October 1, 2001

Mr. Harold W. Keiser
Chief Nuclear Officer & President
PSEG Nuclear LLC - X04
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Hancocks Bridge, NJ 08038

SUBJECT: SALEM NUCLEAR GENERATING STATION, UNIT NOS. 1 AND 2, SITE-SPECIFIC WORKSHEETS FOR USE IN THE NUCLEAR REGULATORY COMMISSION'S SIGNIFICANCE DETERMINATION PROCESS (TAC NO. MA6544)

Dear Mr. Keiser:

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 publicly available through the Nuclear Regulatory Commission (NRC) external website at http://www.nrc.gov/NRC/IM/salem.pdf.

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 by our letter dated December 29, 1999. 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 enclosed Phase 2 Worksheets have incorporated much of the information we obtained during our site visits. The staff encourages further licensee comments where it is identified that the Worksheets give inaccurately low significance determinations. Any comments should be provided to the Document Control Desk, with a copy to the Chief, Probabilistic Safety Assessment Branch, Office of Nuclear Reactor Regulation. We will continue to assess SDP accuracy and update the document based on continuing experience.

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

If you have any questions, please contact me at (301) 415-1324.

Sincerely,

/RA/

Robert J. Fretz, Project Manager, Section 2
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-272 and 50-311

Enclosure: Risk-Informed Inspection Notebook

cc w/encls: See next page

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RISK-INFORMED INSPECTION NOTEBOOK FOR

SALEM GENERATING STATION

PWR, WESTINGHOUSE, FOUR-LOOP PLANT WITH LARGE DRY CONTAINMENT

Prepared by

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NOTICE

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

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ABSTRACT

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

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

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

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1. INFORMATION SUPPORTING SIGNIFICANCE DETERMINATION PROCESS (SDP)

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

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

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

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

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

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

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

1. The special initiator should degrade at least one of the mitigating safety functions thereby changing its mitigation capability in the worksheet. For example, when a safety function with two redundant trains, classified as a multi-train system, degrades to a one-train system, it is classified as 1 Train, due to the loss of one of the trains as a result of the special initiator.

2. The special initiators which degrade the mitigation capability of the systems/functions associated with the initiator from comparable transient sequences by two and higher orders of magnitude must be considered.

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

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

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

1. Loss of Offsite Power (LOOP),
2. LOOP with failure of 1 Emergency AC bus or associated EDG (LEAC),
3. Loss of 1 DC Bus (LDC),

4. Loss of component cooling water (LCCW),
5. Loss of instrument air (LIA),
6. Loss of service water (LSW).

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

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

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

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

1. Event trees and sequences were developed such that the worksheet contains all the major accident sequences identified by the plant-specific IPEs/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 take into account the IPE/PRA models and event trees for all similar plants. For modeling the response to an initiating event, any major deviations in one plant from similar plants may be noted at the end of the worksheet.

3. The event trees and the sequences were designed to capture core-damage scenarios, without including containment-failure probabilities and consequences. Therefore, branches of event

trees that are developed only for the purpose of a Level II PRA analysis are not considered. The resulting sequences are merged, using Boolean logic.

4. The simplified event trees focus on classes of initiators, as defined above. In so doing, many separate event trees in the IPEs/PRAs often are represented by a single tree. For example, some IPEs/PRAs define four classes of LOCAs rather than the three classes considered here. The sizes of LOCAs for which high-pressure injection is not required are sometimes divided into two classes, the only difference between them being the need for reactor scram in the smaller break size. There may be some consolidation of transient event trees besides defining the special initiators following the criteria defined above.

5. Major actions by the operator during accident scenarios are credited using four categories of Human Error Probabilities (HEPs). They are termed operator action =1 (representing an error probability of 5E-2 to 0.5), operator action=2 (error probability of 5E-3 to 5E-2), operator action=3 (error probability of 5E-4 to 5E-3), and operator action=4 (error probability of 5E-5 to 5E-4). An human action is assigned to a category bin, based on a generic grouping of similar actions among a class of plants. This approach resulted in designation of some actions to a higher bin, even though the IPE/PRA HEP value may have been indicative of a lower category. In such cases, it is noted at the end of the worksheet. On the other hand, if the IPE/PRA HEP value suggests a higher category than that generically assumed, the HEP is assigned to a bin consistent with the IPE/PRA value in recognition of potential plant-specific design; a note is also given in these situations. Operator's actions belonging to category 4, i.e., operator action=4, may only be noted at the bottom of worksheet because, in those cases, equipment failures may have the dominating influence in determining the significance of the findings.

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

1.1 INITIATING EVENT LIKELIHOOD RATINGS

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

Table 1 Categories of Initiating Events for Salem Generating Station

Row	Approximate Frequency	Example Event Type	Estimated Likelihood Rating		
I	> 1 per 1-10 yr	Reactor Trip (TRANS), Loss of Power Conversion System (TPCS)	A	B	C
II	1 per 10-10^2 yr	Loss of offsite power (LOOP), Loss of 125 VDC Bus (LBDC)	B	C	D
III	1 per 10^2 - 10^3 yr	SGTR, Stuck open PORV/SRV (SORV), Small LOCA including RCP seal failures (SLOCA), MSLB (outside containment), Loss of Control Area Air Conditioning (CAAC), Loss of Switchgear HVAC (SVAC)	C	D	E
IV	1 per 10^3 - 10^4 yr	Medium LOCA (MLOCA), LOOP and Loss of Vital 4 kV AC Bus (LEAC)	D	E	F
V	1 per 10^4 - 10^5 yr	Large LOCA (LLOCA)	E	F	G
VI	less than 1 per 10^5 yr	ATWS[1], Loss of SWS (LSW), 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. Thus, the ATWS frequency to be used by these worksheets must represent the ATWS condition that can only be mitigated by the systems shown in the worksheet (e.g., boration). Any inspection finding that represents a loss of capability for manual reactor trip for a postulated ATWS scenario should be evaluated by a risk analyst to consider the probability of a successful manual trip.

1.2 INITIATORS AND SYSTEM DEPENDENCY

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

Table 2 Initiators and System Dependency for Salem Generating Station

Affected System	Major Components	Support Systems	Initiating Event Scenarios
AC Power System	Three 4,160V AC Vital buses	125 V-DC, 28 V-DC, Switchgear HVAC	All
	Three 460V Vital buses	4,160V AC, 125 V-DC, 28 V-DC, Switchgear HVAC	CAAC, SVAC
	Three 230V AC Vital buses	4,160V AC, 28 V-DC, Switchgear HVAC	All
	Three diesel generators (EDGs)	125 V-DC, 28 V-DC, SWS, DG Area Ventilation (VDG), CAS (for dampers of VDG), Fuel Oil Transfer	LOOP, LEAC
	One gas turbine generator	Actuated manually from the local control panel or control room[1]	
Accumulators (ACC)	Four accumulators	None	MLOCA, LLOCA
Auxiliary Feedwater System (AFS)[2]	One turbine-driven pump	125 V-DC, CAS, ESF	All except MLOCA, LLOCA, SGTR
	Two motor-driven pumps	4 KV bus A&B, 125 V-DC, 28 V-DC, 115V AC Vital Instrument Buses, CAS, ESF, SWS (room cooler)	All except MLOCA, LLOCA
Chilled Water System (CHS)	Two 100%-capacity chilled water pumps	460V AC, 230V AC, SWS	CAAC
Component Cooling Water System (CCS)	Three pumps, two heat exchangers	4.16 KV, 125 V-DC, 28 V-DC, SWS (room cooling)	All except LBDC
Control Air System (CAS)	Two emergency control air compressors	460V AC, 125 V-DC, CHS, ESF, SWS	All except MLOCA, LLOCA, SGTR

Table 2 (continued)

Affected System	Major Components	Support Systems	Initiating Event Scenarios
Control Area Air Conditioning System (VCA)	Three 50%-capacity supply air fans	230V AC, ESF, CHS	CAAC
DC Power System	Three 125V DC buses, batteries, and battery chargers	230V AC, Switchgear HVAC	LBDC
	Two 28V DC buses[3] and batteries	230V AC, Relay room HVAC	All
Engineered Safety Features Actuation System (ESF)	Subsystems: RPS, SEC, SSPS	115V AC Vital Instrument Buses, VCA	All
High Pressure Charging / Injection System (CVS)	Two charging pumps (shutoff head 2,670 psig)	4.16 KV, 230V AC, 125 V-DC, 28 V-DC, ESF, CCS (mechanical seal and gland plate seal cooling), SWS (pump lube oil cooling and room cooling)	All except LLOCA, LBDC
	Two boric acid transfer pumps	460V AC	ATWS
Main Feedwater / Condensate System[4]	Two feedwater pumps	Non-safety related AC, Non-safety related DC, Steam, SWS, CAS	TRANS, SLOCA, SORV, ATWS, MSLB, CAAC, SVAC
	Three condensate pumps	Non-safety related 4.16 KV, non-safety related DC, SWS, CAS	
Main Steam System	One MSIV per SG	115V AC Vital Instrument Buses, 230V AC Vital Control Centers, ESF	MSLB
	One Main Steam Atmospheric Relief valve (ARV) per SG	115V AC Vital Instrument Buses, CAS	All except MLOCA, LLOCA
	Five safety relief valves per SG	None	TRANS, TPCS, SLOCA, SORV, LOOP, SGTR, ATWS, MSLB, LBDC, LEAC

Table 2 (continued)

Affected System	Major Components	Support Systems	Initiating Event Scenarios
Power-Operated Relief Valves (PORV)	Two PORVs	125 V-DC, 28 V-DC and 115V AC Vital Instrument Buses (for control), CAS[5]	All except MLOCA, LLOCA, LBDC
	Two motor-operated block valves	230V AC Vital Control Centers	SORV
Reactor Coolant Pump (RCP)	Seals	1 / 1 positive displacement charging pump, or 1 / 2 centrifugal charging pump to seal injection (i.e., 1 / 3 charging pumps) or 1 / 3 CCS pumps to thermal barrier heat exchanger	SLOCA
Residual Heat Removal System (RHS)	Two pumps	4.16 KV, 125 V-DC, 28 V-DC, SWS (room cooling), CCS, ESF	All except SGTR, ATWS, LBDC
Safety Injection System (SJS)	Two SI pumps (shutoff head 1,520 psig)	4.16 KV, 125 V-DC, 28 V-DC, SWS (pump lube oil cooling and room cooling), CCS (seal cooling), ESF	All except LLOCA, ATWS, LBDC
Safety Relief Valves (SRV)	Three SRVs	None	ATWS
Service Water System (SWS)	Six pumps	4.16 KV, 125 V-DC	LSW[6]
Switchgear HVAC System (VSW)	Three 50%-capacity supply air fans	460V AC, 125V DC, ESF[7]	SVAC

Notes:

1. No other dependencies were found in the IPE.

2. The IPE (page 3.2-4) states that the AFS pumps do not require cooling. The AFS motor-driven pumps require room cooling. There is an independent room cooler that can cool all three pumps (cooled by SWS). The TDP will operate without room cooling.

