UNITED STATES
NUCLEAR REGULATORY COMMISSION
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February 27, 2001

Mr. C. Lance Terry
Senior Vice President &
Principal Nuclear Officer
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Attn: Regulatory Affairs Department
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SUBJECT: COMANCHE PEAK STEAM ELECTRIC STATION (CPSES) UNITS 1 AND 2 - SITE-SPECIFIC WORKSHEETS FOR USE IN THE NUCLEAR REGULATORY COMMISSION'S (NRC) SIGNIFICANCE DETERMINATION PROCESS

Dear Mr. Terry:

Enclosed please find the site-specific 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 at CPSES Units 1 and 2. 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 NRC Agencywide Documents and Access Management System.

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 staff 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 that visit.

The Phase 2 Worksheets, contained within the enclosure, have incorporated much of the information we obtained during our site visits. While the Phase 2 Worksheets have been verified by our staff to include the site specific data that we have collected to date, we will continue to assess their accuracy as they are used and will update them based on comments by our inspectors and your staff.

The staff encourages you to provide additional comments if you identify areas for which the Phase 2 Worksheets give inaccurate (high or low) significance determinations. Any written comments may be provided in accordance with 10 CFR 50.4, "Written communications, " with copies to the Chief, Probabilistic Safety Assessment Branch, Office of Nuclear Reactor Regulation (NRR), and Chief, Inspection Program Branch, NRR. We will continue to assess SDP accuracy and update the document based on continuing experience with the program.

We will coordinate our efforts through your licensing or risk organizations as appropriate. If you have questions, please call me at 301-415-1439.

Sincerely,

David H. Jaffe, Senior Project Manager, Section 1
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Enclosure: As stated

Docket Nos. 50-445 and 50-446

Comanche Peak Steam Electric Station

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RISK-INFORMED INSPECTION NOTEBOOK FOR

COMANCHE PEAK STEAM ELECTRIC STATION

UNITS 1 AND 2

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

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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 Comanche Peak Steam Electric Station, Units 1 and 2.

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 Comanche Peak Units 1 & 2.

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 Comanche Peak Steam Electric Station Units 1 and 2

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), MSLB (outside containment), Loss of Component Cooling Water (LCCW), Loss of a 125V DC Safeguards Bus (LBDC), Loss of a Non-Vital AC Bus (LBAC)	B	C	D
III	1 per 10^2 - 10^3 yr	SGTR, Stuck open PORV/SRV (SORV), Small LOCA including RCP seal failures (SLOCA), Loss of Station Service Water (LSW), Loss of Instrument Air (LOIA)	C	D	E
IV	1 per 10^3 - 10^4 yr	Medium LOCA (MLOCA), LOOP and Loss of One Class 1E 6.9kV Bus (LOAC)	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], ISLOCA	F	G	H
			> 30 days	**3-30 days**	**< 3 days**
			Exposure Time for Degraded Condition		

Notes:

1. The SDP worksheets for ATWS core damage sequences assume that the ATWS is not recoverable by manual actuation of the reactor trip function 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). Any inspection finding that represents a loss of manual reactor trip capability for a postulated ATWS scenario should be evaluated by a risk analyst for consideration of 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 Comanche Peak Steam Electric Station Units 1 and 2

Affected Systems	Major Components	Support Systems	Initiating Event
Auxiliary Feedwater (AF)	2 MDPs	Safety chilled water (CH), Class 1E 6.9kv AC, Class 1E 480V AC, Class 1E 125V DC, ES, Instrument air (CI)	All except MLOCA, LLOCA, LCCW
	1 TDP	Class 1E 480V AC, Class 1E 125V DC (for overfill/flow control), MS, Engineering safeguards feature actuation (ES), CI (for SG overfill)	All except MLOCA, LLOCA, LBDC
Chemical and Volume Control (CS)	Two Centrifugal Charging Pumps (CCPs)	CH, Class 1E 6.9kV AC, Class 1E 480V AC, Class 1E 125V DC (for pump start), SW, ES, CI	All
	Two Boric Acid Transfer Pumps (BATP)	Class 1E 480V AC, Non-Class 1E 480V AC, Class 1E 125V DC (for pump start)	ATWS
Circulating Water (CW)	Four pumps (CWPs)	Non-Class 1E 6.9kV AC, Non-Class 1E 480V AC, Non-Class 1E 125V DC, CI, Demineralized Water	TRANS, SLOCA, SORV, ATWS, LSW
Component Cooling Water (CC)	Two pump trains	SW, CH, Class 1E 6.9kV AC, Class 1E 480V AC, Class 1E 125V DC, ES	LCCW

Table 2 (Continued)

Affected Systems	Major Components	Support Systems	Initiating Event
Condensate and Feedwater (CF)	Two Condensate pumps	Non-Class 1E 6.9kV AC, Non-Class 1E 125V DC, CW, TPCW, CI	TRANS, SLOCA, SORV, ATWS, LSW
	Two turbine-driven Main Feed Pumps (MFPs)	Condensate system, TPCW, MS, CI, ES, Non-Class 1E 480V AC, Non-Class 1E 125V DC	TRANS, SLOCA, SORV, ATWS, LSW
Diesel Fuel Oil Transfer System	Two trains	Class 1E 480V AC, Class 1E 125V DC	LOOP, LOAC
Electric Power (EP)	Class 1E 6.9kV: two buses	CH (for room cooling only), Class 1E 480V AC (for room cooling only), Class 1E 125V DC, Non-Class 1E 125V DC, ES, Non-Safety Chilled water	LOOP, LOAC
	Two diesel generators	Class 1E 480V AC (for room cooling only), Class 1E 125V DC, SW, ES, Diesel Fuel Oil Transfer System	LOOP, LOAC
	Class 1E 480V AC: two pairs of buses, and several MCCs	Class 1E 6.9kV AC	All
	Class 1E (ES) 118V AC UPS: four panels (two per train)	Class 1E 480V AC, 120V AC, Class 1E 125V DC, CC, UPS HVAC	All
	120V AC: a panel board	Class 1E 480V AC, a bypass transformer	All
	Non-Class 1E 6.9kV: Four unit buses and one common bus	Non-Class 1E 125V DC, Ventilation Chilled Water	LBAC

Table 2 (Continued)

Affected Systems	Major Components	Support Systems	Initiating Event
	Non-Class 1E 480V AC	Non-Class 1E 6.9kV AC, Ventilation Chilled Water	All
	Class 1E 125V DC: Four buses (two per train), each with a battery, and two chargers	Class 1E 480V AC, ES (for Battery Room Exhaust only (BOS/SI signal)), UPS HVAC	LBDC
	Non-Class 1E 125V DC: two batteries, three chargers, and one bus	Non-Class 1E 480V AC, ES (for Battery Room Exhaust only (BOS/SI signal))	All
Engineered Safeguards Features Actuation System (ES)	Two SSPS cabinets	Class 1E 118V AC, Class 1E 125V DC, Control Room (CR) HVAC (for long-term events), CC (provides cooling to CR HVAC)	All
Instrument Air (CI)	Two unit air compressor trains	Class 1E 480V AC, CC, ES	LOIA
	Two common air compressor trains[1]	Non-Class 1E 480V AC, TPCW	
Main Steam (MS)	Per SG: One ARV, five safety valves, and one MSIV. Four banks of three steam dump valves	ES, CI, Class 1E 125V DC, Non-Class 1E 125V DC (for turbine trip failures), Non-Class 1E 118V AC	All except MLOCA, LLOCA
Reactor Coolant (RC)	RCP Seals	1 / 3 Charging pumps to seal injection or 1 / 2 CC pumps to thermal barrier heat exchanger	SLOCA

Table 2 (Continued)

Affected Systems	Major Components	Support Systems	Initiating Event
	Two PORVs, each with an associated block valve	Class 1E 480V AC, Class 1E 125V DC, Class 1E 118V AC, Nitrogen Gas system[2]	All except MLOCA, LLOCA
	Three SRVs		LOOP, ATWS
Refueling Water Storage Tank (RWST)	One tank, one motor-operated valve, and one isolation valve	Not found in IPE	All except ATWS
Residual Heat Removal (RH)	Two trains, each with one pump and heat exchanger	CC, CH, Class 1E 6.9kV AC, Class 1E 480V AC, Class 1E 125V DC, ES	All except ATWS
Safety Chilled Water (CH)	Two trains, each with one pump and one chiller unit	CC, Class 1E 480V AC, Class 1E 125V DC, ES, CI	All
Safety Injection (SI)	Two pumps	SW, CH, Class 1E 6.9kV AC, Class 1E 480V AC, Class 1E 125V DC, ES	All except ATWS
	Four accumulators	Nitrogen system	MLOCA, LLOCA
Station Service Water (SW)	Two trains, each with one pump	ES, Class 1E 6.9kV AC, Class 1E 480V AC, Class 1E 125V DC	LSW
Turbine Plant Cooling Water system (TPCW)	Two trains, each with one pump and a common heat exchanger	CW, Non-Class 1E 6.9kV AC, Non-Class 1E 125V DC	TRANS, SLOCA, SORV, ATWS, LSW
UPS HVAC	Two trains	Class 1E 480V AC, CC, ES (for BOS/SI start signal)	All

Table 2 (Continued)

Table 2 (Continued)

Notes:

1. The licensee requested to include the two common air compressor trains. These trains (and their support systems) are assumed to be associated with all the initiating events associated with the two unit air compressor trains.

