CRD to perform core cooling. (See RIVB IPE page 412.)

3. RCIC fails in the long term due to inadequate net positive suction head (NPSH) as the suppression pool heats up. (See RIVB IPE page 411). RCIC can provide flow from the CST for 6 hours assuming the Tech. Spec. minimum CST level. RCIC injection beyond 6 hours might also be limited by room heat up assuming gland steam leaks that would occur during an SBO.

4. River Bend has a portable diesel generator (BYS-EG1) that is used to power the swing charger (BYS-CHGR1D). The swing charger can power either of the emergency DC buses to maintain DC power during a station blackout. The DC charging diesel (also called the SBO diesel) is located in a protected area and is dedicated for DC operation during power operation. If the DC charging diesel fails, then the DC batteries are assumed to deplete at 4 hours causing failure of RCIC due to loss of control power and failure of the SRVs due to loss of control power to open the valves.

5. Depressurization (DEP) using SRV is considered as an operator action with assigned probability of 2.0E-3 in the original IPE and 1.7E-4 in the updated IPE.

6. No containment heat removal is available during an extended station blackout. The SBO procedure gives a method to align HPCS to cool the suppression pool during SBO, but this method is not credited in the PRA. Without containment heat removal, containment pressure will rise. At approximately 18 hours, the containment will fail into the annulus due to overpressurization. Annulus pressurization will lead to a steam release into the Aux. Building, which would fail HPCS, RCIC, and ADS equipment.

7. Aligning FPW under SBO conditions involves manual closing of several MOVs and manually opening the RHR cross-tie and shutdown cooling injection valve. Although adequate time and personnel exist to perform this action, the HEP values are expected to be high due to the number of manipulations outside the control room. A credit of one is given in the SDP worksheet .

Table 3.8 SDP Worksheet for River Bend Station, Unit 1 — Anticipated Transients Without Scram (ATWS)[1]

Estimated Frequency (Table 1 Row) __________ **Exposure Time** __________ **Table 1 Result (circle): A B C D E F G H**

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Overpressure Protection (OVERP)	10/16 SRVs (1 multi-train system)
Recirculation Pump Trip (RPT)	Manual or automatic trip of recirculation pumps (1 multi-train system)
Inhibit ADS (INH)	Operator inhibits ADS (operator action = 3)[2]
High Pressure Injection (HPCS)	1/1 HPCS (operator action = 1)
Reactivity Control (SLC)	1/2 SLC pumps and valves (operator action = 1)[3]
Depressurization (DEP)	3/16 SRVs [7 ADS relief valves (auto ADS is inhibited) or 9 SRVs manually opened] (operator action = 3)[4]
Low Pressure Injection (LPI)	1/3 RHR pumps in LPCI mode (1 multi-train system) or 1/1 LPCS pump (1 diverse train) or 1/1 SSW cross-tie (operator action = 2)
Containment Heat Removal (CHR)	1/2 RHR pumps in SPC (operator action = 2)

Circle Affected Functions:	**Recovery or Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 ATWS - CHR (2, 4)			
2 ATWS - HPCS - LPI (5)			
3 ATWS - DEP (6)			
4 ATWS - INH (7)			

5 ATWS - SLC (8)			
6 ATWS - RPT (9)			
7 ATWS - OVERP (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. No credit is given for the Power Conversion System, since even with SLC injection and level control, any delay in initiation of either action results in the condenser hotwell being depleted. The small turbine bypass capacity (10%) results in a loss of a significant amount of condenser inventory to the suppression pool. With a limited makeup capacity of 800 gpm, the condenser hotwell inventory depletes. Any attempt at feedwater level control while the core is at high power results in a rapid vessel level reduction and MSIV closure on Level 1 before any attempts to jumper this trip logic is performed. Thus, MSIV closure is always assumed to occur. (RIVB IPE page 127).

2. Licensee comment has indicated that the operator error for inhibiting the ADS is negligible. An operator action credit of 3 is given in this worksheet based on generic HEP values.

3. A Human Error Probability (HEP) of 1.0E-1 is assigned in RIVB IPE for SLC initiation.

4. A HEP value of 2.0E-3 is assigned by the RIVB IPE for DEP action. A credit of 3 is consistently given in this worksheet.

Table 3.9 SDP Worksheet for River Bend Station, Unit 1 — Loss of Reactor Plant Component Cooling Water (TCCP) [1]

Estimated Frequency (Table 1 Row) ________ **Exposure Time** ________ **Table 1 Result (circle): A B C D E F G H**

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Power Conversion System (PCS)	1/3 Feedwater pumps if Rx pressure > 435 psi with operable condenser and CST (operator action = 2) [2]
High Pressure Core Spray (HPCS)	HPCS (1 train)
Reactor Core Isolation Cooling (RCIC)	RCIC (1 ASD train)
Early Inventory Control CRD Pumps (EICRD)	Failed by Initiator
Depressurization (DEP)	4/16 SRVs manually opened [7 ADS relief valves (auto ADS is inhibited) and 9 SRVs] (operator action = 3) [3]
Low Pressure Injection (LPI)	1/3 RHR trains in LPCI Mode (1 multi-train system) or 1/1 LPCS pumps (1 diverse train) or 1/2 SPCC pumps aligned for injection (operator action = 1)
Containment Heat Removal (CHR)	1/2 RHR pumps and corresponding 1/2 RHR heat exchangers in suppression pool cooling (SPC) mode or shutdown cooling mode (SDC) or 1/2 SPCC Pumps and the corresponding heat exchanger aligned for SPC mode (operator action = 3) [4]
Late Inventory CRD (LICRD)	Failed by the initiator
Late Depressurization (LDEP)	{4/16 SRVs manually opened and [1/3 Condensate Injection if RX pressure < 435 psi or 1/1 SSW cross-tie or (1/1 MD FPW Pump or 1/2 DD FPW Pump, with RX pressure <= 150 psi)]} or 1/2 SPCC pumps (operator action = 2) [5]

Circle Affected Functions:	**Recovery or Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 TCCP - PCS- CHR - LDEP (5)			
2 TCCP - PCS - RCIC - CHR (8,11)			

3 TCCP - PCS - RCIC - HPCS - LPI (12)			
4 TCCP - PCS - RCIC - HPCS -DEP - (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 loss of plant component cooling water results in a loss of cooling to the reactor recirculation pumps and also results in loss of CRD pump cooling. Therefore, the CRD pumps are not credited. The initiator frequency is estimated about 2.0E-3 per year based on IPE. The transient event tree was used for this SDP worksheet.