3. 28V DC buses provide power for control and remote control of components.

Table 2 (continued)

4. A description of the PCS (main feedwater and condensate) and its support systems was not found in the IPE. The support systems for main feedwater and condensate systems are currently assigned generically pending licensee's response.

5. There is a backup air system (accumulators) which is fully redundant to the control air.

6. This is an unprotected event. Any performance issue that has degraded the SWS system requires a phase 3 analysis to be performed.

7. The IPE (page 3.2-83) states that cooling for components and room cooling are not required.

8. CDF for Salem Generating Station (SGS) Unit 1 is 4.4E-5 per year. CDF for SGS Unit 2 is 4.8E-5 per year. The IPE (page 1-7) states that it has been established that SGS Units 1 and 2 have virtually identical systems and containments, and that differences in results are wholly attributable to differences in unit specific data.

1.3 SDP WORKSHEETS

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

1. Transients with PCS Available (Reactor Trip) (TRANS)
2. Transients with Loss of PCS (TPCS)
3. Small LOCA (SLOCA)
4. Stuck-open PORV (SORV)
5. Medium LOCA (MLOCA)
6. Large LOCA (LLOCA)
7. Loss of Offsite Power (LOOP)
8. Steam Generator Tube Rupture (SGTR)
9. Anticipated Transients Without Scram (ATWS)
10. Main Steam Line Break (MSLB)
11. Loss of Control Area Air Conditioning (CAAC)
12. Loss of Switchgear HVAC (SVAC)
13. Loss of Vital DC Bus (LBDC)
14. LOOP and Loss of Vital 4.16 kV AC Bus (LEAC)
15. Interfacing Systems LOCA (ISLOCA)

Table 3.1 SDP Worksheet for Salem Generating Station — Transients with PCS Available (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:**
Secondary Heat Removal (AFW)	1/2 MDAFS pumps (1 multi-train system) or 1/1 TDAFS pump (1 ASD train) with 1 / 4 ARVs or 1 / 5 safety relief valves (per steam generator) (1)
Power Conversion System (PCS)	1/2 feedwater pumps with 1/3 condensate pumps (operator action = 2) (2)
High Pressure Injection for FB (EIHP)	1/2 charging pumps (1 multi-train system) or 1/2 SI pumps (1 multi-train system)
Primary Heat Removal, Feed/Bleed (FB)	2/2 PORVs open for Feed/Bleed (operator action = 2)
High Pressure Recirculation (HPR)	1/2 charging pumps or 1/2 SI pumps taking suction from 1/2 RHS pumps with successful switchover to sump (operator action = 3)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 TRANS - AFW - PCS - HPR (4)			
2 TRANS - AFW - PCS - FB (5)			
3 TRANS - AFW - PCS - EIHP (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.

Notes:

1. The success criteria for steam relief for this worksheet and the subsequent worksheets was not found in the IPE. We assume that the success criteria is 1 / 4 ARVs or 1 / 5 safety relief valves (per steam generator).

2. The IPE (page 3.3-91) developed a simplified fault tree combining dominant hardware failures and human error for “Main feedwater/condensate failure following AFS failure”, and obtained a failure probability = 2.2E-2. Accordingly, we assigned operator action = 2.

Table 3.2 SDP Worksheet for Salem Generating Station — Transients with Loss of PCS (TPCS)

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:**
Secondary Heat Removal (AFW)	1/2 MDAFS pumps (1 multi-train system) or 1/1 TDAFS pump (1 ASD train) with 1/4 ARVs or 1 / 5 safety relief valves (per steam generator)
High Pressure Injection for FB (EIHP)	1/2 charging pumps (1 multi-train system) or 1/2 SI pumps (1 multi-train system)
Primary Heat Removal, Feed/Bleed (FB)	2/2 PORVs open for Feed/Bleed (operator action = 2)
High Pressure Recirculation (HPR)	1/2 charging pumps or 1/2 SI pumps taking suction from 1/2 RHS pumps with successful switchover to sump (operator action = 3)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 TPCS - AFW - HPR (3)			
2 TPCS - AFW - FB (4)			
3 TPCS - AFW - EIHP (5)			

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

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

Table 3.3 SDP Worksheet for Salem Generating Station — Small LOCA (SLOCA)[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:**
Early Inventory, HP Injection (EIHP)	1/2 charging pumps (1 multi-train system) or 1/2 SI pumps (1 multi-train system)
Secondary Heat Removal (AFW)	1/2 MDAFS pumps (1 multi-train system) or 1/1 TDAFS pump (1 ASD train) with 1/4 ARVs or 1 / 5 safety relief valves (per steam generator)
Power Conversion System (PCS)	1/2 feedwater pumps with 1/3 condensate pumps (operator action = 2) [2]
Primary Heat Removal, Feed/Bleed (FB)	1/2 PORVs open for Feed/Bleed[3] (operator action = 2)
High Pressure Recirculation (HPR)	1/2 charging pumps or 1/2 SI pumps taking suction from 1/2 RHS pumps with successful switchover to sump (operator action = 3)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 SLOCA - HPR (2,4,6)			
2 SLOCA - AFW - PCS - FB (7)			
3 SLOCA - EIHP (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.

Notes:

1. The success criteria in the IPE (page 3.1-85) does not credit RCS depressurization and low pressure injection or recirculation.

2. The IPE (page 3.3-91) developed a simplified fault tree combining dominant hardware failures and human error for “Main feedwater/condensate failure following AFS failure”, and obtained a failure probability = 2.2E-2. Accordingly, we assigned operator action = 2.

3. The IPE (page 3.1-33) assumes that feed and bleed requires only one PORV fully open because the small LOCA provides the relief normally accomplished by the other PORV.

Table 3.4 SDP Worksheet for Salem Generating Station — Stuck Open PORV (SORV)[1, 2]

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:**
Isolation of Small LOCA (BLK)	The closure of the block valve associated with the stuck open PORV (operator action = 3)
Early Inventory, HP Injection (EIHP)	1/2 charging pumps (1 multi-train system) or 1/2 SI pumps (1 multi-train system)
Power Conversion System (PCS)	1/2 feedwater pumps with 1/3 condensate pumps (operator action = 2) [3]
Secondary Heat Removal (AFW)	1/2 MDAFS pumps (1 multi-train system) or 1/1 TDAFS pump (1 ASD train) with 1/4 ARVs or 1 / 5 safety relief valves (per steam generator)
Primary Heat Removal, Feed/Bleed (FB)	1/1 remaining PORV open for Feed/Bleed [4] (operator action = 2)
High Pressure Recirculation (HPR)	1/2 charging pumps or 1/2 SI pumps taking suction from 1/2 RHS pumps with successful switchover to sump (operator action = 3)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 SORV - BLK - HPR (2,4,6)			
2 SORV - BLK - AFW - PCS - FB (7)			
3 SORV - BLK - EIHP (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.

Notes:

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

2. The success criteria for a small LOCA in the IPE (page 3.1-85) does not credit RCS depressurization and low pressure injection or recirculation.

3. The IPE (page 3.3-91) developed a simplified fault tree combining dominant hardware failures and human error for “Main feedwater/condensate failure following AFS failure”, and obtained a failure probability = 2.2E-2. Accordingly, we assigned operator action = 2.

4. The IPE (page 3.1-33) assumes that feed and bleed requires only one PORV fully open because the small LOCA provides the relief normally accomplished by the other PORV.

Table 3.5 SDP Worksheet for Salem Generating Station — Medium LOCA (MLOCA)

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for each Safety Function:**
Early Inventory, Accumulators (EIAC)	2/3 remaining accumulators (1 multi-train system)
Early Inventory, HP Injection (EIHP)	2/4 charging or SI pumps (1 multi-train system)
High Pressure Recirculation (HPR)	1/2 charging pumps or 1/2 SI pumps taking suction from 1/2 RHS pumps with successful switchover to sump (operator action = 3)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 MLOCA - HPR (2)			
2 MLOCA - EIHP (3)			
3 MLOCA - EIAC (4)			

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

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

Table 3.6 SDP Worksheet for Salem Generating Station — Large LOCA (LLOCA)

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Early Inventory (EIAC)	3/3 remaining accumulators (1 train)
Early Inventory, LP Injection (EILP)	1/2 RHS pumps (1 multi-train system)
Low Pressure Recirculation (LPR)	1/2 RHS pumps with successful switchover to sump (operator action = 3)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 LLOCA - LPR (2)			
2 LLOCA - EILP (3)			
3 LLOCA - EIAC (4)			

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

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

Table 3.7 SDP Worksheet for Salem Generating Station — Loss of Offsite Power (LOOP)

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 AC Power (EAC)	2/3 Emergency Diesel Generators (1 multi-train system) or 1/1 Gas Turbine Generator (operator action = 1) [(1)]
Secondary Heat Removal (TDAFW)	1/1 TDAFS pump (1 ASD train) with 1/4 ARVs or 1 / 5 safety relief valves (per steam generator)
Secondary Heat Removal (AFW)	1/2 MDAFS pumps (1 multi-train system) or 1/1 TDAFS pump (1 ASD train) with 1/4 ARVs or 1 / 5 safety relief valves (per steam generator)
Recovery of AC Power in < 2 hrs (REC2)	Recover a source of AC to allow primary injection (operator action = 1)
Recovery of AC power in < 6 hrs (REC6)	Recovery of or source of AC including Turbine Generator (operator action = 1) [(2),(3)]
Early Inventory, HP Injection (EIHP)	1/2 charging pumps (1 multi-train system) or 1/2 SI pumps (1 multi-train system)
Primary Heat Removal, Feed/Bleed (FB)	2/2 PORVs open for Feed/Bleed (operator action = 2)
High Pressure Recirculation (HPR)	1/2 charging pumps or 1/2 SI pumps taking suction from 1/2 RHS pumps with successful switchover to sump (operator action = 3)

Circle Affected Functions	Recovery of Failed Train	Remaining Mitigation Capability Rating for Each Affected Sequence	Sequence Color
1 LOOP - AFW - HPR (3)			
2 LOOP - AFW - FB (4)			
3 LOOP - AFW - EIHP (5)			
4 LOOP - EAC - HPR (7, 11) (AC recovered)			
5 LOOP - EAC - EIHP (8, 13) (AC recovered)			
6 LOOP - EAC - REC6 (9)			
7 LOOP - EAC - TDAFW - FB (12) (AC recovered)			
8 LOOP - EAC - TDAFW - REC2 (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.

Notes:

1. The IPE (page 3.2-56) states that the gas turbine generator must be actuated manually from the local control panel or control room. The IPE (page 3.3-90) models this action as “Operator fails to start gas turbine” (event ACP-XHE-FO-GTG) and assesses a human error probability = 6.6E-3. However, the mitigating credit is limited by hardware failure with a credit = 1.

2. The IPE (page 3.3-92) assesses a human error probability = 0.05 to the non-recovery of off-site power by 6 hours.

3. In an SBO situation, an RCP seal LOCA may occur, with subsequent core damage at about 6 hours when the TDAFW is providing secondary cooling.