2. The PORVs fail closed on loss of nitrogen or control power (IPE, page 3-95).

3. Plant internal event CDF (including internal floods) = 5.72E-5/reactor year.

1.3 SDP WORKSHEETS

This section presents the SDP worksheets to be used in the Phase 2 evaluation of the inspection findings for the Comanche Peak Steam Electric Station, Units 1 and 2. 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 (LOCA)
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 Station Service Water (LSW)
12. Loss of Component Cooling Water (LCCW)
13. Loss of Instrument Air (LOIA)
14. Loss of a 125V DC Safeguards Bus (LBDC)
15. Loss of a Non-Vital AC Bus (LBAC)
16. LOOP and Loss of One Class 1E 6.9kV Bus (LOAC)
17. Interfacing Systems LOCA (ISLOCA).

Table 3.1 SDP Worksheet for Comanche Peak Steam Electric Station Units 1 and 2 — 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:**
Auxiliary Feedwater (AFW)	1/2 MDAFW pumps or 1/1 TDAFW pump with 2/4 ARVs and with operator controlling AF flow (operator action = 2) (1)
Main Feedwater (MFW)	1/2 MFPs with operator re-establishing main feedwater (operator action = 1) (2)
High Pressure Injection (HPI)	1/2 CCPs (1 multi-train system) or 1/2 SI pumps (1 multi-train system)
Feed/Bleed (FB)	1/2 PORVs open for Feed/Bleed (operator action = 2)
High Pressure Recirculation (HPR)	1/2 CCPs or 1/2 SI pumps with 1/2 RHR pumps and with operator action to transfer suction of pumps (operator action = 3)
Makeup to RWST (MKRWST)	Operators align a source of makeup water to the RWST (operator action = 1) (3)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 TRANS - AFW - MFW - HPR - MKRWST			
2 TRANS - AFW - MFW - FB (6)			
3 TRANS - AFW - MFW - HPI (7)			

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

Notes:

1. According to the IPE (page 3-13), success of AFW includes operator actions required to control the auxiliary feedwater flow to prevent the overfilling or dryout of any steam generator. The human error probability (HEP) assessed in the IPE (page 3-196) is 1E-2 (event &SGLXAFWXNY). Accordingly, a credit of 2 is assigned.

2. The human error probability (HEP) assessed in the IPE (page 3-197) is 5E-2 (event CF&MFWREST) and 1.0E-1 (event CF&MFWRESTS). Accordingly, a credit of 1 is assigned.

3. If the operators are unable to transition to recirculation due to unavailability of equipment, they are directed to remain in the injection alignment, and to provide makeup water to the RWST via various sources (IPE, page 3-14). The human error probability (HEP) assessed in the IPE (page 3-198) is 1E-1 (event ECA-1.1). Accordingly, a credit of 1 is assigned.

Table 3.2 SDP Worksheet for Comanche Peak Steam Electric Station Units 1 and 2 — 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:**
Auxiliary Feedwater (AFW)	1/2 MDAFW pumps or 1/1 TDAFW pump with 2/4 ARVs and with operator controlling AF flow (operator action = 2) [1]
High Pressure Injection (HPI)	1/2 CCPs (1 multi-train system) or 1/2 SI pumps (1 multi-train system)
Feed/Bleed (FB)	1/2 PORVs open for Feed/Bleed (operator action = 2)
High Pressure Recirculation (HPR)	1/2 CCPs or 1/2 SI pumps with 1/2 RHR pumps and with operator action to transfer suction of pumps (operator action = 3)
Makeup to RWST (MKRWST)	Operators align a source of makeup water to the RWST (operator action = 1) [2]

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 TPCS - AFW - HPR - MKRWST (4)			
2 TPCS - AFW - FB (5)			
3 TPCS - AFW - HPI (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. According to the IPE (page 3-13), success of AFW includes operator actions required to control the auxiliary feedwater flow to prevent the overfilling or dryout of any steam generator. The human error probability (HEP) assessed in the IPE (page 3-196) is 1E-2 (event &SGLXAFWXNY). Accordingly, a credit of 2 is assigned.

2. If the operators are unable to transition to recirculation due to unavailability of equipment, they are directed to remain in the injection alignment, and to provide makeup water to the RWST via various sources (IPE, page 3-14). The human error probability (HEP) assessed in the IPE (page 3-198) is 1.0E-1 (event ECA-1.1). Accordingly, a credit of 1 is assigned.

Table 3.3 SDP Worksheet for Comanche Peak Steam Electric Station Units 1 and 2 — Small LOCA (SLOCA)[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:**
Early Inventory, HP Injection (EIHP)	1/2 CCPs (1 multi-train system) or 1/2 SI pumps (1 multi-train system)
Auxiliary Feedwater (AFW)	1/2 MDAFW pumps or 1/1 TDAFW pump with 2/4 ARVs and with operator controlling AF flow (operator action = 2) [3]
Main Feedwater (MFW)	1/2 MFPs with operator re-establishing main feedwater and with 2/4 ARVs (operator action = 1) [4]
Primary Bleed (FB)	1/2 PORVs open for Feed/Bleed (operator action = 2)
High Pressure Recirculation (HPR)	(1/2 CCPs or 1/2 SI pump) with 1/2 RHR pumps and with operator action to transfer suction of pumps (operator action = 3)
Makeup to RWST (MKRWST)	Operators align a source of makeup water to the RWST (operator action = 1) [5]

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 SLOCA - HPR - MKRWST (3, 6, 9)			
2 SLOCA - AFW - MFW - FB (10)			
3 SLOCA - EIHP (11)			

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

Notes:

1. The licensee's very small LOCA is similar to the SDP's small LOCA (decay heat is not removed through break, and hence, it has to be removed using a system such as AFW or MFW).

2. The IPE only mentions the high and intermediate injection pumps, and it does not mention depressurization, so we assume in this worksheet that low pressure injection and recirculation are not available.

3. According to the IPE (page 3-13), success of AFW includes operator actions required to control the auxiliary feedwater flow to prevent the overfilling or dryout of any steam generator. The human error probability (HEP) assessed in the IPE (page 3-196) is 1E-2 (event &SGLXAFWXNY). Accordingly, a credit of 2 is assigned.

4. The human error probability (HEP) assessed in the IPE (page 3-197) is 1E-1 (event CF&MFWRESTS). Accordingly, a credit of 1 is assigned.

5. If the operators are unable to transition to recirculation due to unavailability of equipment, they are directed to remain in the injection alignment, and to provide makeup water to the RWST via various sources (IPE, page 3-14). The human error probability (HEP) assessed in the IPE (page 3-198) is 1E-1 (event ECA-1.1). Accordingly, a credit of 1 is assigned.

Table 3.4 SDP Worksheet for Comanche Peak Steam Electric Station Units 1 and 2 — 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 stuck open PORV (operator action = 3)
Early Inventory, HP Injection (EIHP)	1/2 CCPs (1 multi-train system) or 1/2 SI pumps (1 multi-train system)
Auxiliary Feedwater (AFW)	1/2 MDAFW pumps or 1/1 TDAFW pump with 2/4 ARVs and with operator controlling AF flow (operator action = 2) [3]
Main Feedwater (MFW)	1/2 MFPs with operator re-establishing main feedwater and with 2/4 ARVs (operator action = 1) [4]
Primary Bleed (FB)	Operator conducts feed and bleed (operator action = 2)
High Pressure Recirculation (HPR)	1/2 CCPs or 1/2 SI pumps with 1/2 RHR pumps and with operator action to transfer suction of pumps (operator action = 3)
Makeup to RWST (MKRWST)	Operators align a source of makeup water to the RWST (operator action = 1) [5]

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 SORV - BLK - HPR - MKRWST (3, 6, 9)			
2 SORV - BLK - AFW - MFW - FB (10)			
3 SORV - BLK - EIHP (11)			

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

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

Notes:

1. The licensee's very small LOCA is similar to the SDP's small LOCA (decay heat is not removed through break, and hence, it has to be removed using a system such as AFW or MFW).

2. 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. The bleed part of feed-and-bleed is provided by the stuck open PORV. The operator actions needed for feed-and-bleed are included in the safety function FB.

3. According to the IPE (page 3-13), success of AFW includes operator actions required to control the auxiliary feedwater flow to prevent the overfilling or dryout of any steam generator. The human error probability (HEP) assessed in the IPE (page 3-196) is 1E-2 (event &SGLXAFWXNY). Accordingly, a credit of 2 is assigned.

4. The human error probability (HEP) assessed in the IPE (page 3-197) is 1E-1 (event CF&MFWRESTS). Accordingly, a credit of 1 is assigned.

5. If the operators are unable to transition to recirculation due to unavailability of equipment, they are directed to remain in the injection alignment, and to provide makeup water to the RWST via various sources (IPE, page 3-14). The human error probability (HEP) assessed in the IPE (page 3-198) is 1E-1 (event ECA-1.1). Accordingly, a credit of 1 is assigned.