2. The operator action in the updated PRA for use of PCS is 5E-3, therefore, a credit of 2 is given.

3. Depressurization (DEP) using SRVs is considered a high-stress operator action; RIVB IPE Table 3.3.-4 assigns a failure probability for failure to depressurize (DEP) of 2.0E-3. The updated PRA estimates a HEP value of 1.7E-4. An operator action credit of 3 is given based on generic HEP values.

4. The operator action credit of 3 is assigned based on generic values.

5. The operator actions associated with LDEP is combined and a credit of 2 is given based on generic HEP values for BWRs.

Table 3.10 SDP Worksheet for River Bend Station, Unit 1 — Loss of Normal Service Water (LNSW)[(1)]

Estimated Frequency (Table 1 Row) ________ **Exposure Time** ________ **Table 1 Result (circle): A B C D E F G H**

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Power Conversion System (PCS)	Failed by the initiator
High Pressure Core Spray (HPCS)	HPCS (1 train)
Reactor Core Isolation Cooling (RCIC)	RCIC (1 ASD train)
Early Inventory Control CRD Pumps (EICRD)	2/2 CRD pumps (operator action =2)
Depressurization (DEP)	4/16 SRVs manually opened [7 ADS relief valves (auto ADS is inhibited) and 9 SRVs] (operator action = 3)
Low Pressure Injection (LPI)	1/3 RHR trains in LPCI Mode (1 multi-train system) or 1/1 LPCS pumps (1 train)
Containment Heat Removal (CHR)	1/2 RHR pumps and corresponding 1/2 RHR heat exchangers in suppression pool cooling (SPC) mode or shutdown cooling mode (SDC) (operator action = 3)
Late Inventory CRD (LICRD)	1/2 CRD pumps (operator action = 2)
Late Depressurization (LDEP)	{4/16 SRVs manually opened and [1/1 SSW cross-tie or (1/1 MD FPW Pump or 1/2 DD FPW Pump, with RX pressure <= 150 psi)]} (operator action = 2)

Circle Affected Functions:	**Recovery or Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 TNSW - CHR - LICRD - LDEP (5)			
2 TNSW - RCIC - CHR - LICRD (8,11)			
3 TNSW - RCIC - HPCS - LPI (12)			

4 TNSW - RCIC - HPCS - DEP -EICRD (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.			

Note:

1. The Normal Service Water System cools the Turbine Plant Component Cooling Water System which, in turn, cools the condensate and feedwater pump motor coolers. Therefore, loss of Normal Service Water causes loss of feedwater. The power conversion system most likely will not be available since the turbine bypass valves will fail and an MSIV closure may occur due to loss of condenser vacuum upon loss of inter-cooling for the Steam Jet Air Ejectors (SJAE). No credit is also given to SPCC trains. The mean frequency of this event is 7.6E-3 per year (RIVB IPE, pages 41, 91 and 159). The transient event tree is used for this worksheet.

Table 3.11 SDP Worksheet for River Bend Station, Unit 1 — Loss of 120V Emergency DC - Div I (TDCI)[1]

Estimated Frequency (Table 1 Row) ________ **Exposure Time** ________ **Table 1 Result (circle): A B C D E F G H**

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Power Conversion System (PCS)	1/3 Feedwater pumps with operable condenser and CST (operator action = 2)
High Pressure Core Spray (HPCS)	HPCS (1 train)
Reactor Core Isolation Cooling (RCIC)	Failed by the initiator
Early Inventory Control CRD Pumps (EICRD)	Failed by the initiator [1,2]
Depressurization (DEP)	4/16 SRVs manually opened [7 ADS relief valves (auto ADS is inhibited) and 9 SRVs] (operator action = 3) [3]
Low Pressure Injection (LPI)	1/1 RHR train (2 pumps) in LPCI Mode (1 multi-train system)
Containment Heat Removal (CHR)	1/1 RHR pumps and corresponding RHR heat exchangers in suppression pool cooling (SPC) mode or shutdown cooling mode (SDC) (operator action = 2)
Late Inventory CRD (LICRD)	Failed by the initiator
Late Depressurization (LDEP)	{4/16 SRVs manually opened and [1/3 Condensate Injection if RX pressure < 435 psi or 1/1 SSW cross-tie or (1/1 MD FPW Pump or 1/2 DD FPW Pump, with RX pressure <= 150 psi)]} (operator action = 2)

Circle Affected Functions:	**Recovery or Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 TDCI - PCS - CHR (5,8,11)			
2 TDCI - PCS - HPCS - LPI (12)			
3 TDCI -PCS - HPCS - DEP (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. Loss of either Div I or Div II Emergency DC Power results in a balance of plant containment isolation. A BOP containment isolation is likely to result in a scram. Reactor scram can potentially occur due to loss of Reactor Plant Component Cooling Water (RPCCW) which, in turn, causes loss of the control rod drive pumps, due to isolation of Normal Service Water to the drywell coolers, or due to isolation of instrument air. Loss of the RPCCW also causes a loss of recirculation pump cooling. This procedurally requires a manual scram, particularly because of the loss of recirculation pump cooling. Loss of either Div I or Div II Emergency DC Power is similar to a Transient with Reactor Trip. Loss of Div I DC causes loss of LPCI/RHR Pump A and the LPCS pump. No credit is given to SPCC pumps due to its dependency on the vital AC. The mean frequency of loss of either DC Div I or DC Div II is 6.0E-3 per year. (RIVB IPE, pages 41, 90-91, Table 3.1-10, page 159 and Table 3.1-12, pages 167-169.) The transient event tree is used for this worksheet.

2. The RIVB IPE event trees show enhanced CRD (2 pump operation) as a high pressure injection source only if depressurization fails. According to RIVB IPE Table 3.1-17, two control rod drive (CRD) pump operation is considered to be required for success if CRD is the only injection source to the reactor. This is based on a flow of ~175 to 200 gpm, at high vessel pressure, needed to initially maintain core coverage. One CRD pump is sufficient if CRD is only used in the long term, i.e. when coolant makeup has been provided for a long time. Loss of RPCCW as a result of loss of either Div I or Div II Emergency DC Power may affect the availability of the CRD pumps as a mitigation capability.

3. Depressurization (DEP) using SRVs is impacted by loss of DC Div I but it is not clear how many of the SRVs are fed by division I bus. Reduced redundancy is not shown in the SDP worksheet.