Table 3.8 SDP Worksheet for Salem Generating Station — Steam Generator Tube Rupture (SGTR)[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:**
Secondary Heat Removal (AFW)	1/2 MDAFS pumps (1 multi-train system) [2] with 1/4 ARVs or 1 / 5 safety relief valves (per steam generator)
Early Inventory, HP Injection (EIHP)	1/2 charging pumps (1 multi-train system) or 1/2 SI pumps (1 multi-train system)
Primary/Secondary pressure Equalization (EQ)	Operator isolates the ruptured SG and depressurizes RCS to less than setpoint of relief valve of SG (operator action = 2)
Alternate Source AFW (ALSAFW)	Operator aligns alternate sources of water to the AFS (operator action = 2) [3]
Primary Heat Removal, Feed/Bleed (FB)	2/2 PORVs open for Feed/Bleed (operator action = 2)
Makeup RWST (MKRWST)	Operator aligns borated water sources to RWST (operator action = 1) [4]
High Pressure Recirculation (HPR)	1/2 charging pumps or 1/2 SI pumps taking suction from 1/2 RHS pumps with successful switchover to sump (operator action = 3)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 SGTR - EQ - MKRWST (3, 5)			
2 SGTR - EQ - ALSAFW - FB (6)			
3 SGTR - EIHP - EQ (8)			
4 SGTR - AFW - HPR (10)			

5 SGTR - AFW - MKRWST (11)			
6 SGTR - AFW - FB (12)			
7 SGTR - AFW - EIHP (13)			

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

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

Notes:

1. The success criteria in the IPE (page 3.1-83) does not credit RCS depressurization and low pressure injection or recirculation.

2. Failure to equalize is assumed to result in failure to isolate the SG (loss of SG inventory to atmosphere). If primary/secondary pressure equalization (EQ) (steam generator isolation) fails, the IPE (page 3.1-29) assumes that the steam generator would overfill, resulting in failure of the AFS turbine-driven pump.

3. The IPE (page 3.3-90) models this action as “Failure to align alternate sources of water to the AFS” (event Aas) and assesses a human error probability = 0.01.

4. Per licensee comment, RWST re-fill is currently modeled as a basic event. The detail of the systems required for this action is not currently available.

Table 3.9 SDP Worksheet for Salem Generating Station — Anticipated Transients Without Scram (ATWS)

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for each Safety Function:**
Turbine Trip (TTP)	Operator trips turbine (operator action = 2)
Safety Relief Valves (SRV)	3/3 SRVs or [2/3 SRVs with 2/2 PORVs] (1 train)
Secondary Heat Removal (AFW/PCS)	2/2 MDAFS pumps (1 train) or 1/1 TDAFS pump (1 ASD train) or 1/2 feedwater pumps with 1/3 condensate pumps (operator action = 2) (1) with 2/4 ARVs or 1 / 5 safety relief valves (per steam generator) (2)
Emergency Boration (EMBO)	Emergency boration using 1/2 charging pumps with 1/2 boric acid transfer pumps (operator action = 2)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 ATWS - EMBO (2)			
2 ATWS - AFW/PCS (3)			
3 ATWS - SRV (4)			
4 ATWS - TTP (5)			

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

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

Note:

1. The IPE (page 3.3-91) developed a simplified fault tree combining dominant hardware failures and human error for “Main feedwater/condensate failure following AFS failure”, and obtained a failure probability = 2.2E-2. Accordingly, we assigned operator action = 2.

2. The success criteria for steam relief for this worksheet was not found in the IPE. We assume that the success criteria is 2 / 4 ARVs or 1 / 5 safety relief valves (per steam generator).

Table 3.10 SDP Worksheet for Salem Generating Station — Main Steam Line Break (MSLB)

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for each Safety Function:**
MSIV Isolated (MSIV)	3/4 MSIVs close (1 multi-train system) [(1)]
High Pressure Injection for FB (EIHP)	1/2 charging pumps (1 multi-train system) or 1/2 SI pumps (1 multi-train system)
Secondary Heat Removal (SHR)	1/2 MDAFS pumps (1 multi-train system) or 1/1 TDAFS pump (1 ASD train) with 1/4 ARVs or 1 / 5 safety relief valves (per steam generator)
Feedwater valves close (FWVC)	Operators close the valves feeding the SG whose MSIV did not close (operator action = 1)[(2)]
Stop Injection (STIN)	Operators stop high pressure injection (operator action = 1)[(3)]
Primary Heat Removal, Feed/Bleed (FB)	2/2 PORVs open for Feed/Bleed (operator action = 2)
High Pressure Recirculation (HPR)	1/2 charging pumps or 1/2 SI pumps taking suction from 1/2 RHS pumps with successful switchover to sump (operator action = 3)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 MSLB - FWVC - STIN (3)			
2 MSLB - SHR - HPR (5)			
3 MSLB - SHR - FB (6)			
4 MSLB - EIHP - FWVC (8)			
5 MSLB - EIHP - SHR (9)			
6 MSLB - MSIV (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.

Notes:

1. The IPE (page 3.3-44) assumes that failures of two or more MSIVs to close lead to core damage because of severe overcooling.

2. Since this action would be carried out under time and stress conditions, we assigned a mitigating credit = 1.

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

Table 3.11 SDP Worksheet for Salem Generating Station — Loss of Control Area Air Conditioning (CAAC)[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:**
Recover VCA (RVCA)	Operators recover VCA (operator action = 1) [2]
Alternative Ventilation (AVEN)	Operators open doors and provide portable fans (operator action = 2) [3]
Remote Shutdown (RSD)	Operators shut down the plant by using remote shutdown (operator action = 1) [4]

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 CAAC - RVCA - AVEN - RSD (4)			

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

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

Notes:

1. The IPE (page 3.1-37) models a transient with subsequent loss of the Control Area Air Conditioning System (VCA). The loss of this system without a transient does not lead to a direct trip, and for this reason the IPE did not analyze it (IPE, page 3.4-76). This system provides cooling (ventilation) to the relay room, electrical equipment room, and control room. The IPE assumes that by 2 hours equipment in these rooms would start to malfunction, but it further assumes that by opening doors and providing portable fans the rooms would remain cool. If these recovery actions fail, then the equipment in these rooms can be bypassed by using remote shutdown (IPE, page 3.1-88). The frequency of the loss of the Control Area Air Conditioning System (VCA)= 1.5E-3 / year.

2. Table 3.11-1 provided by the licensee contains the event "Recover CR area cooling given the initiator" (event RVC), with a human error probability = 0.5.

3. The IPE (page 3.3-92) assesses a human error probability = 9E-3.

4. The IPE (page 3.3-93) assesses a human error probability = 8.7E-2.

Table 3.12 SDP Worksheet for Salem Generating Station — Loss of Switchgear HVAC (SVAC)[1]

Estimated Frequency (Table 1 Row) __________ **Exposure Time** __________ **Table 1 Result (circle): A B C D E F G H**			
Safety Functions Needed: **Recover VSW (RVSW)** **Alternative Ventilation (AVEN)**	**Full Creditable Mitigation Capability for each Safety Function:** Operators recover VSW (operator action = 1) (2) Operators open doors and provide portable fans (operator action = 2) (3)		
Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 SVAC - RVSW - AVEN (3)			
Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event: If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available.			

Notes:

1. The IPE (page 3.1-39) models a transient with subsequent loss of the Switchgear HVAC System (VSW). The loss of this system without a transient does not lead to a direct trip, and for this reason the IPE did not analyze it (IPE, page 3.4-76). This system provides cooling (ventilation) to the 64-foot and 84-foot elevations. The IPE assumes that by 2 hours equipment in these rooms would start to fail, that is, loss of all emergency AC and DC power. Cooling can be recovered by repairing the VSW or by opening doors to adjacent rooms and using portable fans. The frequency of the loss of the Switchgear HVAC System (VSW)= 2.5E-3 / year.

2. Table 3.11-1 provided by the licensee contains the event "Recover switchgear room cooling after initiator" (event RVS), with a human error probability = 0.5.

3. The IPE (page 3.3-92) assesses a human error probability = 9E-3.

Table 3.13 SDP Worksheet for Salem Generating Station — Loss of 125 VDC Bus (LBDC)[1]

Estimated Frequency (Table 1 Row) __________	**Exposure Time** __________	**Table 1 Result (circle): A B C D E F G H**	
Safety Functions Needed: **Secondary Heat Removal (AFW)**	**Full Creditable Mitigation Capability for each Safety Function:** 1/1 MDAFS pump (1 train) or 1/1 TDAFS (2) pump (1 ASD train) with 1/4 ARVs or 1 / 5 safety relief valves (per steam generator)		
Circle Affected Functions 1 LBDC - AFW (2)	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**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.			

Notes:

1. A loss of 125 VDC bus deenergizes solenoid trip valve for feedwater regulating and feedwater bypass valves and causes them to close causing a reactor trip on low steam generator level. A detailed description of the loss of 125 VDC bus scenario was not found in the IPE. Mitigating systems affected are RHS, AFS, SJS (charging), and SJS. The IPE (page 3.2-51) states that the PORVs fail closed on a loss of solenoid electrical power. Thus, the Feed/Bleed function is not available because the motive power to one of the PORVs is unavailable. The frequency of the loss of any one of the three DC buses is 0.015 per year.

2. The IPE (page 3.2-154) mentions that the TDAFS pump will start on loss of DC power to the steam isolation valve. Accordingly, we assume that this pump is available.

Table 3.14 SDP Worksheet for Salem Generating Station — LOOP and Loss of Vital 4 kV AC Bus (LEAC)[1]

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

<u>Safety Functions Needed</u>:[2]	<u>Full Creditable Mitigation Capability for each Safety Function</u>:
PORV Recloses (PORV)	2/2 Pressurizer PORVs reclose after opening during transient (1 train) (3)
Secondary Heat Removal (AFW)	1/1 MDAFS pump (1 train) or 1/1 TDAFS pump (1 ASD train) with 1/4 ARVs or 1 / 5 safety relief valves (per steam generator)
High Pressure Injection for FB (EIHP)	1/2 charging pumps (1 multi-train system) or 1/1 SI pump (1 train)
Primary Heat Removal, Feed/Bleed (FB)	2/2 PORVs open for Feed/Bleed (operator action = 2)
Primary Heat Removal, Feed/Bleed (FB1P)	1/1 PORV open for Feed/Bleed (operator action = 2)
High Pressure Recirculation (HPR)	1/2 charging pumps or 1/1 SI pump taking suction from 1/1 RHS pump with successful switchover to sump (operator action = 3)

<u>Circle Affected Functions</u>	<u>Recovery of Failed Train</u>	<u>Remaining Mitigation Capability Rating for Each Affected Sequence</u>	<u>Sequence Color</u>
1 LEAC - AFW - HPR (3, 10)			
2 LEAC - AFW - FB (4)			
3 LEAC - AFW - EIHP (5, 12)			
4 LEAC - PORV - HPR (7)			
5 LEAC - PORV - EIHP (8)			

6 LEAC - PORV - AFW - FB1P (11)				
Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event: If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available.				