Table 3.5 SDP Worksheet for Comanche Peak Steam Electric Station Units 1 and 2 — Medium LOCA (MLOCA)[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 CCPs (1 multi-train system) or 1/2 SI pumps (1 multi-train system)
Early Inventory, Accumulators (EIAC)	2/3 remaining accumulators (1 multi-train system)
High Pressure Recirculation (HPR)	1/2 CCPs or 1/2 SI pumps with 1/2 RHR pumps and with operator action to transfer suction of pumps (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 - EIAC (3)			
2 MLOCA - EIHP (4)			

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

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

Note:

1. The licensee's small LOCA is similar to the SDP's medium LOCA (decay heat is removed through break). According to the IPE (page 3-31), sufficient cooling is provided by a single high or intermediate injection pump; discharge from two accumulators is also required.

Table 3.6 SDP Worksheet for Comanche Peak Steam Electric Station Units 1 and 2 — 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:[1]	**Full Creditable Mitigation Capability for Each Safety Function:**
Early Inventory, HP Injection (EIHP)	1/2 CCPs (1 multi-train system) or 1/2 SI pumps (1 multi-train system) [2]
Early Inventory, Accumulators (EIAC)	2/3 remaining accumulators (1 multi-train system)
Early Inventory, LP Injection (EILP)	1/2 RH pumps (1 multi-train system)
Low Pressure Recirculation (LPR)	1/2 RH motor-operated valves open for switchover to recirculation with 1/2 heat exchangers (1 multi-train system) [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)			
4 LLOCA - 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 and ready for use.

Notes:

1. The IPE (pages 3-30 and 3-31) assessed that the pressure excursion due to the large LOCA does not exceed the anticipated failure pressure of 114 psia. Hence, the function of containment cooling is not required.

2. The IPE (page 3-30) states that a large LOCA requires a single high or intermediate injection pump, two accumulators, and either RH pump.

3. The suction of the RH pumps will automatically switchover to the containment sumps when the low RWST level is received (IPE, page 3-30).

Table 3.7 SDP Worksheet for Comanche Peak Steam Electric Station Units 1 and 2 — 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)	1/2 diesel generators (1 multi-train system)
Turbine-driven AFW pump (TDAFW)	1/1 TDAFW with 2 / 4 ARVs (1 ASD train)
Recovery of AC Power in < 2 hrs (REC2)	SBO procedures implemented (operator action = 1) (1)
Secondary Heat Removal (AFW)	1/2 MDAFW pumps or 1/1 TDAFW pump with 2/4 ARVs and with operator controlling AF flow (operator action = 2) (2)
Recovery of AC Power in < 5 hrs (REC5)	SBO procedures implemented (operator action = 2) (3)
Early Inventory, HP Injection (EIHP)	1/2 CCPs (1 multi-train system) or 1/2 SI pumps (1 multi-train system)
Primary Heat Removal (FB)	1/2 PORVs open for Feed/Bleed (operator action = 2)
High Pressure Recirculation (HPR)	1/2 CCPs or 1/2 SI pumps with 1/2 RHR pumps and with operator action to transfer suction of pumps (operator action = 3)
Makeup to RWST (MKRWST)	Operators align a source of makeup water to the RWST (operator action = 1) (4)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 LOOP - AFW - HPR - MKRWST (4)			
2 LOOP - AFW - FB (5)			
3 LOOP - AFW - EIHP (6)			
4 LOOP - EAC - HPR - MKRWST (9, 14) (AC recovered)			

5 LOOP - EAC - EIHP (10, 16) (AC recovered)			
6 LOOP - EAC - REC5 (11)			
7 LOOP - EAC - TDAFW - FB (15) (AC recovered)			
8 LOOP - EAC - TDAFW - REC2 (17)			

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

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

Notes:

1. For the function "Recovery of AC Power in < 2 hrs (REC2)," the most similar human actions in the IPE are "Operator fails to recover a diesel generator when both have failed to run" (IPE, page 3-201, event EPDGRUN2, human error probability (HEP) = 1E-1), and "Operator fails to recover a diesel generator when both have failed to start" (IPE, page 3-202, event EPDGSTART2, HEP = 1E-1). Accordingly, a credit of 1 is assigned.

2. According to the IPE (page 3-13), success of AFW includes operator actions required to control the auxiliary feedwater flow to prevent the overfilling or dryout of any steam generator. The human error probability (HEP) assessed in the IPE (page 3-196) is 1E-2 (event &SGLXAFWXNY). Accordingly, a credit of 2 is assigned.

3. In an SBO situation, an RCP seal LOCA may occur, with subsequent core damage at about 5 hours.

4. If the operators are unable to transition to recirculation due to unavailability of equipment, they are directed to remain in the injection alignment, and to provide makeup water to the RWST via various sources (IPE, page 3-14). The human error probability (HEP) assessed in the IPE (page 3-198) is 1E-1 (event ECA-1.1). Accordingly, a credit of 2 is assigned.

Table 3.8 SDP Worksheet for Comanche Peak Steam Electric Station Units 1 and 2 — Steam Generator Tube Rupture (SGTR)

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>:
Secondary Heat Removal (AFW)	1/2 MDAFW pumps or 1/1 TDAFW pump with 2/4 ARVs (operator action = 2) [(1)]
Early Inventory, HP Injection (EIHP)	1/2 CCPs (1 multi-train system) or 1/2 SI pumps (1 multi-train system)
Pressure Equalization (EQ1)	Operator isolates the ruptured SG and depressurizes RCS using 2/4 ARVs with 1/2 PORVs to less than setpoint of relief valves of SG (1 multi-train system) [(2)]
Pressure Equalization (EQ2)	Operator isolates the ruptured SG and depressurizes RCS using 2/4 ARVs with 1/2 PORVs to less than setpoint of relief valves of SG (no ECCS injection) (operator action = 2)
Feed-and-Bleed (FB)	1/2 PORVs open for Feed/Bleed (operator action = 2)
Makeup to RWST (MKRWST)	Operators align a source of makeup water to the RWST and cooldown of RCS to RHR entry (operator action = 1) [(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 SGTR - EQ1 (2)			
2 SGTR - EIHP - EQ2 (4)			
3 SGTR - AFW - MKRWST (6)			
4 SGTR - AFW - FB (7)			
5 SGTR - AFW - 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 and ready for use.

<u>Notes</u>:

1. According to the IPE (page 3-13), success of AFW includes operator actions required to control the auxiliary feedwater flow to prevent the overfilling or dryout of any steam generator. The human error probability (HEP) assessed in the IPE (page 3-196) is 1E-2 (event &SGLXAFWXNY). Accordingly, a credit of 2 is assigned.

2. IPE's operator action has a credit = 4. Accordingly, the mitigating credit for function EQ1 is dominated by hardware failures, i.e., a multi-train system.

3. The human error probability (HEP) assessed in the IPE for providing makeup water to the RWST via various sources(page 3-198) is 1E-1 (event ECA-1.1). Accordingly, a credit of 1 is assigned.

Table 3.9 SDP Worksheet for Comanche Peak Steam Electric Station Units 1 and 2 — 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 the turbine (operator action = 2)
Primary Relief (SRV)	3/3 SRVs with 2/2 PORVs open (1 train)
Main Feedwater (MFW)	1/2 MFPs with 2/4 ARVs (1 multi-train system)
Auxiliary Feedwater (AFW)	2/2 MDAFW pumps with 1/1 TDAFW pump with 2/4 ARVs and with operator controlling AF flow (operator action = 2) [(1)]
Emergency Boration (EMBO)	Operator conducts emergency boration using 1/2 CCPs with 1/2 BATPs (operator action = 2)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 ATWS - EMBO (2, 4)			
2 ATWS - MFW - AFW (5)			
3 ATWS - SRV (6)			
4 ATWS - TTP (7)			

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

Note:

1. Since manual rod insertion is considered failed, the success criteria of the safety function AFW in the SDP worksheet requires full AFW capability. According to the IPE (page 3-13), success of AFW includes operator actions required to control the auxiliary feedwater flow to prevent the overfilling or dryout of any steam generator. The human error probability (HEP) assessed in the IPE (page 3-196) is 1E-2 (event &SGLXAFWXNY). Accordingly, a credit of 2 is assigned.

Table 3.10 SDP Worksheet for Comanche Peak Steam Electric Station Units 1 and 2 — Main Steam Line Break (MSLB)[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 MDAFW pumps or 1/1 TDAFW pump with 2/3 ARVs and with operator controlling AF flow (operator action = 2) [2]
HP Injection (HPI)	1/2 CCPs (1 multi-train system) or 1/2 SIPs (1 multi-train system)
Primary Heat Removal, Feed/Bleed (FB)	1/2 PORVs open for Feed/Bleed (operator action = 2)
High Pressure Recirculation (HPR)	1/2 CCPs or 1/2 SI pumps with 1/2 RHR pumps and with operator action to transfer suction of pumps (operator action = 3)
Makeup to RWST (MKRWST)	Operators align a source of makeup water to the RWST (operator action = 1) [3]

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 MSLB - AFW - HPR - MKRWST (4)			
2 MSLB - AFW - FB (5)			
3 MSLB - AFW - HPI (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. If the break occurs upstream of the MSIV , the break is non-isolable. In the SDP event tree and worksheet we assumed that the break is non-isolable. The IPE states (page 3-16) that isolation of the break is not required to prevent core damage.

2. It appears that the TDAFW pump will be available after an MSLB due to the redundancy and isolation capabilities provided by two independent steam lines supplying steam to the TDAFW pump (IPE, page 3-79). According to the IPE (page 3-13), success of AFW includes operator actions required to control the auxiliary feedwater flow to prevent the overfilling or dryout of any steam generator. The human error probability (HEP) assessed in the IPE (page 3-196) is 1E-2 (event &SGLXAFWXNY). Accordingly, a credit of 2 is assigned.