Table 3.12 SDP Worksheet for River Bend Station, Unit 1 — Loss of 120 V Emergency DC - Div II (TDCII) [1]

Estimated Frequency (Table 1 Row) ________ **Exposure Time** ________ **Table 1 Result (circle): A B C D E F G H**

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Power Conversion System (PCS)	1/3 Feedwater pumps with operable condenser and CST (operator action = 2)
High Pressure Core Spray (HPCS)	HPCS (1 train)
Reactor Core Isolation Cooling (RCIC)	1/1 Turbine Driven Pump and the associated train (1 ASD Train)
Early Inventory Control CRD Pumps (EICRD)	Failed by the initiator [1,2]
Depressurization (DEP)	4/16 SRVs manually opened [7 ADS relief valves (auto ADS is inhibited) and 9 SRVs] (operator action = 3) [3]
Low Pressure Injection (LPI)	1/1 RHR train (1 pump) in LPCI Mode (1 multi-train system) and 1/1 LPCS train (1 train)
Containment Heat Removal (CHR)	1/1 RHR pumps and corresponding 1/1 RHR heat exchangers in suppression pool cooling (SPC) mode or shutdown cooling mode (SDC) (operator action = 2) [4]
Late Inventory CRD (LICRD)	Failed by the initiator
Late Depressurization (LDEP)	{4/16 SRVs manually opened and [1/3 Condensate Injection if RX pressure < 435 psi or (1/1 MD FPW Pump or 1/2 DD FPW Pump, with RX pressure <= 150 psi)]} or 1/2 SPCC pumps (operator action = 2)

Circle Affected Functions:	**Recovery or Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 TDCII - PCS - CHR - LDEP (5)			
2 TDCII - PCS - RCIC - CHR (8,11)			
3 TDCII - PCS - RCIC - HPCS - LPI (12)			

4 TDCII -PCS - RCIC - HPCS - DEP (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. Loss of either Div I or Div II Emergency DC Power results in a balance of plant containment isolation. A BOP containment isolation is likely to result in a scram. Reactor scram can potentially occur due to loss of Reactor Plant Component Cooling Water (RPCCW) which, in turn, causes loss of the control rod drive pumps, or due to isolation of Normal Service Water to the drywell coolers, or due to isolation of instrument air. Loss of the RPCCW also causes a loss of recirculation pump cooling. This procedurally requires a manual scram, particularly because of the loss of recirculation pump cooling. Loss of either Div I or Div II Emergency DC Power is similar to a Transient with Reactor Trip. Loss of DC Div II causes loss of the Standby Service Water cross-tie and LPCI/RHR pumps B and C. No credit is given to SPCC trains due to its dependency on vital AC. The mean frequency of loss of either DC Div I or DC Div II is 6.0E-3 per year. (RIVB IPE, pages 41, 90-91, Table 3.1-10, page 159, and Table 3.1-12, pages 167-169.) The transient event tree is used for this work sheet.

2. The RIVB IPE event trees show enhanced CRD (2 pump operation) as a high pressure injection source only if depressurization fails. According to RIVB IPE Table 3.1-17, two control rod drive (CRD) pump operation is considered to be required for success if CRD is the only injection source to the reactor. This is based on a flow of ~175 to 200 gpm, at high vessel pressure, needed to initially maintain core coverage. One CRD pump is sufficient if CRD is only used in the long term, i.e. when coolant makeup has been provided for a long time. Loss of RPCCW as a result of loss of either Div I or Div II Emergency DC Power may affect the availability of the CRD pumps as a mitigation capability.

3. Depressurization (DEP) using SRVs is impacted by loss of DC Div II but it is not clear how many of the SRVs are fed by Div II bus. Reduced redundancy is not shown in the SDP worksheet.

Table 3.13 SDP Worksheet for River Bend Station, Unit 1 — Interfacing System LOCA (ISLOCA)[1,2]

Estimated Frequency (Table 1 Row) ________	**Exposure Time** __________	**Table 1 Result (circle): A B C D E F G H**	
Initiation Pathways: **LPCI Injection Lines** **LPCS Injection Line** **RHR Shutdown Cooling Suction Line** **HPCS Suction Line** **RCIC Suction line** **Feedwater Lines**	**Mitigation Capability: Ensure Component Operability for Each Pathway** 3 lines 1 line 1 line 1 line 1 line 2 feedwater pump suction lines		
Circle Affected Component in Pathways	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Pathway**	**Sequence Color**
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:

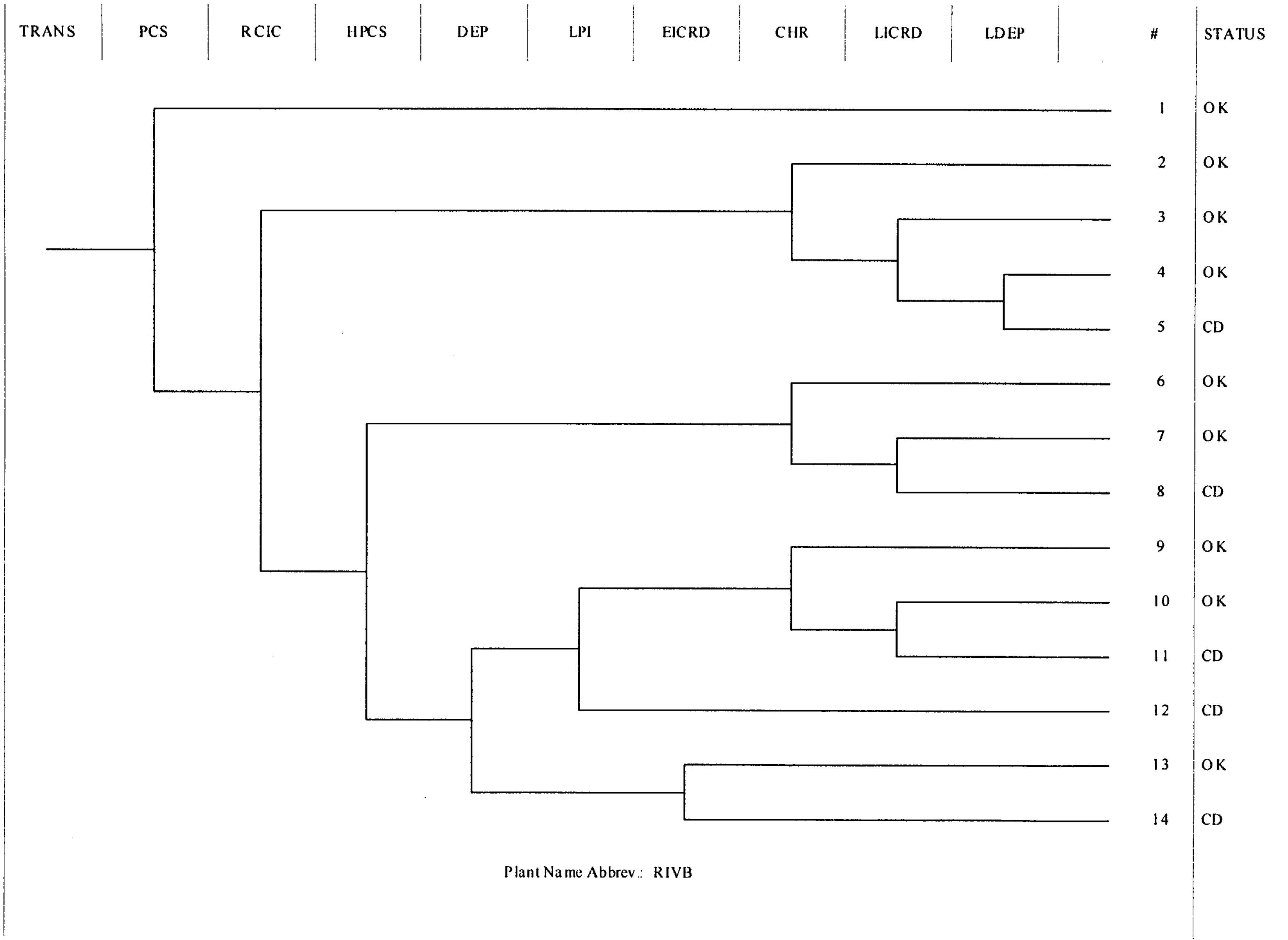
1. No detailed information currently is available on the ISLOCA in River Bend Station.

1.3 SDP Event Trees

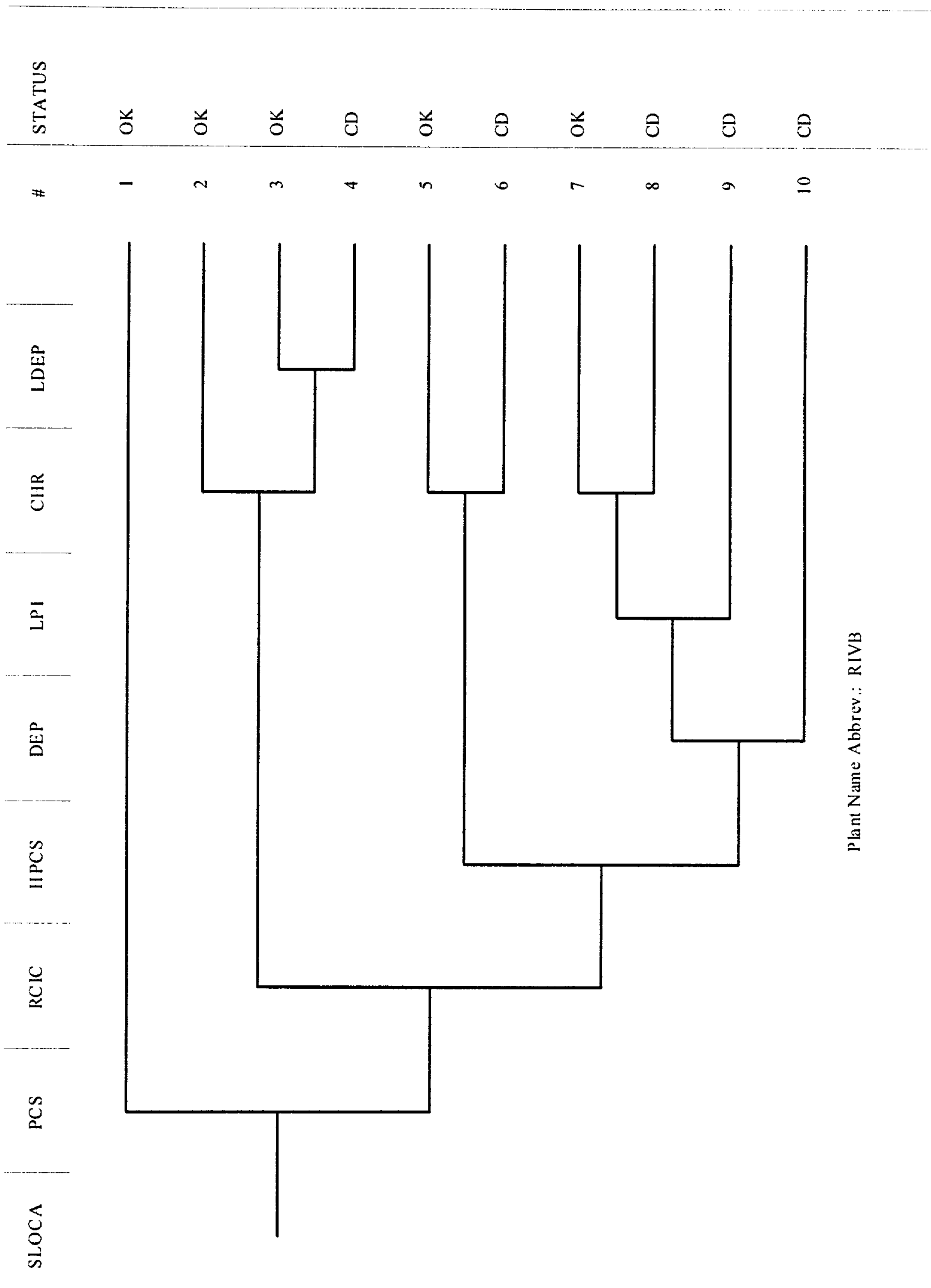
This section provides the simplified event trees, called SDP event trees, used to define the accident sequences identified in the SDP worksheets in the previous section. The event tree headings are defined in the corresponding SDP worksheets.