<u>**Notes**</u>**:**

1. Loss of vital 4 kV AC bus renders several equipment unavailable. For example, loss of bus A causes the loss of the following equipment: 1 CCS pump, 1 AFS pump, 1 SJS pump, 1 CSS pump, 1 RHS pump, and 2 SWS pumps. This worksheet was developed under these conditions.

2. Since the success criteria in the IPE (page 3.1-85) does not credit low pressure injection in a small LOCA, we did not credit it in this worksheet.

3. The block valves of the PORVs are powered from the vital control centers. Hence, if a vital 4 kV AC bus is lost, it appears that there may not be motive power available to close the block valve of a stuck open PORV.

Table 3.15 SDP Worksheet for Salem Generating Station — Interfacing Systems LOCA (ISLOCA)[1]

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>:**		
RHR Suction Line from Hot Leg 1	Leakage through RHR suction line normally closed motor-operated isolation valves RH1 and RH2 such that RCS fluid pressurizes the RHR system to the rupture pressure.		
RHR Cold Leg Discharge Lines	Flow through one of four cold leg discharge lines (isolated by two series check valves; e.g., SJ43 and SJ56) such that RCS fluid pressurizes the RHR system to the rupture pressure.		
<u>Circle Affected Functions</u>	**<u>Recovery of Failed Train</u>**	**<u>Remaining Mitigation Capability Rating for Each Affected Sequence</u>**	**<u>Sequence Color</u>**
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.			

<u>Note</u>:

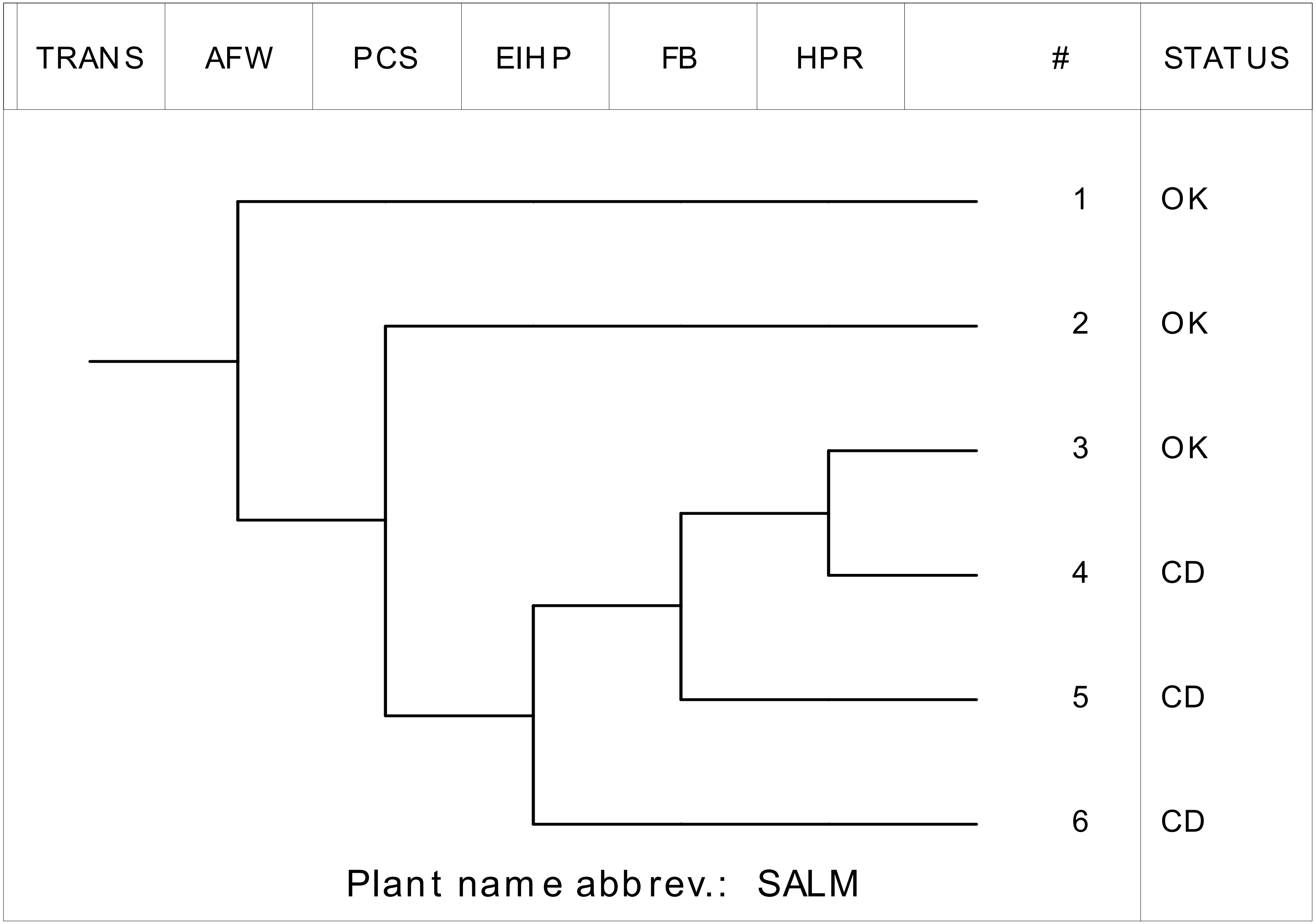
1. This worksheet is different from the other worksheets in that ISLOCA is typically an unmitigated initiating event in most PRAs. Therefore, the right side of the worksheet contains paths which may lead to an ISLOCA rather than mitigating systems to address an event in progress. As such, it is not intended to be referenced by the last column of Table 2, Initiators and System Dependency Table.

1.4 SDP Event Trees

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

The following event trees are included:

1. Transients with PCS Available (Reactor Trip) (TRANS)
2. Transients with Loss of PCS (TPCS)
3. Small LOCA (SLOCA)
4. Medium LOCA (MLOCA)
5. Large LOCA (LLOCA)
6. Loss of Offsite Power (LOOP)
7. Steam Generator Tube Rupture (SGTR)
8. Anticipated Transients Without Scram (ATWS)
9. Main Steam Line Break (MSLB)
10. Loss of Control Area Air Conditioning (CAAC)
11. Loss of Switchgear HVAC (SVAC)
12. Loss of 125 VDC Bus (LBDC)
13. LOOP and Loss of Vital 4.16 kV AC Bus (LEAC)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AFW
PCS
EIHP
FB
HPR
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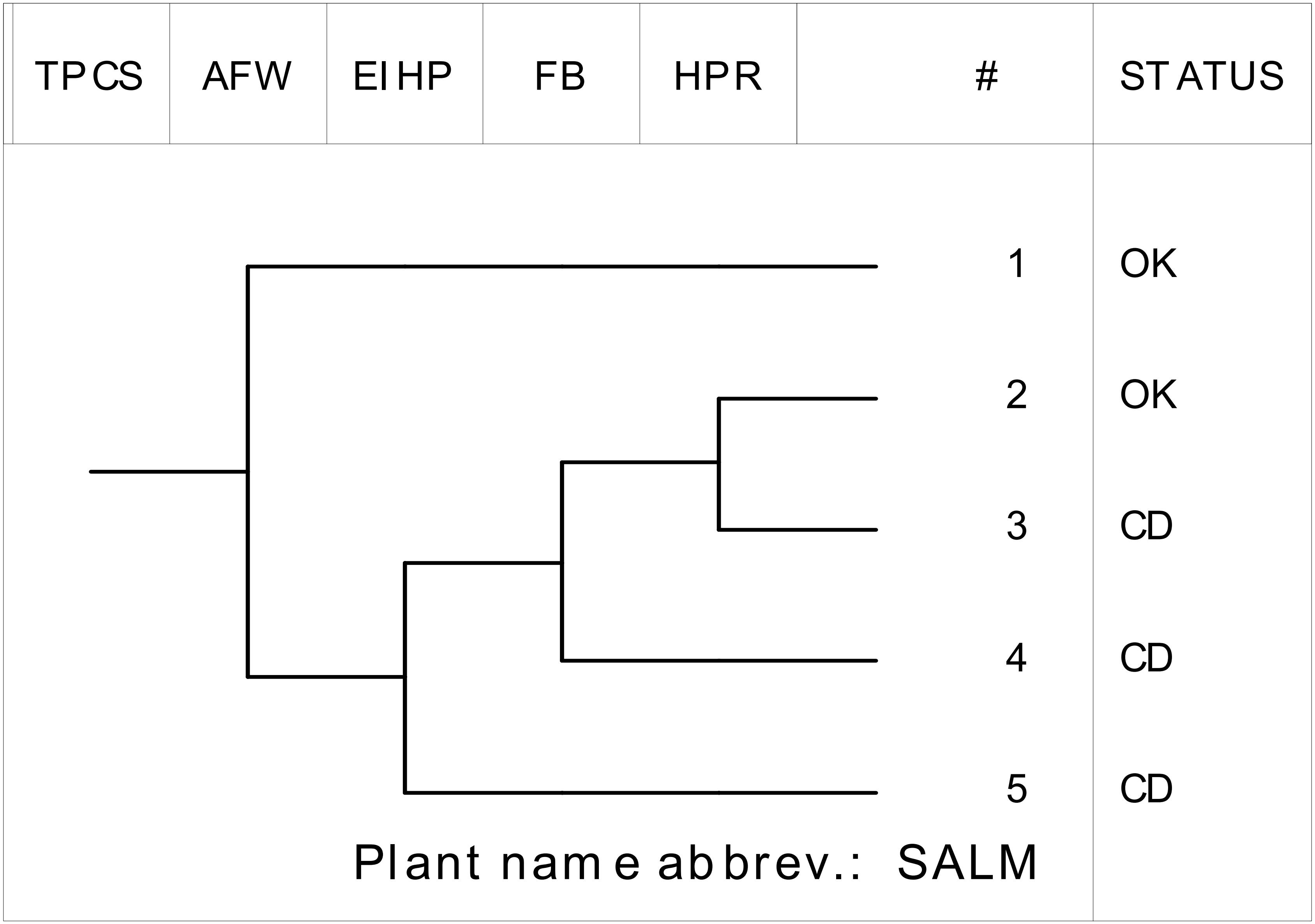
2
OK
3
OK
4
CD
5
CD
6
CD
Plant name abbrev.: SALM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EIHP
FB
HPR
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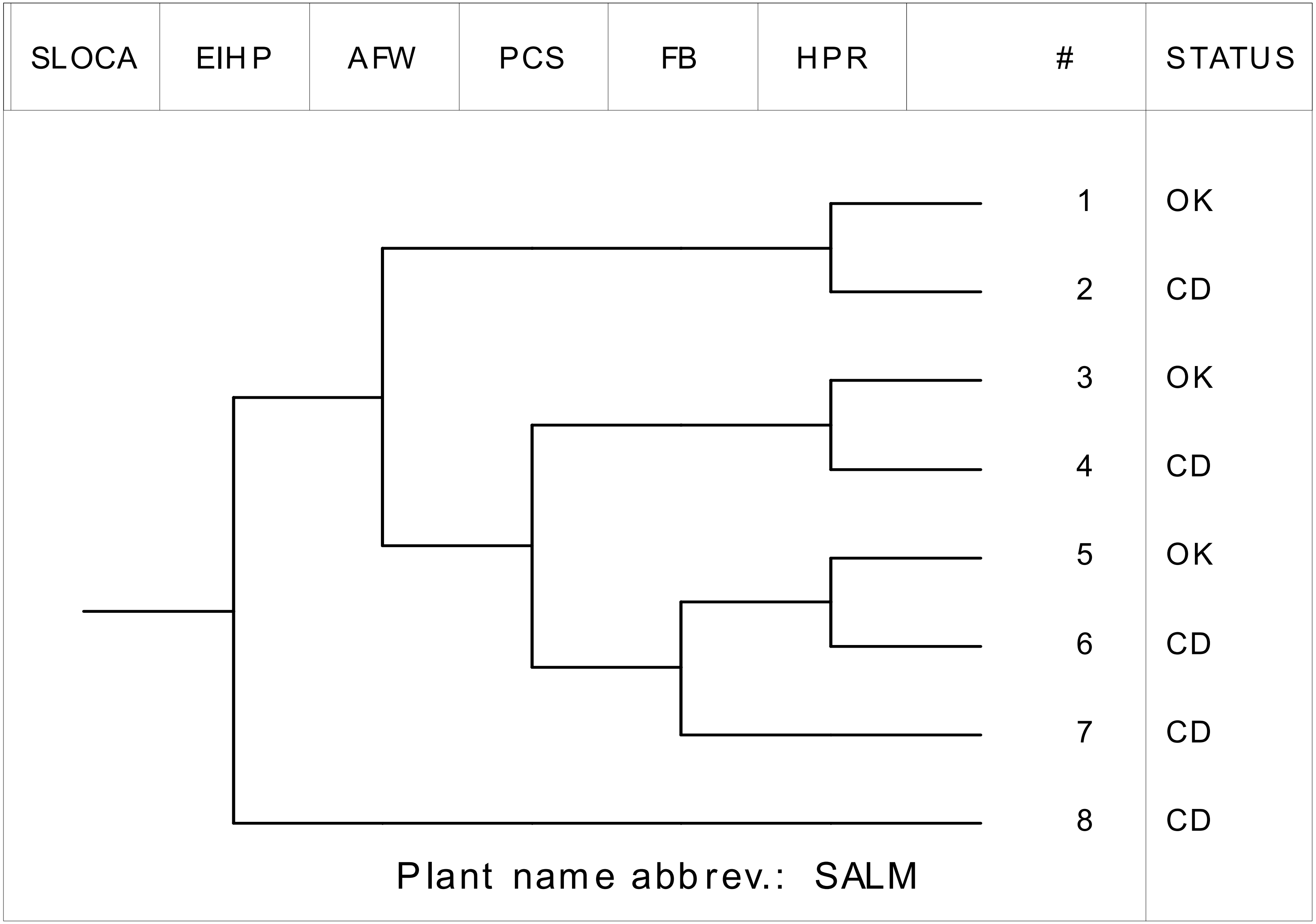
Plant name abbrev.: SALM