3. If the operators are unable to transition to recirculation due to unavailability of equipment, they are directed to remain in the injection alignment, and to provide makeup water to the RWST via various sources (IPE, page 3-14). The human error probability (HEP) assessed in the IPE (page 3-198) is 1E-1 (event ECA-1.1). Accordingly, a credit of 1 is assigned.

Table 3.11 SDP Worksheet for Comanche Peak Steam Electric Station Units 1 and 2 — Loss of Station Service Water (LSW)[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:**
Operator Trips RCPs (RCPT)	Operator Trips RCPs (operator action = 3) [2]
Operator Recovers One Train of SW (RSW)	Operator restores one train of SW (operator action = 2) [3]
Early Inventory, HP Injection (EIHP)	1/1 CCP (1 train) or 1/1 SI pump (1 train)
Auxiliary Feedwater (AFW)	1/1 MDAFW pump or 1/1 TDAFW pump with 2/4 ARVs and with operator controlling AF flow (operator action = 2) [4]
Main Feedwater (MFW)	1/1 MFP with operator re-establishing main feedwater and with 2/4 ARVs (operator action = 1) [5]
Primary Bleed (FB)	1/2 PORVs open for Feed/Bleed (operator action = 2)
High Pressure Recirculation (HPR)	1/1 CCP or 1/1 SI pump with 1/1 RHR pump and with operator action to transfer suction of pumps (operator action = 3)
Makeup to RWST (MKRWST)	Operators align a source of makeup water to the RWST (operator action = 1) [6]

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 LSW - HPR - MKRWST (3, 6, 9)			
2 LSW - AFW - MFW - FB (10)			
3 LSW - EIHP (11)			
4 LSW - RSW (12)			

5 LSW - RCPT (13)			

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

Notes:

1. The Station Service Water supplies cooling for the Component Cooling Water system, the diesel generators, and the lube oil coolers for the centrifugal charging pumps and the safety injection pumps. Because the CCPs are cooled by Station Service Water, RCP seal injection flow is lost (the positive displacement charging pump is cooled by CC). Thus, loss of Station Service Water causes an RCP seal LOCA, which we modeled as a small LOCA. The frequency of loss of Station Service Water is 4.79E-3 / year.

2. For this operator action we used the SDP's generic value.

3. The operators restore one train of SW prior to core uncovery. Since each train of SW provides cooling to one train of mitigating equipment, then it appears that only one train of mitigating equiment would be available after this restoration.

4. According to the IPE (page 3-13), success of AFW includes operator actions required to control the auxiliary feedwater flow to prevent the overfilling or dryout of any steam generator. The human error probability (HEP) assessed in the IPE (page 3-196) is 1E-2 (event &SGLXAFWXNY). Accordingly, a credit of 2 is assigned.

5. The human error probability (HEP) assessed in the IPE (page 3-197) is 1E-1 (event CF&MFWRESTS). Accordingly, a credit of 1 is assigned.

6. If the operators are unable to transition to recirculation due to unavailability of equipment, they are directed to remain in the injection alignment, and to provide makeup water to the RWST via various sources (IPE, page 3-14). The human error probability (HEP) assessed in the IPE (page 3-198) is 1E-1 (event ECA-1.1). Accordingly, a credit of 1 is assigned.

Table 3.12 SDP Worksheet for Comanche Peak Steam Electric Station Units 1 and 2 — Loss of Component Cooling Water (LCCW)[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:**		
Operator Trips RCPs (RCPT)	Operator Trips RCPs (operator action = 3)		
Operator Restores One Train of CCW (RCCW)	Operator recovers one train of CCW [2] (operator action = 2)		
Auxiliary Feedwater (AFW)	1/1 MDAFW pump [3] or 1/1 TDAFW pump with 2/4 ARVs and with operator controlling AF flow (operator action = 2) [4]		
Main Feedwater (MFW)	1/1 MFP with operator re-establishing main feedwater and with 2/4 ARVs (operator action = 1) [5]		
High Pressure Injection (EIHP)	1/1 CCPs (1 multi-train system)		
Feed/Bleed (FB)	1/2 PORVs open for Feed/Bleed (operator action = 2)		
High Pressure Recirculation (HPR)	1/1 CCPs or 1/1 SI pumps with 1/1 RHR pumps and with operator action to transfer suction of pumps (1 train) [6]		
Makeup to RWST (MKRWST)	Operators align a source of makeup water to the RWST (operator action = 1) [7]		

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 LCCW - AFW - MFW - HPR - MKRWST			
2 LCCW - AFW - MFW - FB (6, 20)			
3 LCCW - AFW - MFW - EIHP (7, 21)			
4 LCCW - RCCW (8, 22)			

5 LCCW - RCPT - HPR - MKRWST (11, 15)			
6 LCCW - RCPT - EIHP (12, 16)			

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

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

Notes:

1. The initiating event is the loss of both trains of Component Cooling Water. According to the procedure, if CC cannot be restored, the reactor operators trip the RCPs, thus causing a reactor trip and subsequent turbine trip. In addition to other functions, the CC provides cooling for: Safety Chilled Water system condenser, RCP thermal barriers, oil coolers and motor air coolers, instrument air compressors, and UPS HVAC chillers. CC also provides cooling water for the recirculation phase of safety injection and feed and bleed operation. Following the loss of Component Cooling Water, all room cooling is lost due to the dependency of Safety Chilled Water on CC. As a result, the equipment in these rooms has an increased probability of failure. We assumed in the SDP's worksheet that if CCW cannot be recovered, such equipment is not available. The frequency of loss of Component Cooling Water is 1.53E-2 / year.

2. The safety function "Operator Restores One Train of CCW (RCCW)" requires that the operators recover one train of CCW before RCP seal LOCA happens due to loss of RCP seal cooling. For the SDP's event tree and worksheet, we assume this recovery is before two hours after loss of RCP seal cooling.

3. Due to the loss of room cooling, the MDAFWPs are less reliable. We assumed that, since only one train of CCW is recovered, only one MDAFWP is available.

4. According to the IPE (page 3-13), success of AFW includes operator actions required to control the auxiliary feedwater flow to prevent the overfilling or dryout of any steam generator. The human error probability (HEP) assessed in the IPE (page 3-196) is 1E-2 (event &SGLXAFWXNY). Accordingly, a credit of 2 is assigned.

5. The human error probability (HEP) assessed in the IPE (page 3-197) is 1E-1 (event CF&MFWRESTS). Accordingly, a credit of 1 is assigned.
6. The safety function "High Pressure Recirculation (HPR)" requires an operator action with credit equal to 3. The mitigating credit of this function is limited by hardware failures, that is, a credit of 1 train.
7. If the operators are unable to transition to recirculation due to unavailability of equipment, they are directed to remain in the injection alignment, and to provide makeup water to the RWST via various sources (IPE, page 3-14). The human error probability (HEP) assessed in the IPE (page 3-198) is 1E-1 (event ECA-1.1). Accordingly, a credit of 1 is assigned.

Table 3.13 SDP Worksheet for Comanche Peak Steam Electric Station Units 1 and 2 — Loss of Instrument Air (LOIA)[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:**
Auxiliary Feedwater (AFW)	1/2 MDAFW pumps or 1/1 TDAFW pump with 2/4 ARVs and with operator controlling AF flow (operator action = 2) [2]
High Pressure Injection (HPI)	1/2 CCPs (operator action = 2) [3] or 1/2 SIPs (1 multi-train system)
Feed/Bleed (FB)	1/2 PORVs open for Feed/Bleed (operator action = 1) [4]
High Pressure Recirculation (HPR)	1/2 CCPs or 1/2 SI pumps with 1/2 RHR pumps and with operator action to transfer suction of pumps (operator action = 1) [5]
Makeup to RWST (MKRWST)	Operators align a source of makeup water to the RWST (operator action = 1) [6]

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 LOIA - AFW - HPR - MKRWST (4)			
2 LOIA - AFW - FB (5)			
3 LOIA - AFW - HPI (6)			

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

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

Notes:

1. The complete loss of instrument air has the following results which may affect the operators' responses: charging control valves fail fully open, letdown isolation valves close, pressurizer spray valves close, MSIVs close, TDAFP steam supply valves open, steam dump valves close, FW regulating valves close, CC surge tank level makeup valves close, RH letdown flow control valves close, RH heat exchanger CC return valves close, N2 supply header valve closes. The loss of this equipment requires the operators to manually control the charging flow to maintain pressurizer pressure and level control. They must also manually align the RH and CC systems for the decay heat removal mode of operation.

   In addition, instrument air provides motive power to the auxiliary feedwater control valves and the steam generator atmospheric relief valves. The closure of the N2 supply header line also results in the loss of nitrogen supply to the pressurizer PORV accumulators. All of these valves are equipped with accumulators to provide a source of motive power for a limited time period. The tree structure of loss of all instrument air is the same as that of Transients with Loss of PCS. Loss of all instrument air has a frequency of 2.02E-3 / year.

2. Upon loss of instrument air, the control valves for the turbine driven AF pump fail open. With full flow admitted to the steam generators, they will overfill and fail the turbine. The operators must locally manually throttle the flow prior to overfill at approximately 90 minutes after loss of instrument air. The human error probability (HEP) assessed in the IPE (page 3-197) is 1E-2 (event AFTDMAN). Accordingly, a credit of 2 is assigned.