The following event trees are included:

1. Transients (Reactor Trip) (TRANS)
2. Small LOCA (SLOCA)
3. Medium LOCA (MLOCA)
4. Large LOCA (LLOCA)
5. Loss of Offsite Power (LOOP)
6. Anticipated Transients Without Scram (ATWS)



Plant Name Abbrev.: RIVB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PCS
RCIC
HPCS
DEP
LPI
CHR
LDEP
#
STATUS
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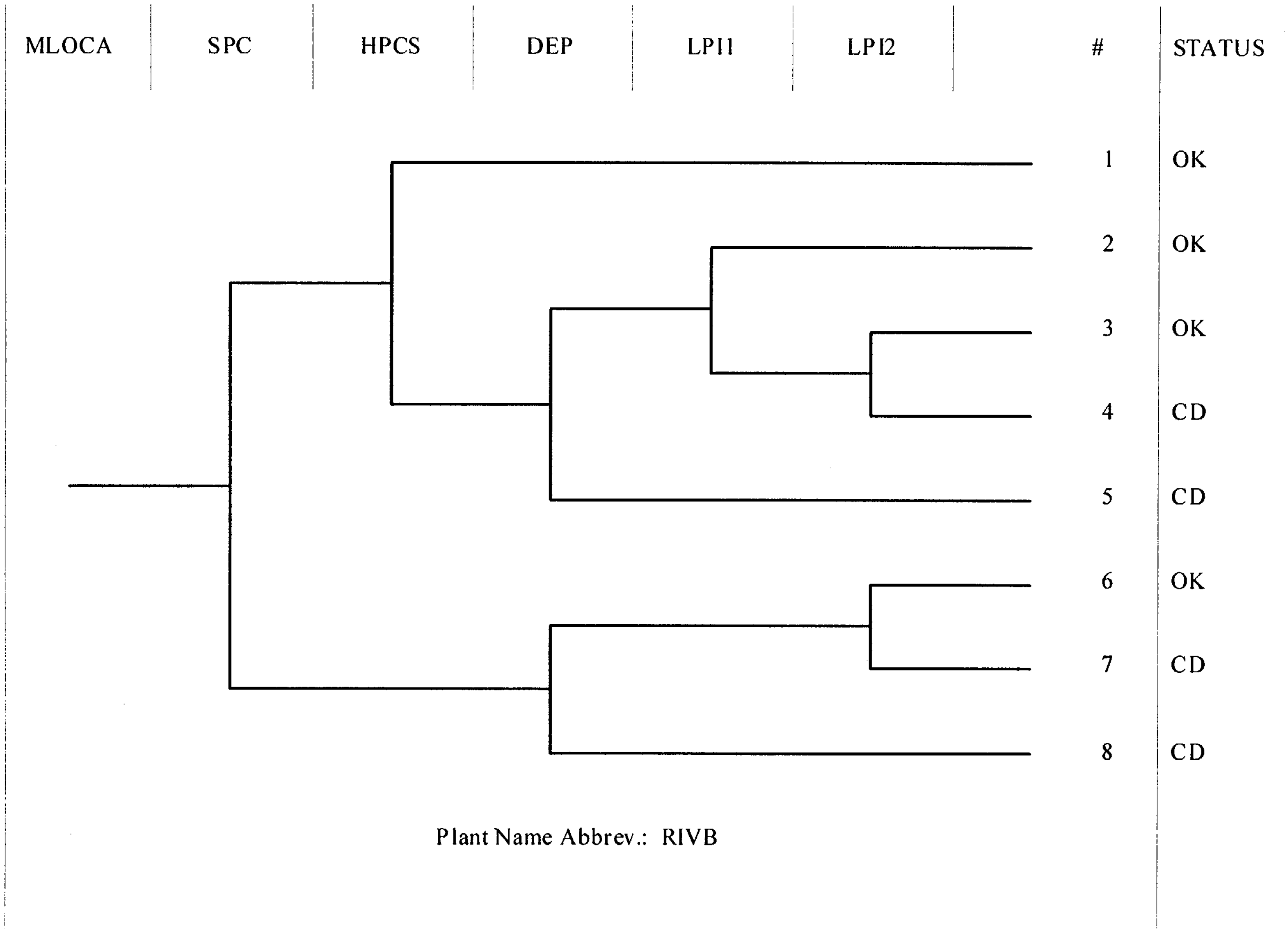
2 OK
3 OK
4 CD
5 OK
6 CD
7 OK
8 CD
9 CD
10 CD
Plant Name Abbrev.: RIVB