SLOCA
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AFW
PCS
FB
HPR
#
STATUS
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2 CD
3 OK
4 CD
5 OK
6 CD
7 CD
8 CD
Plant name abbrev.: SALM

MLOCA	EIAC	EIHP	HPR	#	STATUS
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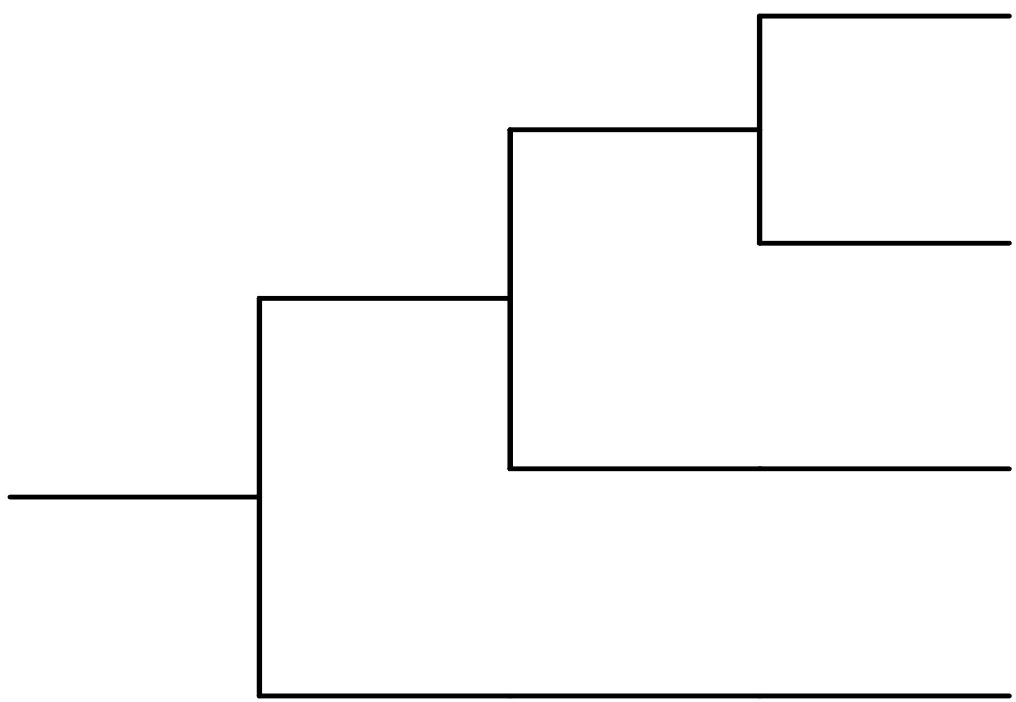
				2	CD
				3	CD
				4	CD



Plant name abbrev.: SALM

LLOCA	EIAC	EILP	LPR	#	STATUS
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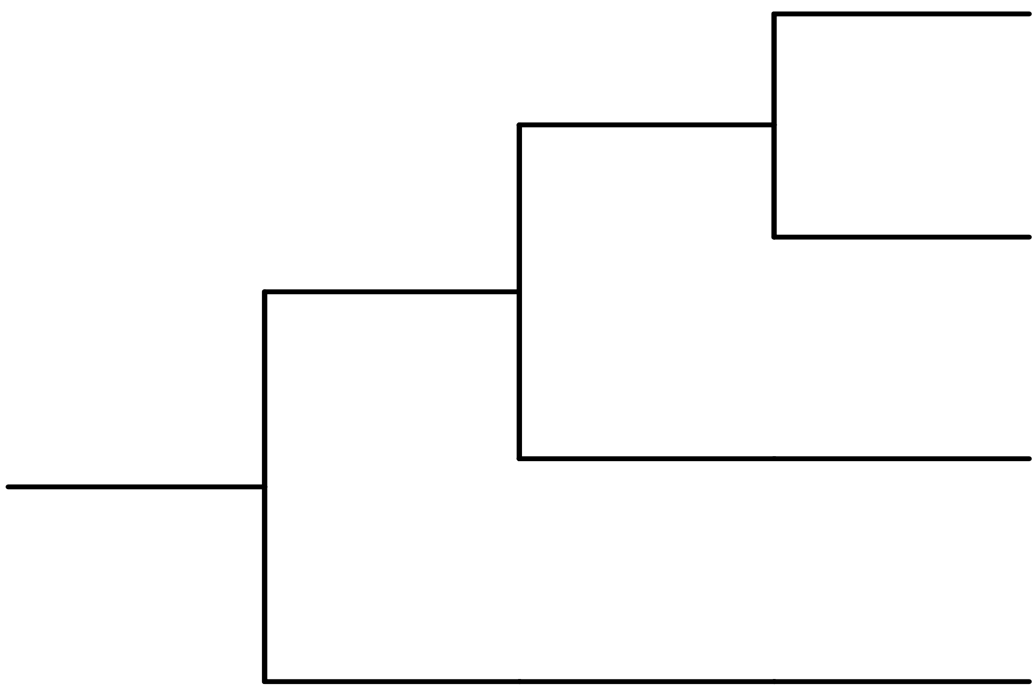
				3	CD
				4	CD



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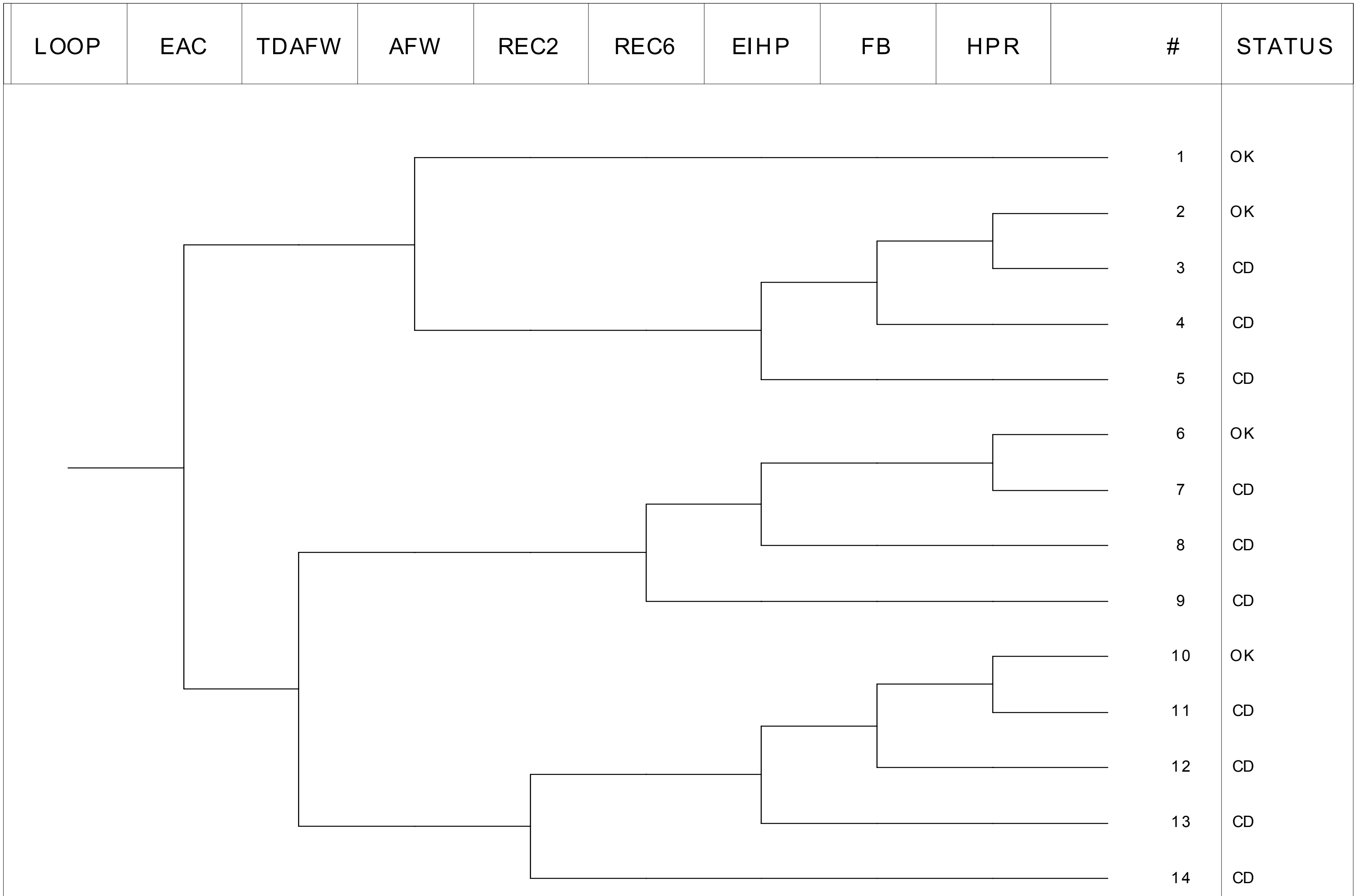