3. The IPE (page 3-28) states that the loss of instrument air requires the operators to manually control the charging flow to maintain pressurizer pressure and level control. For the SDP worksheet, we assumed a credit of 2 for these actions.

4. If the pressurizer PORV is required to cycle more than 100 times, the operators must recharge the nitrogen accumulator that provides motive power to the valves. This task must be accomplished prior to failure of the bleed and feed function, which may take up to one hour, given that the PORV has cycled 100 times. The human error probability (HEP) assessed in the IPE (page 3-200) is 5E-2 (event RCXTKN2SUPTY). Accordingly, a credit of 1 is assigned.

5. Upon loss of instrument air, the operators must locally manually throttle the CC flow through the safety chiller condenser to prevent it from tripping on low suction pressure. Although they have approximately one hour, the location of the control valve relative to the indication is unfavorable. The human error probability (HEP) assessed in the IPE (page 3-195) is 3E-1 (event &CHTHROTTLE). Accordingly, a credit of 1 is assigned.

6. If the operators are unable to transition to recirculation due to unavailability of equipment, they are directed to remain in the injection alignment, and to provide makeup water to the RWST via various sources (IPE, page 3-14). The human error probability (HEP) assessed in the IPE (page 3-198) is 1.0E-1 (event ECA-1.1). Accordingly, a credit of 1 is assigned.

Table 3.14 SDP Worksheet for Comanche Peak Steam Electric Station Units 1 and 2 — Loss of a 125V DC Safeguards 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:	**Full Creditable Mitigation Capability for Each Safety Function:**
Auxiliary Feedwater (AFW)	1/1 MDAFW pump with 2/4 ARVs and with operator controlling AF flow (operator action = 2) (2)
High Pressure Injection (HPI)	1/1 CCP (1 train) or 1/1 SI pump (1 train)
Feed/Bleed (FB)	1/2 PORVs open for Feed/Bleed (operator action = 2)
High Pressure Recirculation (HPR)	1/1 CCP or 1/1 SI pump with 1/1 RHR pump and with operator action to transfer suction of pumps (operator action = 3)
Makeup to RWST (MKRWST)	Operators align a source of makeup water to the RWST (operator action = 1) (3)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 LBDC - AFW - HPR - MKRWST (4)			
2 LBDC - AFW - FB (5)			
3 LBDC - AFW - HPI (6)			

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

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

Notes:

1. Loss of the 1E DC bus 1ED1 leads to a reactor trip due to closure of the feedwater regulating valves. Additionally, several other systems are hampered including: train A motor driven pump of AFW will not start, the TDAFWP may fail due to overfill since the train A regulating valves have lost control power, and train A of CCW, SI, and other systems will not start due to loss of control power. The tree structure of loss of one 1E DC bus is the same as that of Transients with Loss of PCS. The frequency of loss of one 1E DC bus is 3.35E-2 / year.

2. According to the IPE (page 3-13), success of AFW includes operator actions required to control the auxiliary feedwater flow to prevent the overfilling or dryout of any steam generator. The human error probability (HEP) assessed in the IPE (page 3-196) is 1E-2 (event &SGLXAFWXNY). Accordingly, a credit of 2 is assigned.

3. If the operators are unable to transition to recirculation due to unavailability of equipment, they are directed to remain in the injection alignment, and to provide makeup water to the RWST via various sources (IPE, page 3-14). The human error probability (HEP) assessed in the IPE (page 3-198) is 1E-1 (event ECA-1.1). Accordingly, a credit of 1 is assigned.

Table 3.15 SDP Worksheet for Comanche Peak Steam Electric Station Units 1 and 2 — Loss of a Non-Vital AC Bus (LBAC)[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:
Auxiliary Feedwater (AFW)	1/2 MDAFW pumps or 1/1 TDAFW pump with 2/4 ARVs and with operator controlling AF flow (operator action = 2) [2]
High Pressure Injection (HPI)	1/2 CCPs (1 multi-train system) or 1/2 SIPs (1 multi-train system)
Feed/Bleed (FB)	1/2 PORVs open for Feed/Bleed (operator action = 2)
High Pressure Recirculation (HPR)	1/2 CCPs or 1/2 SI pumps) with 1/2 RHR pumps and with operator action to transfer suction of pumps (operator action = 3)
Makeup to RWST (MKRWST)	Operators align a source of makeup water to the RWST (operator action = 1) [3]

Circle Affected Functions	Recovery of Failed Train	Remaining Mitigation Capability Rating for Each Affected Sequence	Sequence Color
1 LBAC - AFW - HPR - MKRWST (4)			
2 LBAC - AFW - FB (5)			
3 LBAC - AFW - HPI (6)			

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

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

Notes:

1. The initiating event is the loss of 6.9kV AC non-Class 1E bus 1A3 and its associated 480V AC bus 1B3. Following such loss, the following equipment is disabled: service air compressor 1, condensate pump 1, TPCW pump 1, circulating water pump 3, RCP 3, turbine shaft lift oil pump, control rod motor-generator set 1, turbine lube oil pump C, and BTRS chillers. An automatic reactor trip signal is generated immediately following the loss of power to the buses due to the loss of power to the RCP, low loop 3 flow, and/or RCP bus undervoltage / underfrequency. The tree structure of loss of a non-vital AC bus is the same as that of Transients with Loss of PCS. The frequency of loss of a non-vital AC bus is 8.23E-2 / year. This worksheet is included here because several components are impacted by this initiator.

2. According to the IPE (page 3-13), success of AFW includes operator actions required to control the auxiliary feedwater flow to prevent the overfilling or dryout of any steam generator. The human error probability (HEP) assessed in the IPE (page 3-196) is 1E-2 (event &SGLXAFWXNY). Accordingly, a credit of 2 is assigned.

3. If the operators are unable to transition to recirculation due to unavailability of equipment, they are directed to remain in the injection alignment, and to provide makeup water to the RWST via various sources (IPE, page 3-14). The human error probability (HEP) assessed in the IPE (page 3-198) is 1E-1 (event ECA-1.1).

Table 3.16 SDP Worksheet for Comanche Peak Steam Electric Station Units 1 and 2 — LOOP and Loss of One Class 1E 6.9kV Bus (LOAC)(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:**
PORV recloses (PORV)	2/2 Pressurizer PORVs reclose after opening during transient (1 train) (2)
Auxiliary Feedwater (AFW)	1/1 MDAFW pump or 1/1 TDAFW pump with 2/4 ARVs and with operator controlling AF flow (operator action = 2) (3)
Early Inventory, HP Injection (EIHP)	1/1 CCP (1 train) or 1/1 SI pump (1 train)
Primary Bleed (FB)	1/1 PORV open for Feed/Bleed (operator action = 2)
Primary Bleed (FBO)	Operator conducts Feed/Bleed (operator action = 2)
High Pressure Recirculation (HPR)	1/1 CCP or 1/1 SI pump with 1/1 RHR pump and with operator action to transfer suction of pumps (operator action = 3)
Makeup to RWST (MKRWST)	Operators align a source of makeup water to the RWST (operator action = 1) (4)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 LOAC - AFW - HPR - MKRWST (4, 13)			
2 LOAC - AFW - FB (5)			
3 LOAC - AFW - EIHP (6, 15)			
4 LOAC - PORV - HPR - MKRWST (9)			
5 LOAC - PORV - EIHP (10)			

6 LOAC - PORV - AFW - FBO (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. In this worksheet, we assumed that given the loss of one Class 1E 6.9kV bus, one division of mitigating equipment will be unavailable.

2. The PORVs receive motive power from the Nitrogen Gas System. The motive power of the PORV block valves is the Class 1E 480V AC (IPE, page 3-161). Hence, if a 4.16kV AC bus is lost, it appears that there may not be motive power available to close the block valve of a stuck open PORV.

3. According to the IPE (page 3-13), success of AFW includes operator actions required to control the auxiliary feedwater flow to prevent the overfilling or dryout of any steam generator. The human error probability (HEP) assessed in the IPE (page 3-196) is 1E-2 (event &SGLXAFWXNY). Accordingly, a credit of 2 is assigned.

4. If the operators are unable to transition to recirculation due to unavailability of equipment, they are directed to remain in the injection alignment, and to provide makeup water to the RWST via various sources (IPE, page 3-14). The human error probability (HEP) assessed in the IPE (page 3-198) is 1E-1 (event ECA-1.1). Accordingly, a credit of 1 is assigned.

Table 3.17 SDP Worksheet for Comanche Peak Steam Electric Station Units 1 and 2 — Interfacing Systems LOCA (ISLOCA)[1]

Estimated Frequency (Table 1 Row) ________	Exposure Time ________	Table 1 Result (circle): A B C D E F G H	
Safety Functions Needed: [2] Letdown Line Excess Letdown Line RH Suction Line Low Pressure Injection to the Cold Legs Low Pressure Injection to the Hot Legs Intermediate Pressure Injection to Cold Legs Intermediate Pressure Injection to Hot Legs Accumulator Injection to the Cold Legs	**Full Creditable Mitigation Capability for Each Safety Function:**		
Circle Affected Functions	**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 and ready for use.			

Notes:

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.