MLOCA
SPC
HPCS
DEP
LPI1
LPI2
#
STATUS
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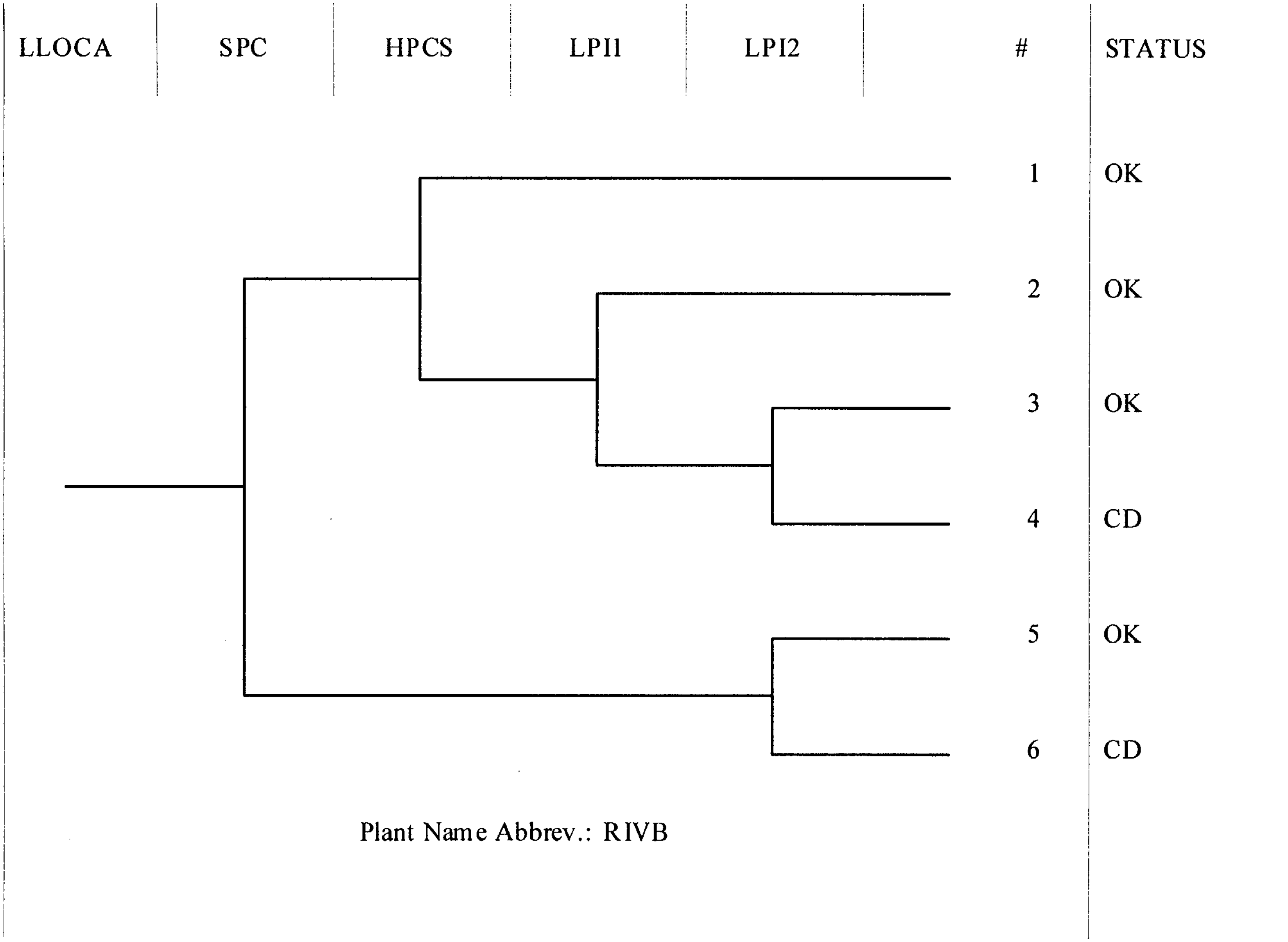
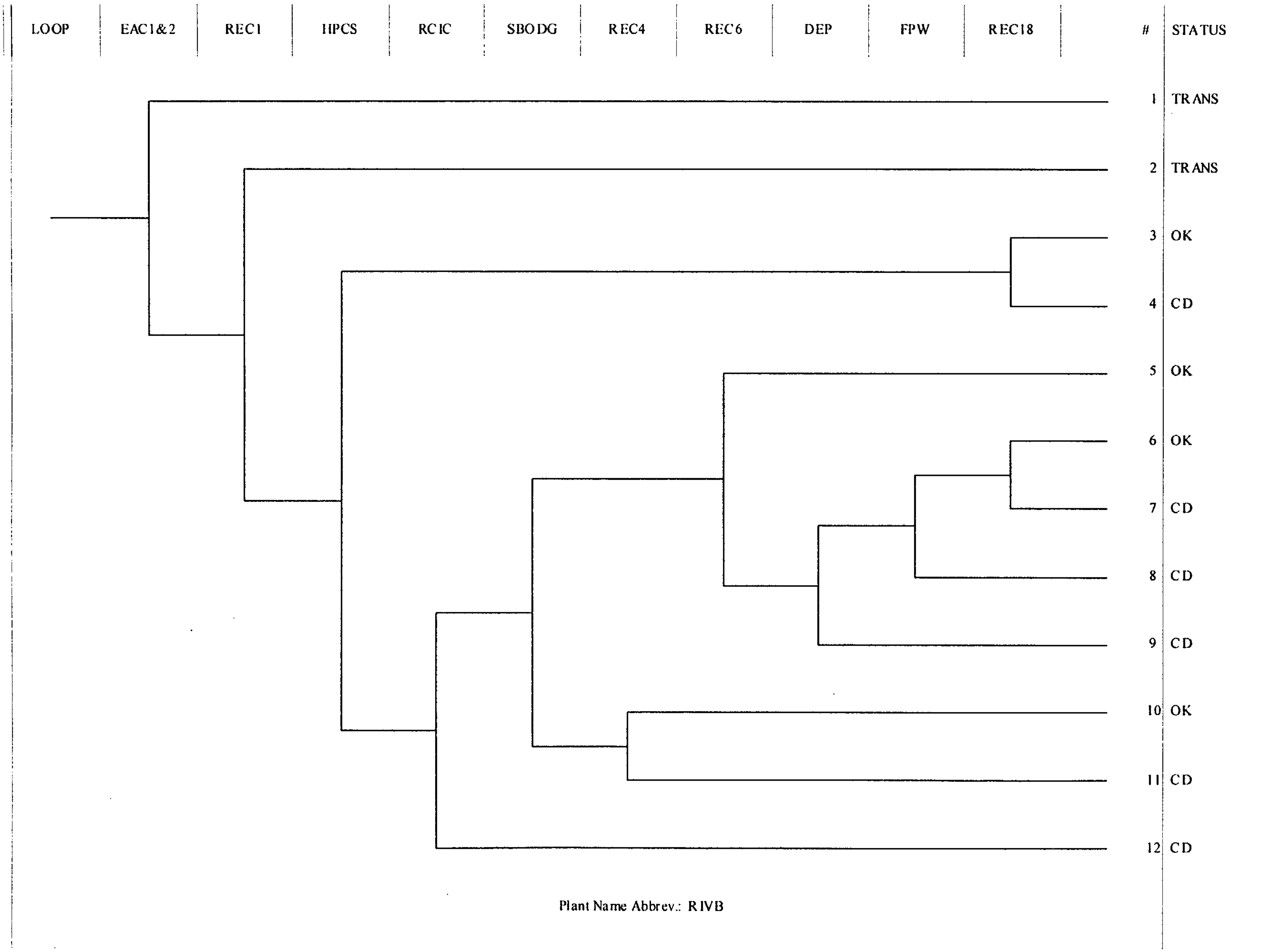
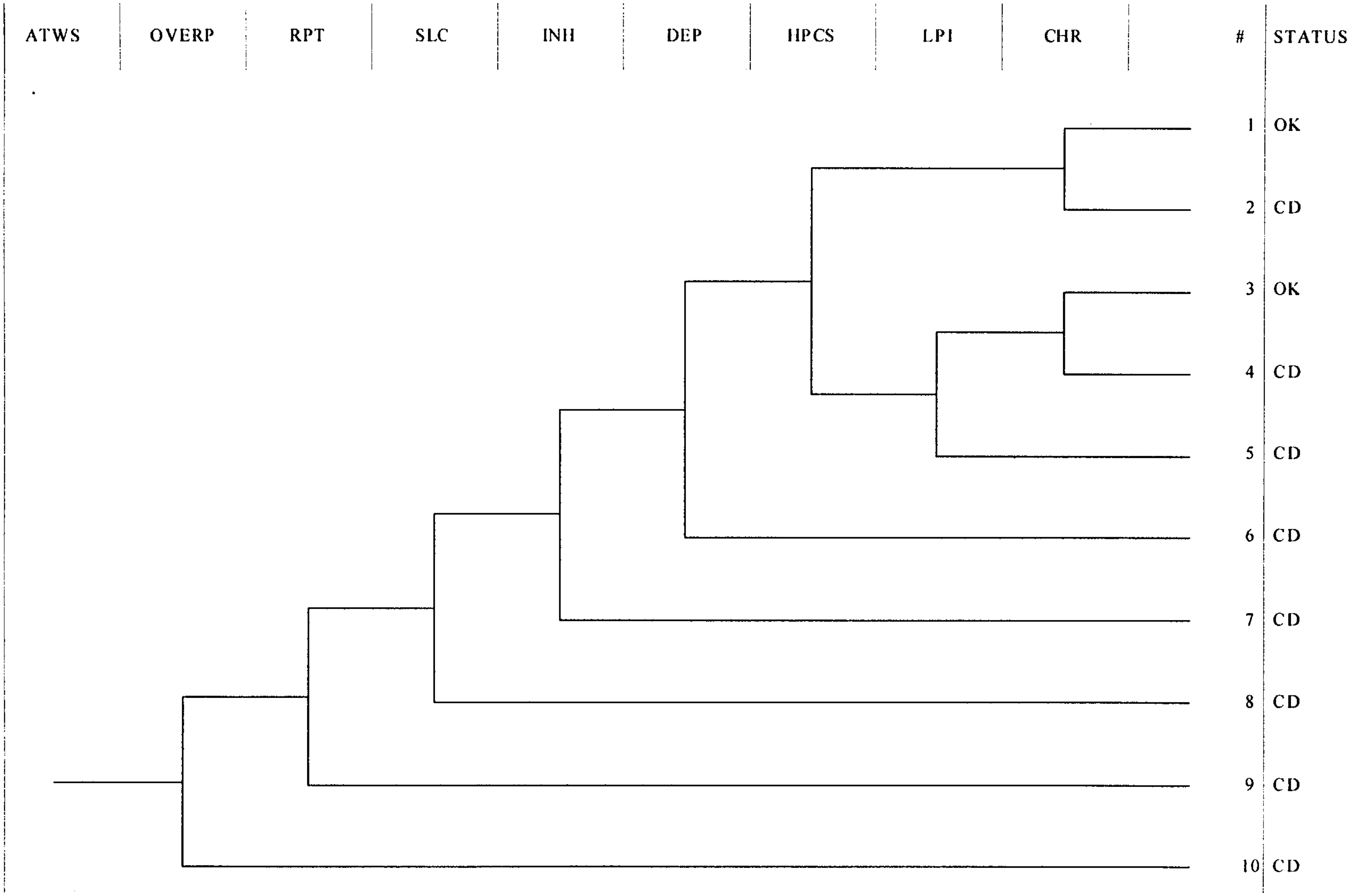
OK
2
OK
3
OK
4
CD
5
CD
6
OK
7
CD
8
CD
Plant Name Abbrev.: RIVB