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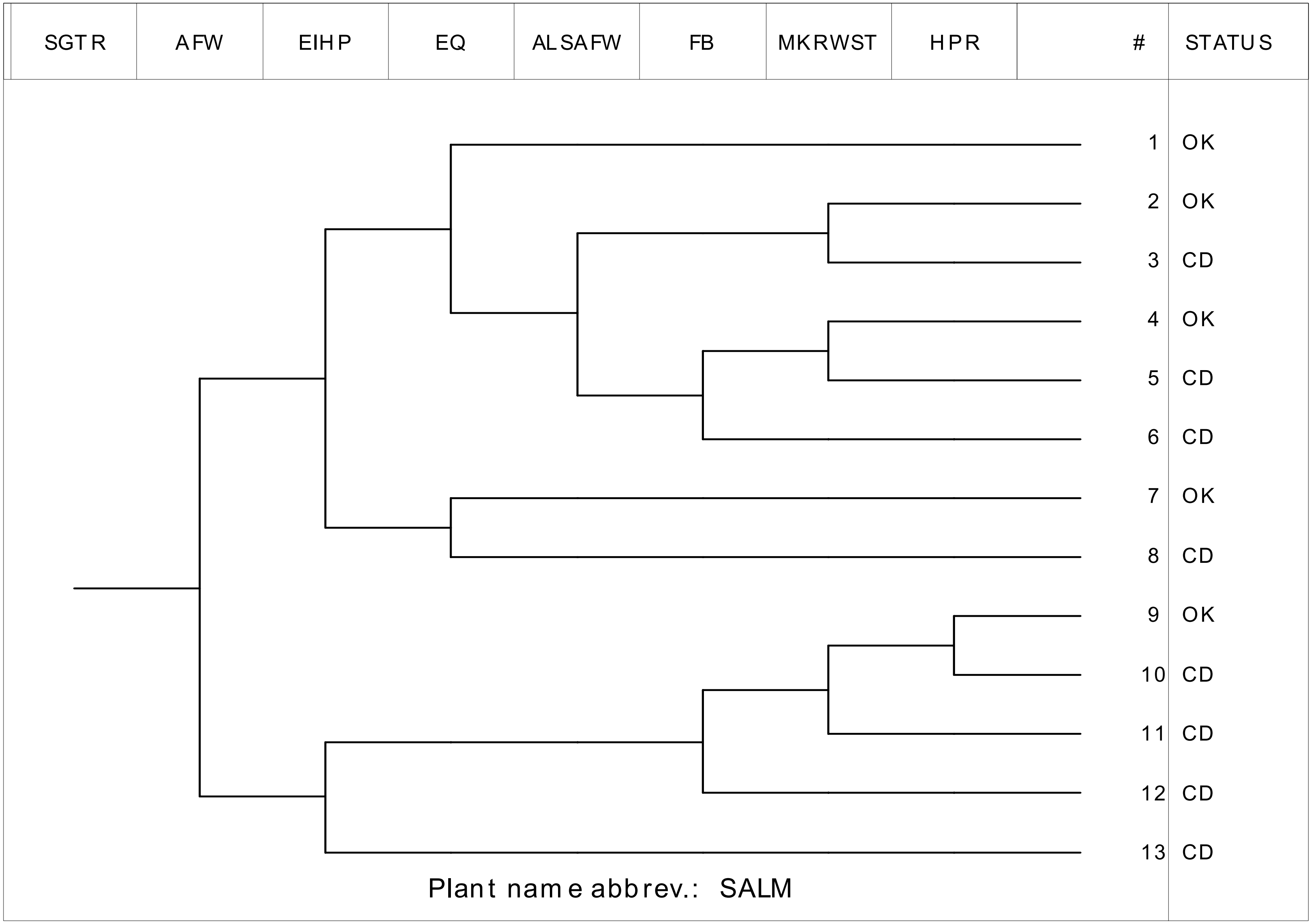
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AFW
EIHP
EQ
ALSAFW
FB
MKRWST
HPR
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STATUS
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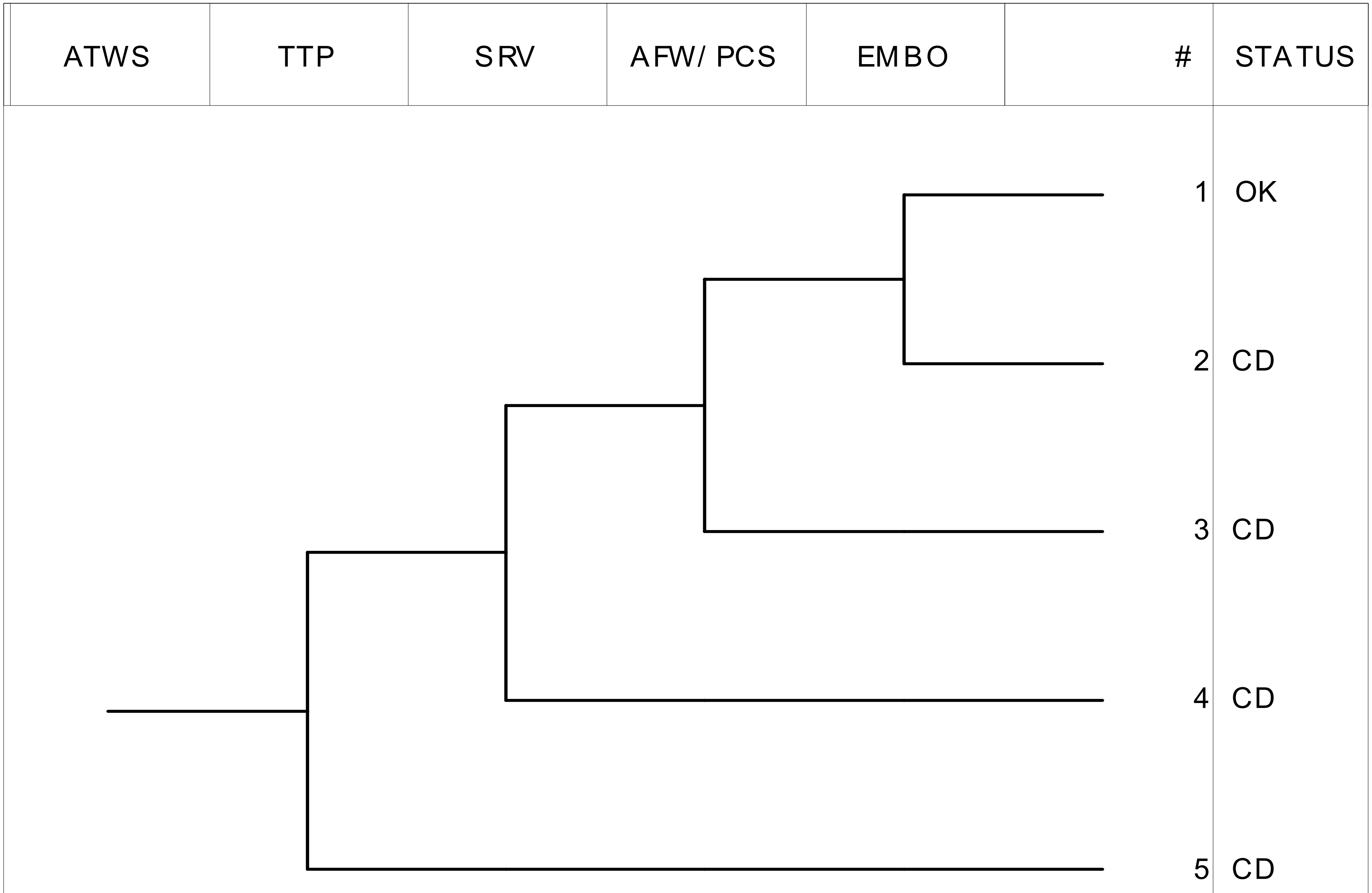
11 CD
12 CD
13 CD
Plant name abbrev.: SALM