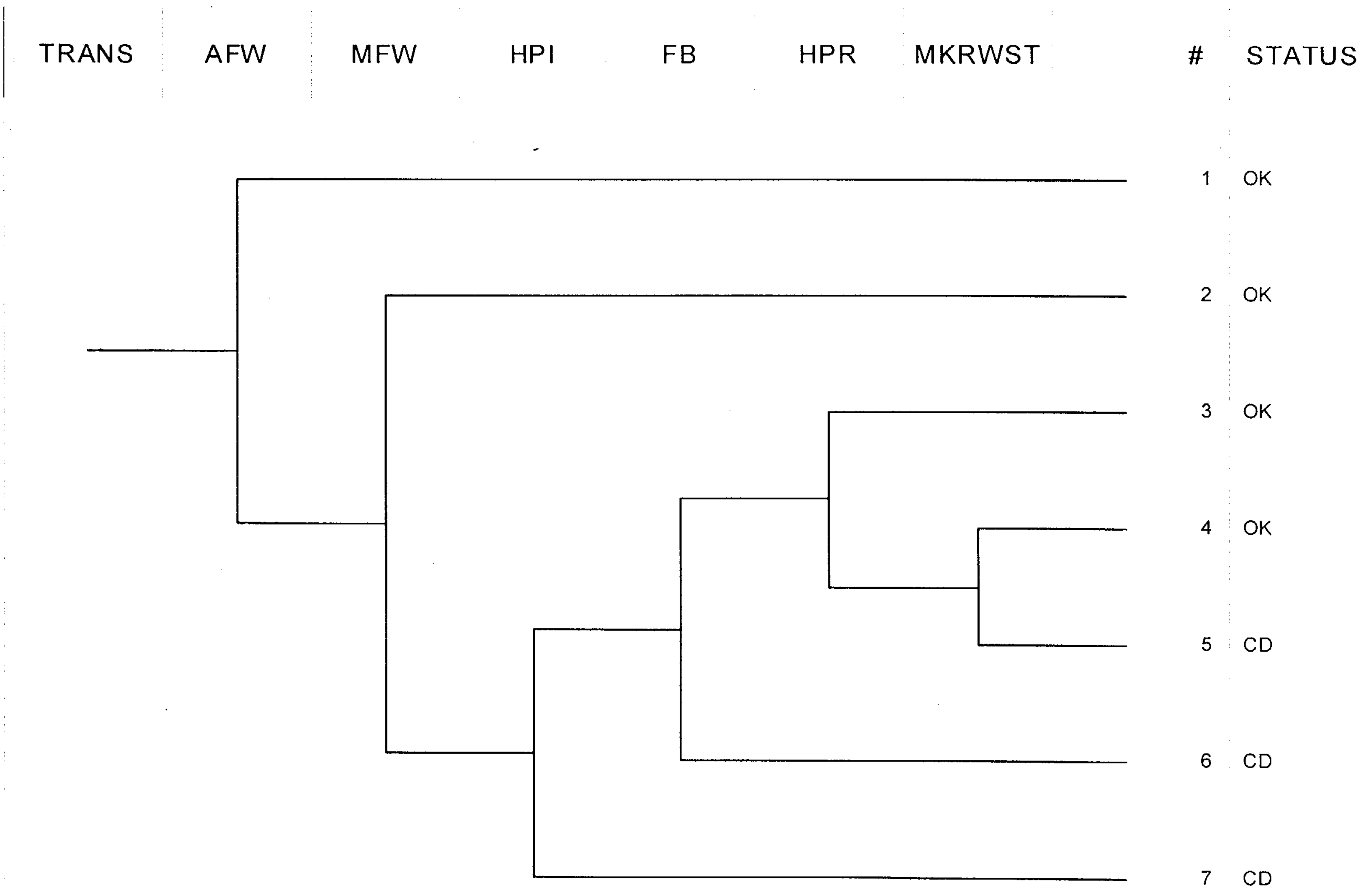
2. The paths mentioned in this worksheet were included in the information provided by the licensee. The specific components, such as valves, in each path were not contained in this information.

1.4 SDP Event Trees

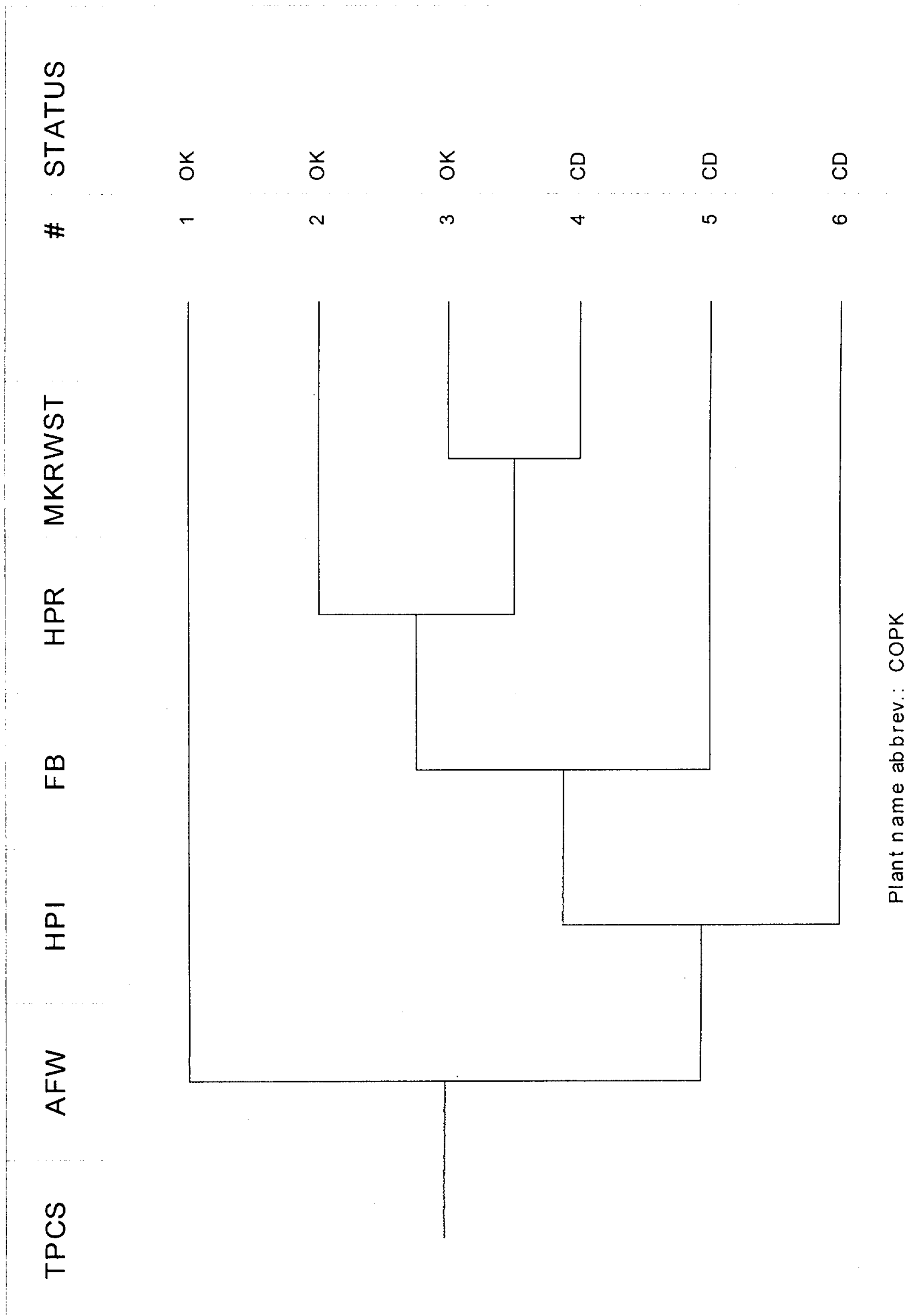
This section provides the simplified event trees called SDP event trees used to define the accident sequences identified in the SDP worksheets in the previous section. An event tree for the stuck-open PORV is not included since it is similar to the small LOCA event tree. The event tree headings are defined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