Plant Name Abbrev.: RIVB



Plant Name Abbrev.: RIVB



Plant Name Abbrev.: RIVR

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 BWR 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 BWRs 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 (BWRs)

Initiating Event Likelihood Rating Table

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 SRVs (IORV), anticipated transients without scram (ATWS), interfacing system LOCA (ISLOCA), and LOCA outside containment (LOC) are assigned into rows based on consideration of industry-average frequency. Plant-specific frequencies can be different, but are not considered. Plant-specific frequencies for LOOP and special initiators are used to assign these initiating events.

2. Inclusion of special initiators:

The special initiators included in the worksheets are those applicable for the plant. A separate worksheet is included for each of the applicable special initiators. The applicable special initiators are primarily based on the plant-specific IPEs. In other words, the special initiator included are those modeled in the IPEs unless it is shown to be a negligible contributor. In some cases, in considering plants of similar design, a particular special initiator may be added for a plant even if it is not included in the IPE if such an initiator is included in other plants of similar design and is considered applicable for the plant. Except for the interfacing system LOCA (ISLOCA) and LOCA outside containment (LOC), 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 focus is on the initiating event and the risk implication of the inspection finding can be directly assessed. For ISLOCA and LOC, a separate worksheet is included noting the pathways that can lead to these events.

3. Inadvertent or stuck open relief valve as an IE in BWRs:

Many IPEs/PRAs model this event as a separate initiating event. Also, the failure of the SRVs to re-close after opening can be modeled within the transient tree. In the SDP worksheet, these events are modeled in a separate worksheet (and, are not included in the transient worksheets) considering both inadvertent opening and failure to re-close. We typically consider a single valve is stuck or inadvertently open. The frequency of this initiator is generically estimated for all BWR plants. This IE may behave similar to a small or medium LOCA depending on the valve size, and the mitigation capability is addressed accordingly.

4. LOCA outside containment (LOC):

A LOCA outside of containment (LOC) can be caused by a break in a few types of lines such as Main Steam or Feedwater. LOC is treated differently among the IPEs. Separate ETs are usually not developed in the IPEs for LOCs. Thus, credit is usually not taken for mitigating actions. LOC sequences typically have a core damage frequency in the E-8 range. As such, LOCs are included

together with ISLOCAs in a separate summary type SDP worksheet. Plant specific notes are included to explain how the particular IPE has addressed LOCs.

Initiating Event and System Dependency Table

1. Inclusion of systems under the support system column:

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

2. 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 ET headings/functions to that included in the Table was not considered necessary.

SDP Worksheets and Event Trees

1. 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 typically those covered under the Technical Specifications (TS) and the Maintenance Rule (MR). No evaluation was performed to assure that the components included in the worksheets are covered under TS or MR. However, if a component was included in the worksheet, and the licensee requested its removal, it may not have been removed if it is considered that the components is included in either TS or MR.

2. 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 to maintain consistency across the SDP worksheets of similar plant designs.

3. Crediting system trains with high unavailability

Some system component/trains may have unavailability higher than 1E-2, but they are treated in a manner similar to other trains with lower unavailability in the range of 1E-2. In this screening approach, this 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 1, i.e., an unavailability in the range of !E-1.