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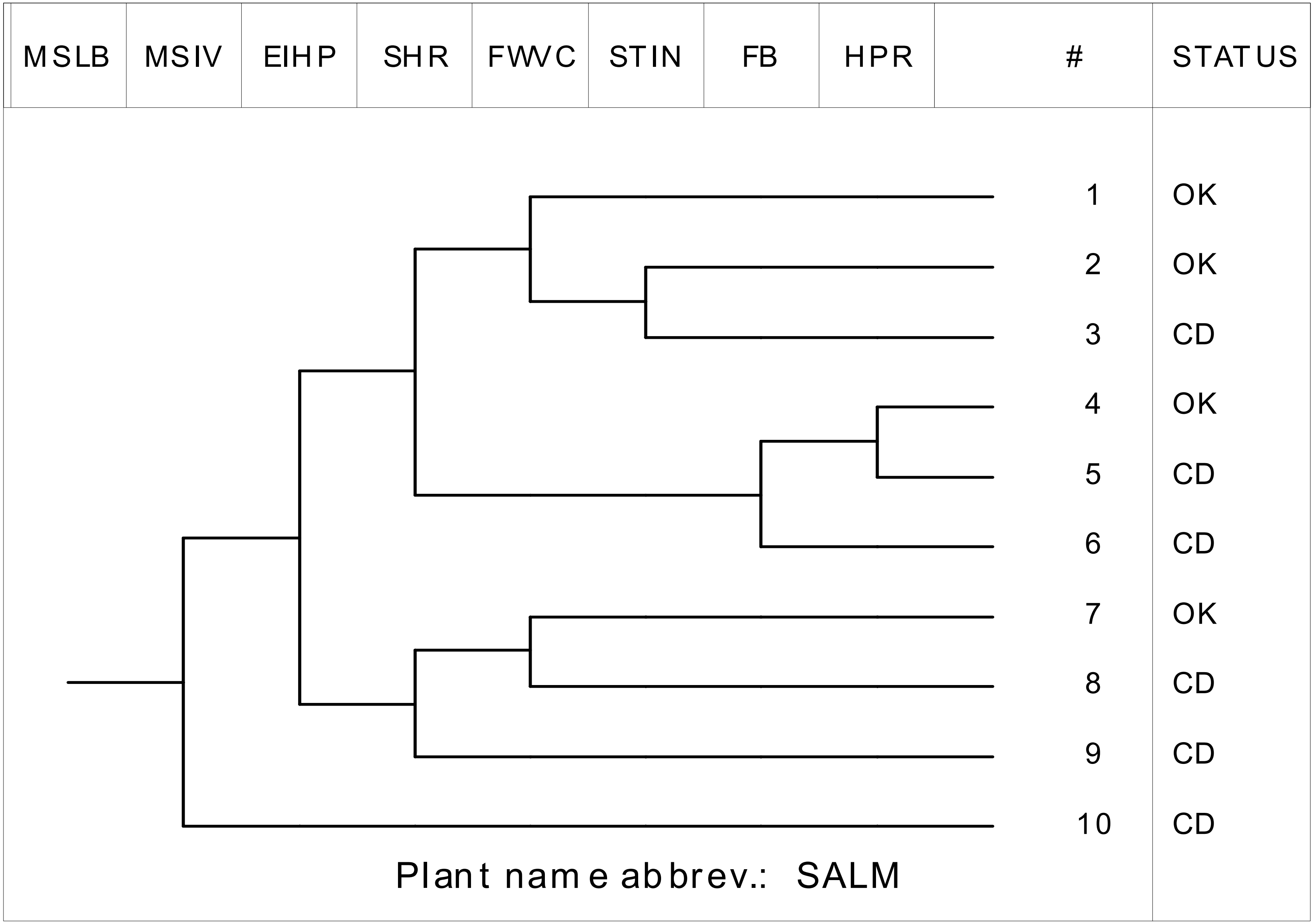
MSLB
MSIV
EIHP
SHR
FWVC
STIN
FB
HPR
#
STATUS
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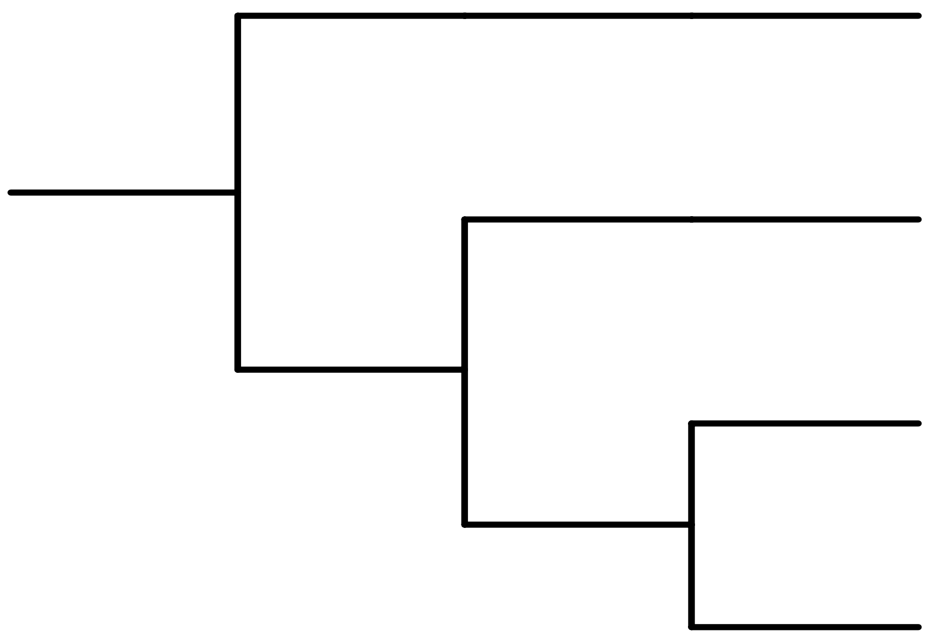
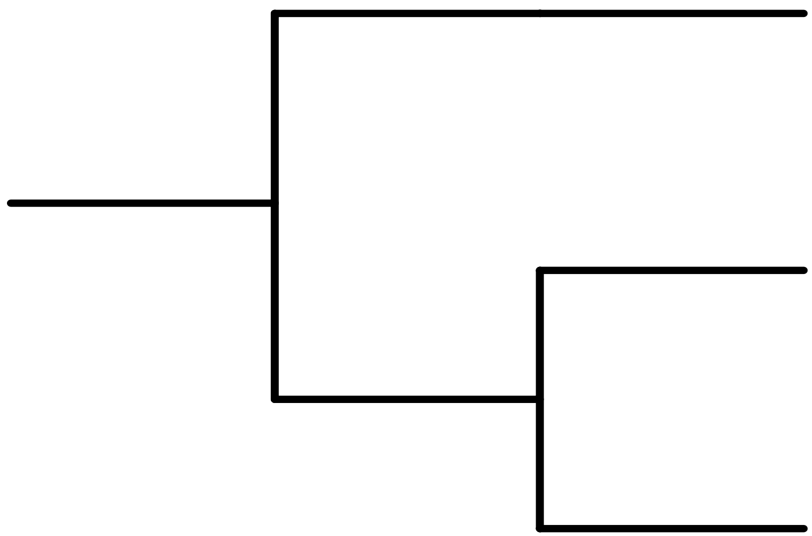
2 OK
3 CD
4 OK
5 CD
6 CD
7 OK
8 CD
9 CD
10 CD
Plant name abbrev.: SALM

CAAC	RVCA	AVEN	RSD	#	STATUS
				1	TRANS
				2	TRANS
				3	TRANS
				4	CD

Plant name abbrev.: SALM



SVAC	RVSW	AVEN	#	STATUS
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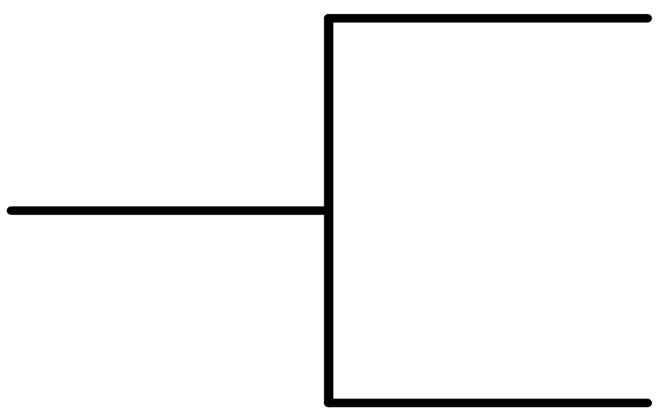
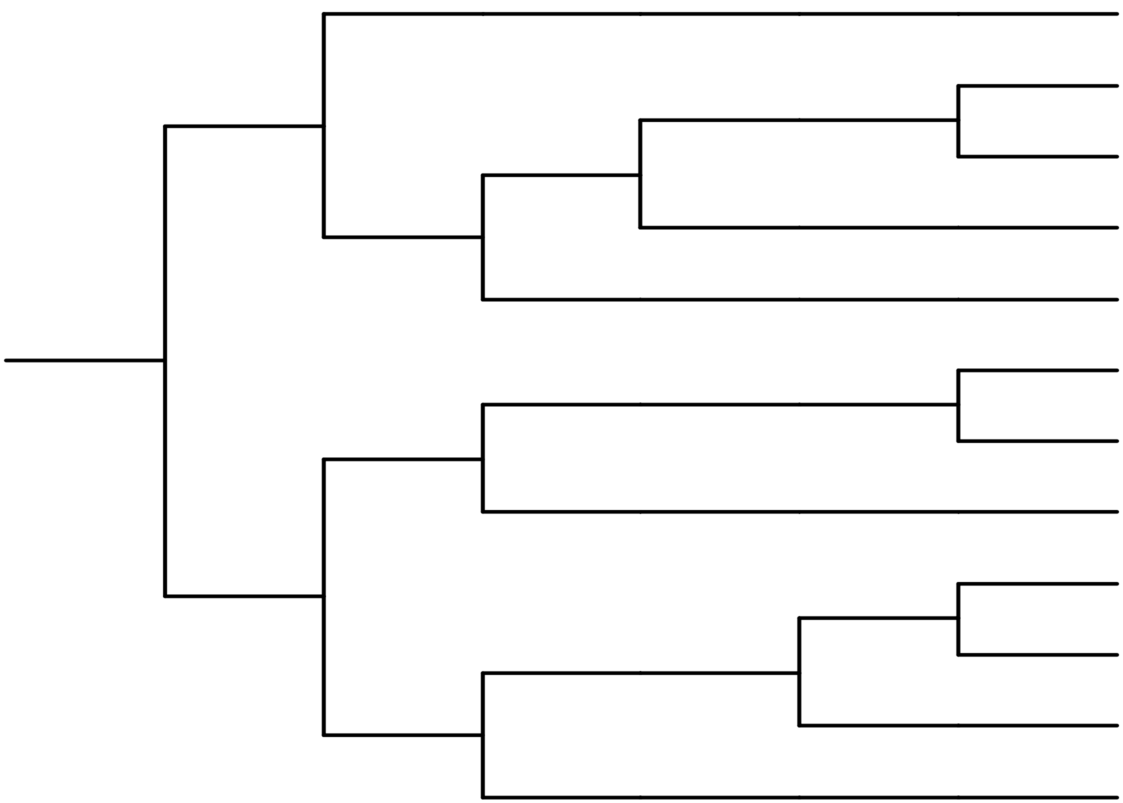
			2	TRANS
			3	CD

Plant name abbrev.: SALM

LBDC	AFW	#	STATUS
		1	OK
		2	CD
Plant name abbrev.:			SALM

LEAC	PORV	AFW	EIHP	FB	FB1P	HPR	#	STATUS



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8	CD
9	OK
10	CD
11	CD
12	CD

Plant name abbrev.: SALM

2. RESOLUTION AND DISPOSITION OF COMMENTS

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

2.1 GENERIC GUIDELINES AND ASSUMPTIONS (PWRs)

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

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

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

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

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

3. Inclusion of special initiators:

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

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

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

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

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

6. Crediting of non-safety related equipment:

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

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

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

8. Crediting system trains with high unavailability:

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

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

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

10. Crediting accumulators:

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

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

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

11. Crediting operator actions:

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

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

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

13. Dependency among multiple operator actions:

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

14. Crediting the standby high-pressure pump:

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

15. Emergency AC Power:

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

a) Describe the success criteria and the mitigation capability of dedicated EDGs.

b) Assign a mitigating capability of “operator action=1" for a swing EDG. The SDP worksheet assumes that the swing EDG is aligned to the other unit at the time of the LOOP (in a sense a dual unit LOOP is assumed). The operator, therefore, should trip, transfer, re-start, and load the swing EDG.