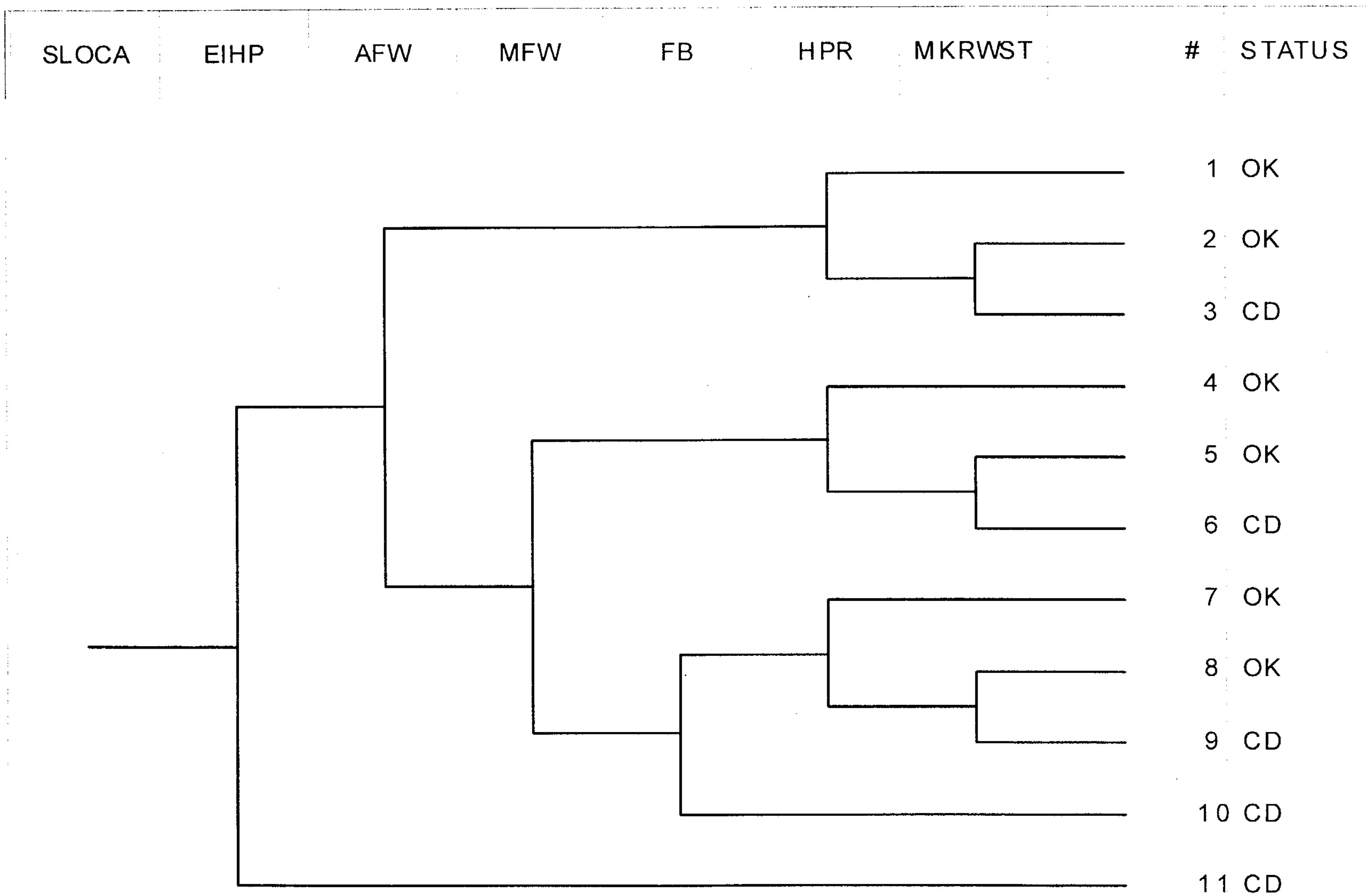
The following event trees are included:

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 Station Service Water (LSW)
11. Loss of Component Cooling Water (LCCW)
12. LOOP and Loss of One Class 1E 6.9kV Bus (LOAC).



Plant name abbrev.: COPK


TPCS
AFW
HPI
FB
HPR
MKRWST
#
STATUS
1 OK
2 OK
3 OK
4 CD
5 CD
6 CD
Plant name abbrev.: COPK



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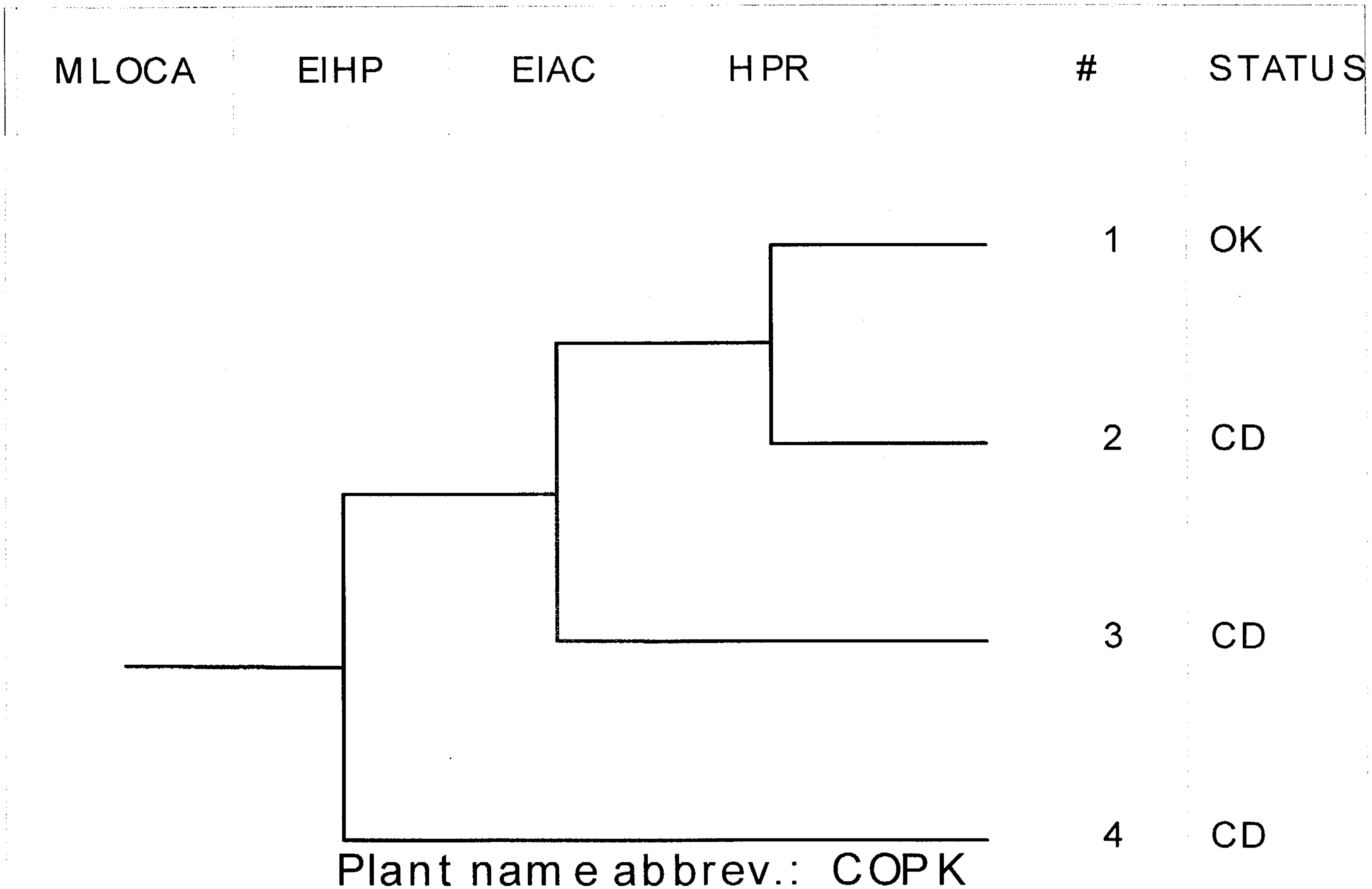
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EIHP
EIAC
HPR
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STATUS
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2
CD
3
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4
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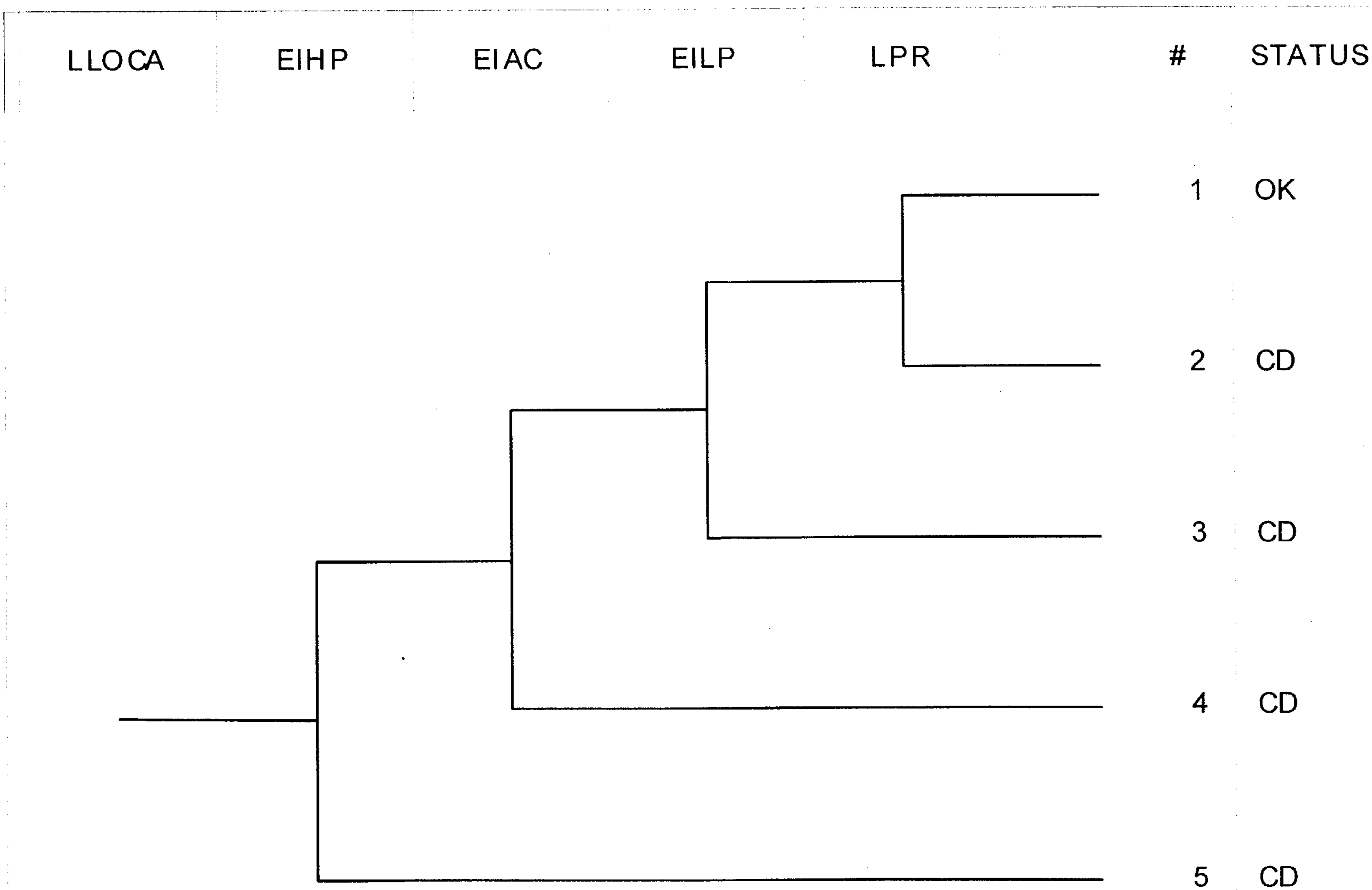