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

Passive components, namely isolation condensers in some BWRs, are credited similar to active components. The reliability of these components are not expected to differ (from that of active components) by more than an order of magnitude. Pipe failures have been excluded in this process except as part of initiating events where appropriate frequency is used. Accordingly, a separate designation for passive components was not considered necessary.

5. Defining credits for 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.

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

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

7. Dependency among multiple operator actions:

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

8. Crediting late injection (LI) following failure of containment heat removal (CHR), i.e., suppression pool cooling:

Following successful high or low pressure injection, suppression pool cooling is modeled. Upon failure of suppression pool cooling, containment venting (CV) is considered followed by late injection. Late injection is credited if containment venting is successful. Further, LI is required following CV success. The suction sources for the LI systems credited are different from the suppression pool. HPCI, LPCI, and CS are not credited in late injection. No credit is given for LI following failure of CV. The survival probability is low and such details are not considered in the screening approach here.

9. Combining late injection (LI) with low pressure injection (LPI) or containment venting (CV):

In some modeling approaches, LI is combined with LPI or CV. In the SDP worksheet approach here, these functions are separate. As discussed above, LPI and LI use different suction sources, and CV and LI may be two different categories of operator actions. In these respects, for some plants, SDP event trees may be different than the plant-specific trees.

10. Crediting condensate trains as part of multiple functions: power conversion system (PCS), low pressure injection (LPI), and late injection (LI):

Typically, condensate trains can be used as an LPI and LI source in addition to its use as part of the power conversion system. However, crediting the same train in multiple functions can result in underestimation of the risk impact of an inspection finding in the SDP screening approach since it does not account for these types of dependencies in defining the accident sequences. To simplify the process and to avoid underestimation, condensate train is not credited in LPI, but may be credited in LI.

11. Modeling vapor suppression success in different LOCA worksheets:

Vacuum breakers typically must remain closed following a LOCA to avoid containment failure and core damage. Some plants justify that vapor suppression is not needed for SLOCA. These sequences typically have low frequency and are not among the important contributors. However, an inspection finding on these vacuum breakers may make these sequences a dominant contributor. Accordingly, success of vapor suppression is included in the SDP worksheets. It is included for all three LOCA worksheets (LLOCA, MLOCA, and SLOCA); for plants presenting justification that they are not needed in a SLOCA appropriate modifications are made.

12. ATWS with successful PCS as a stable plant state:

Some plants model a stable plant state when PCS is successful following an ATWS. Following our comparison of similarly designed plants, such credits are not given.

13. Modeling different EDG configurations, SBO diesel, and cross-ties:

Different capabilities for on-site emergency AC power exist at different plant sites. To treat them consistently across plants, they are typically combined into a single emergency AC (EAC) function. The dedicated EDGs are credited following the standard convention used in the worksheets for equipment (1 dedicated EDG is 1 train; 2 or more dedicated EDGs is 1 multi-train system). The use of the swing EDG or the SBO EDG requires operator action. 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:

1. Describe the success criteria and the mitigation capability of dedicated EDGs.

2. 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.

3. Assign a mitigating capability of "operator action=1" for an SBO EDG similar to the swing EDG. Note, some of the plants do not take credit for an SBO EDG for non-fire initiators. In these cases, credit is not given.

4. 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.

14. 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.

15. Mitigation capability for containment heat removal:

The mitigation capability for containment heat removal (CHR) function is considered dominated by the hardware failure of the RHR pumps. The applicable operator action is categorized as an operator action with a credit 4, i.e., operator action=4. For this situation, the function is defined as 1 multi-train system since the operator action involved is considered routine and reliable, and is assigned a credit of 4. No other operator action in the worksheets is generically assigned this high credit.

16. Crediting CRD pumps as an alternate high pressure injection source:

In many plants, CRD pumps can be used as a high pressure injection source following successful operation of HPCI or RCIC for a period of time, approximately 1 to 2 hours. In some plants, CRD system is enhanced where it can be directly used and does not need the successful operation of other HPI sources. In the worksheets, if the CRD pumps require prior successful operation of HPCI or RCIC as a success criteria, then CRD is not credited as a separate high pressure injection source. If the CRD can be used and does not require successful operation of HPCI or RCIC, then it is credited as a separate success path within the HPI function.

2.2 RESOLUTION OF PLANT-SPECIFIC COMMENTS

NRC staff met with the Licensee's personnel who provided useful comments on the updated worksheets. The updated information was transferred to BNL. It contained a total of 93 specific comments and recommendation, an annotated earlier version of the worksheet, and a summary sequence description of the ATWS scenarios. No information were provided on special initiators, plant response, and the initiator impacts. Also not included were the information required for HEP evaluation. The licensee comments were reviewed and incorporated into the SDP worksheet to the extent possible within the framework, scope, and limitations of the SDP worksheets. The licensee's comment and feedback have significantly contributed to the improvement of this document.

1. Licensee's comments on the Initiator and System Dependency Tables reflecting the up-to-date plant-specific system interactions, clarification notes, and plant specific acronyms were all incorporated.

2. Licensee's comments reflecting the current understanding of success criteria were all incorporated in the SDP worksheets. As an example, the SPCC system now is credited as a part of LPI and CHR function. However, it is not credited as a part of late inventory injection after depressurization with no CHR function available.

3. With the exception of a very few cases for which the specific HEP values were extracted from the licensee's comments, all HEP values are assigned generically. This plant sometimes require special manual actions which is not typical of other similar plants. Therefore, the assigned HEP values may be re-examined at a later time.

4. The 93 specific licensee's recommendation were reviewed and incorporated into the SDP work sheet within the current limitations and the framework of this report. Minor deviations from these comments were made to avoid double crediting the same system. As an example, the condensate injection is only credited in LDEP function rather than both LDEP and PCS to avoid double counting.

REFERENCES

1. NRC SECY-99-007A, Recommendations for Reactor Oversight Process Improvements (Follow-up to SECY-99-007), March 22, 1999.

2. Entergy Operations, Inc., "River Bend Unit 1 – Individual Plant Examination Report," dated February 1993.

We will coordinate our efforts through Mr. Robert L. Biggs, Coordinator, Safety and Regulatory Affairs, in the licensing organization. If you have any questions, please contact me at 301-415-1737

Sincerely,

/RA/

Robert E. Moody, Project Manager
Project Directorate IV & Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-458

Enclosure: As stated

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