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

d) Do not credit the nearby power station as a backup to EDGs. The offsite power source from such a station could also be affected by the underlying cause for the LOOP. As an example, overhead cables connecting the station to the nuclear power plant also could have been damaged due to the bad weather which caused the LOOP. This level of detail should be left for a Phase 3 analysis.

16. Treatment of HPR and LPR:

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

17. SGTR event tree:

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

18. ATWS scenarios:

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

19. Recovery of losses of offsite power:

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

20. RCP seal LOCA in a SBO:

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

21. RCP Seal LOCA for Westinghouse Plants during SBO Scenarios:

The modeling of the RCP seal failures upon loss of cooling and injection as occurs during SBO scenarios has been the subject of many studies (e.g., BNL Technical report W6211-08/99 and NUREG/CR-4906P). These studies are quite complex and assign probabilities of seal failure as a function of time (duration of SBO) and the associated leak rates. The leak rates, in turn, will determine what would be the safe period for recovery of the AC source and the use of SI pumps before core uncovery and damage. On the contrary, the SDP worksheets simplify the analysis of the RCP seal LOCA during the SBO scenarios using the following two assumptions: (1) The probability of catastrophic RCP seal failure is assumed to be 1 if the SBO lasts beyond two hours, and (2) Given a catastrophic seal LOCA, the available time prior to core damage for recovery of offsite power and establishing injection is about two hours. Therefore, in almost all cases, to prevent a core damage, a source of AC should be recovered within 4 hours in SBO scenarios.

22. Tripping the RCP on loss of CCW:

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

23. Hot leg/Cold leg switchover:

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

2.2 RESOLUTION OF PLANT-SPECIFIC COMMENTS

Salem Generating Station was a pilot plant in the risk-informed inspection program. Plant-specific comments were received during the pilot phase of the program and again during a meeting with the plant staff in May, 2000. Below, we address these comments, and other relevant considerations.

Transient

(1) From the IPE Figure 3.1.2-1 (page 3.1-109). Sequence 15, is Trans*AFW*PCS*CNT and there is no core damage. This differs from the SDP Transient Sequence 1 that goes to core damage. I believe that the RHR heat exchangers will remove adequate heat during the high pressure recirculation phase and containment will not be challenged during the injection phase of feed and bleed. Recommend that this sequence be deleted.

Resolution: The conservative assumption on CNT function is adjusted and the sequence is removed.

(2) The HPI is defined but never used in the Transient sequences. I think we need to add a sequence to include HPI such as TRANS*AFW*PCS*HPI. This sequence is needed to complement the TRANS*AFW*PCS*FB sequence since FB only questions PORV operability. Recommend we add this sequence.

Resolution: Agreed and incorporated.

(3) The TRANS*AFW*PCS*LPR sequence in the SDP worksheets is not needed. The HPR sequence is more than adequate. If LPR would work you could just close the PORV and simply place RHR I/s in shutdown cooling. The IPE event tree does not appear to include a top for Loss of LPR. Recommend we delete this sequence.

Resolution: Generic removal of LPR function and the associated sequences for all initiators with the exception of LLOCA.

(4) The success criteria for PCS should be changed to 1/3 condensate and 1/2 MFW pumps. (I guess the SDP will give no credit for depressurizing, dumping the SGs to the condensate pump pressure on a loss on AFW & B&F).

Resolution: PCS success criteria was corrected. The SDP currently assumes that MFW is needed for PCS success right after scram.

(5) We may want to add a sequence to recognize the need for RCP seal cooling. For example: TRANS*HPI*RCP Thermal Barrier Cooling. A considerable chunk of risk is associated with

a loss of RCP seal cooling that is not currently captured in the SDP. From the PRA figure 3.3-2B sequences S20-S31 seal LOCAs with AFW available CDF ~ 5E-7. In fact this exceeds many of the sequences included in the SDP.

Resolution: Agree with the comment but it should be addressed generically for all PWRs. See General discussion on Small LOCA issue.

LOOP

(1) For SDP LOOP sequences 6-9 emergency power is available so MDAWFPs should be included in the AFW top.

Resolution: The current sequences of SDP has the problem corrected (per July 20 update)

(2) SDP sequence 9, CNT is not considered in the IPE for LOOPs - see IPE page 3.1-24, section 3.1.2.3.3 last paragraph. It doesn't appear that this sequence would go to core damage in the PRA event tree (page 3-149, sequence S14 results in no core damage).

Resolution: CNT function and the associated sequences were removed.

(3) SDP sequences 3-5 are SBO sequences with seal LOCAs. Why question or include AFW for these sequences? AFW no longer matters if you have a 250 gpm/RCP leak rate out of the RCS. All you need is primary makeup capability. The IPE SBO Event Tree (page 3.1-116) sequences 36-54 are all LOOP*EAC (seal LOCA with power recovery in 4 or 6 hours). The only success is #36 if charging and HP recirculation are successful. AFW and LPR are never questioned in the IPE LOOP event tree.

Resolution: The sequences and event trees are updated (July 20th)

(4) I would recommend revising SDP sequences 2-5. The PRAs generally don't assume a loss of offsite power * loss of onsite power * seal LOCA * recovery of power * and then! a loss of other LOCA mitigation equipment. While this sequence can occur and result in core damage, I believe when you string that many tops together the sequences would generally get truncated out. I would recommend the following LOOP sequences (note many are currently included in the SDP):

a. LOOP*AFW*HPR
b. LOOP*AFW*FB
c. LOOP*AFW*EIHP
d. LOOP*EAC*Power Recovery Time > 30 hrs
e. LOOP*EAC*TDAFWP*Power Recovery Time > 2 hrs
f. LOOP * EAC*Seal LOCA*Recovery Time > 7 hrs

We could assign various numbers to recovery times 2 hrs-1, 7 hrs-2, 30 hrs-3, based on the PRA recovery model.

Resolution: The updated sequences include the above sequences with two exceptions. We do not consider recovery of offsite power after 30 hours, that is RCP seal LOCA is assumed always to occur in SBO with probability of one after 2 hours, and the recovery after 6 hours rather than 7 hours is used (this will have no impact on SDP screening process).

<u>SBLOCA</u>

(1) IPE page 3.2-52 section 3.2.1.8.4.2 small LOCAs need only 1/2 PORVs for success. The success criteria in the SDP is 2/2. The leakage + 1 PORV should be sufficient. This is also consistent with PRA (page 3-110).

Resolution: Agree and July 20 update has included the comment.

(2) If HPR is successful then Core Damage will not occur if LPR is unavailable. Recommend we delete SDP sequence 4. The would be consistent with the PRA (page 3-161).

Resolution: Removal of LPR function is generically incorporated.

(3) The success criteria for SI and Charging pumps is 1/4 SI or Cps not 1/2 charging and 1/2 SI. (PRA page 3-110)

Resolution: Agree, initially we wrote it that way to show that it is 2 multi-train system. We now modify it according to the comment and retain the 2 multi train system.

(4) The SDP PCS acceptance criteria might include only a condensate pump to be consistent with the PRA. I'm not sure if adequate steam would be available for the FW pumps?

Resolution: Agreed and incorporated.

(5) The SDP sequence 3 does not go to core damage in the PRA (page 3-161, sequence S32). You may want to change the success criteria for CNT to spray recirculation fails. If adequate HPR is available, it looks like enough heat is removed via the RHR heat exchangers to protect containment.

Resolution: Agreed and incorporated.

IBLOCA

(1) The event tree Figure 3.1.2-11 (page 3-162) show the failure of CFCUs and CSS inj as sequence 13 that does not result in core damage. The SDP results in CD for this sequence?

Resolution: Agreed and incorporated.

(2) Licensee PRA does not question LPR. I believe that's because if HPR is successful you can stay on that and LPR would not be needed if it couldn't be established.

Resolution: Agreed and incorporated generically for all initiators.

LBLOCA

(1) May want to consider changing success criteria for CNT. The PRA shows that (page 3-163 sequence S13) that core damage will not occur if 1/2 CS train or 3/5 CFCUs are not available. However, core damage does occur if CSS recirculation fails. I guess the robust large dry containments can handle the initial pressure spike without active mitigation.

Resolution: Agreed and incorporated.

ATWS

(1) Why isn't MFW considered in the acceptance/success criteria if AFW fails. The IPE event tree allows either source.

Resolution: Agreed and incorporated.

SGTR

(1) In the success criteria change the wording for "Makeup CST." The AFW system has 3 means for suppling suction to the AFW other than the normal CST. They are, in order of preference:

a. Manual valve manipulations to align the Demineralized Water Storage Tanks

b. Manual valve manipulations to align the fresh water and fire protection storage tanks

c. Install a spool piece to align service water.

Resolution: Agreed and incorporated back in July 20th.

(2) Sequence 1 in the SDP does not require isolation failure to go to core damage. Replace with SGTR*AFW*FB.

Resolution: Agreed and incorporated back in July 20th.

(3) Sequence 3 in the SDP does not go to core damage. You could still bleed and feed. You need to add an “FB” to this sequence.

Resolution: Agreed and incorporated.

(4) Sequence 4 in the SDP would go to core damage; however, the licensee’s PRA has another similar sequence that is far more probable. SGTR*EQ*MKCST*MKRWST. We may want to consider adding this sequence. The CDF for this sequence is 3E-8). The current sequence 4 in the SDP was truncated out.

Resolution: Agreed and incorporated back in July 20th.

(5) We may want to add a sequence SGTR*EIHP*AFW. While the probability is not high, isolation is successful, unlike all the SDP sequences.

Resolution: Agreed and incorporated back in July 20th.

(6) The PRA credits using a condensate pump for secondary makeup. The SDP gives no credit for this supply if AFW is unavailable. Recommend considering including a condensate pump.

Resolution: We have no information on use of condensate in SGTR sequences for Salem, the SDP sheet for the purpose of screening did not credit this additional redundancy to AFSs for secondary heat removal. No update has performed but could be included in the detailed analysis if necessary.

Relevant considerations in the development of this inspection notebook.

1. The IPE (page 3.1-40) states that the loss of CCS is not a significant event, and hence, no worksheet was developed.

2. A loss of Control Air System (CAS) causes a complete loss of control air to vital systems, and feedwater regulating valves close. The reactor trips on low steam generator level. The IPE (page 3.2-154) states that the PORVs fail closed on a loss of all control air, but that accumulators are provided to ensure continued operation of the PORVs if control air is unavailable. Thus, the Feed/Bleed function is available. Since the structure of the event tree is the same as that for Transients with Loss of PCS (TPCS), and the frequency of the loss of Control Air System (CAS) is 1.0E-4 per year, we consider that the impact of this initiator is bounded by TPCS.

REFERENCES

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

2. Public Service Electric and Gas Company, "Salem Generating Station – Individual Plant Examination Report," dated July, 1993.