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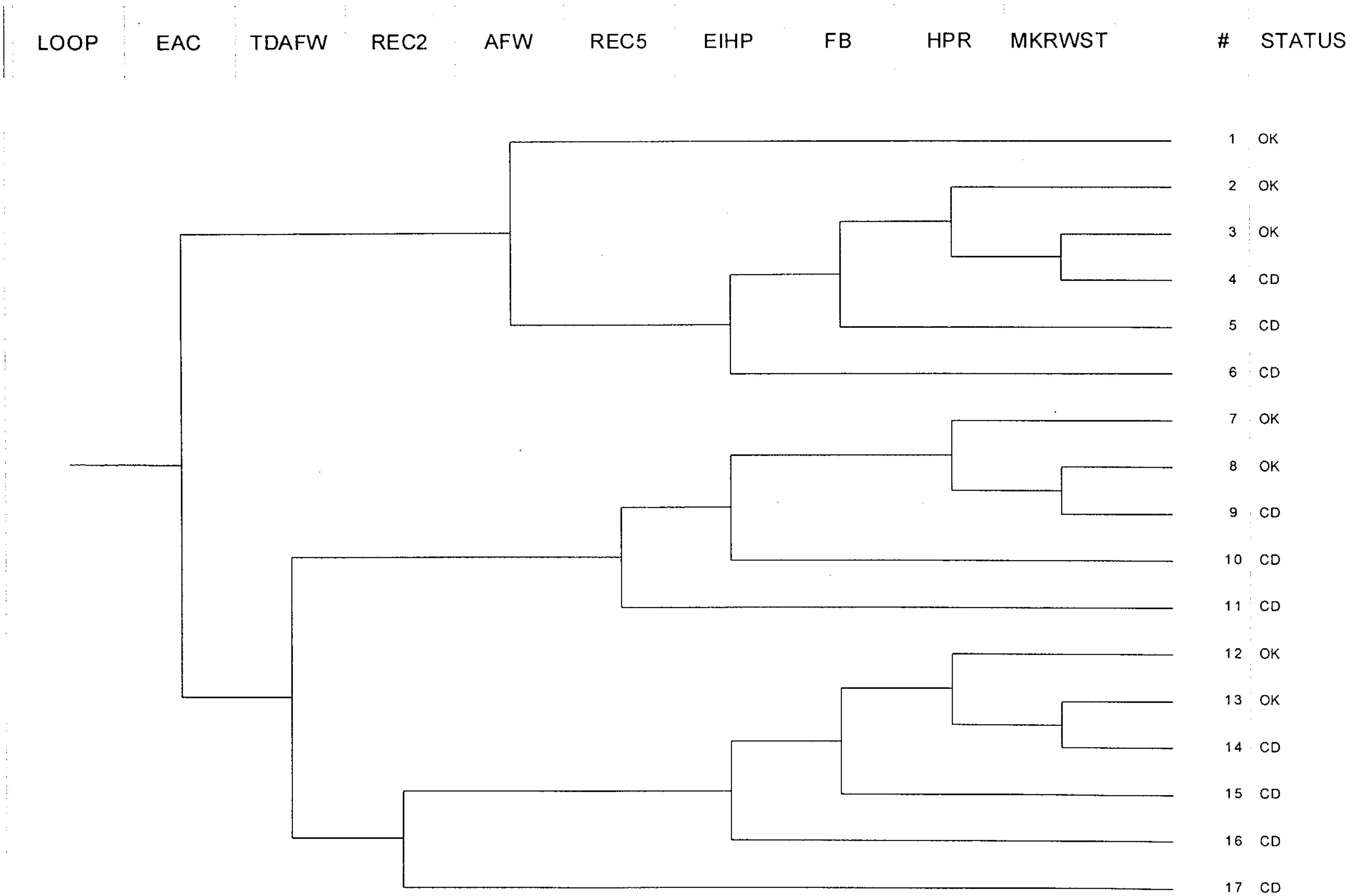

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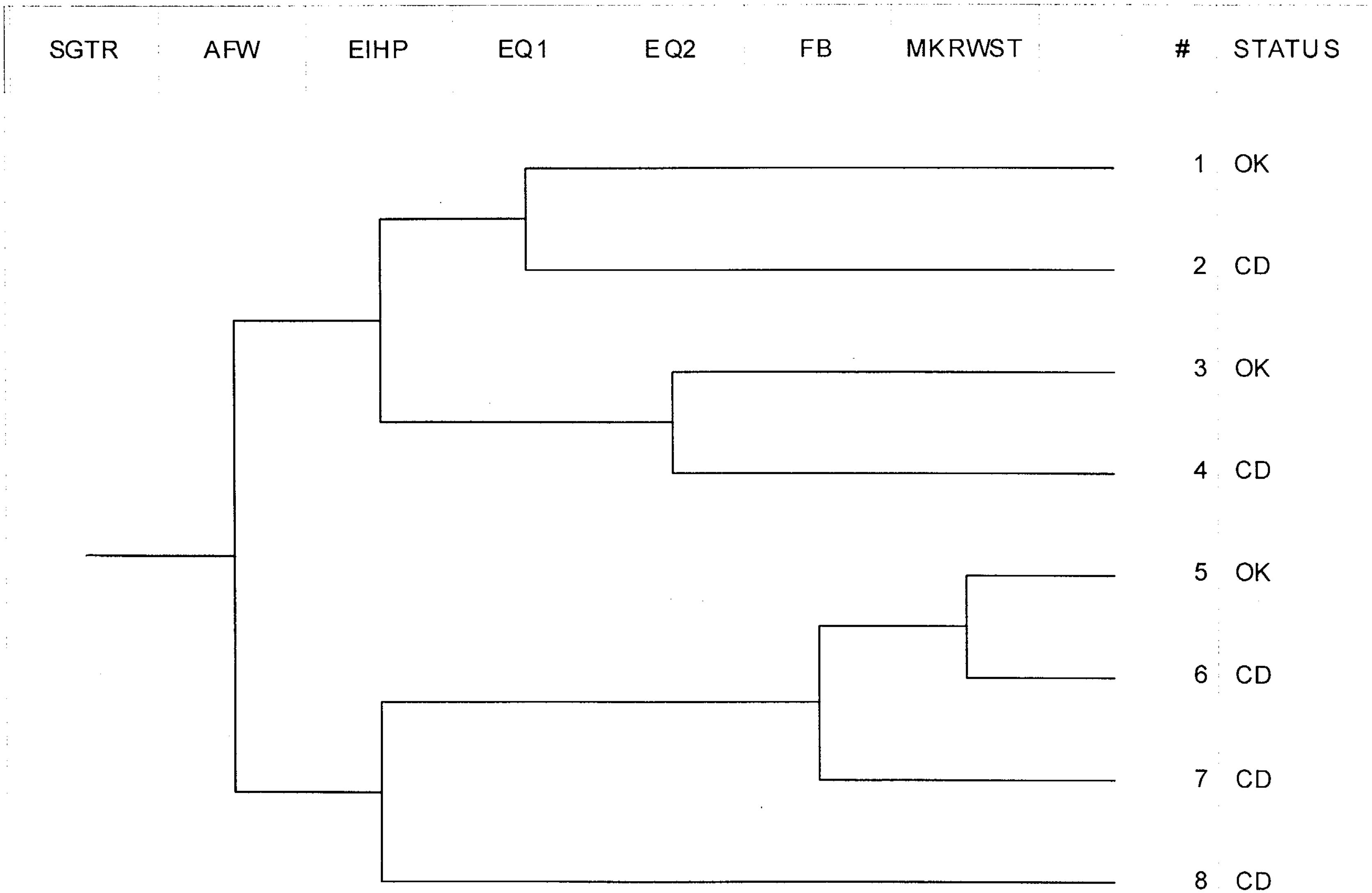

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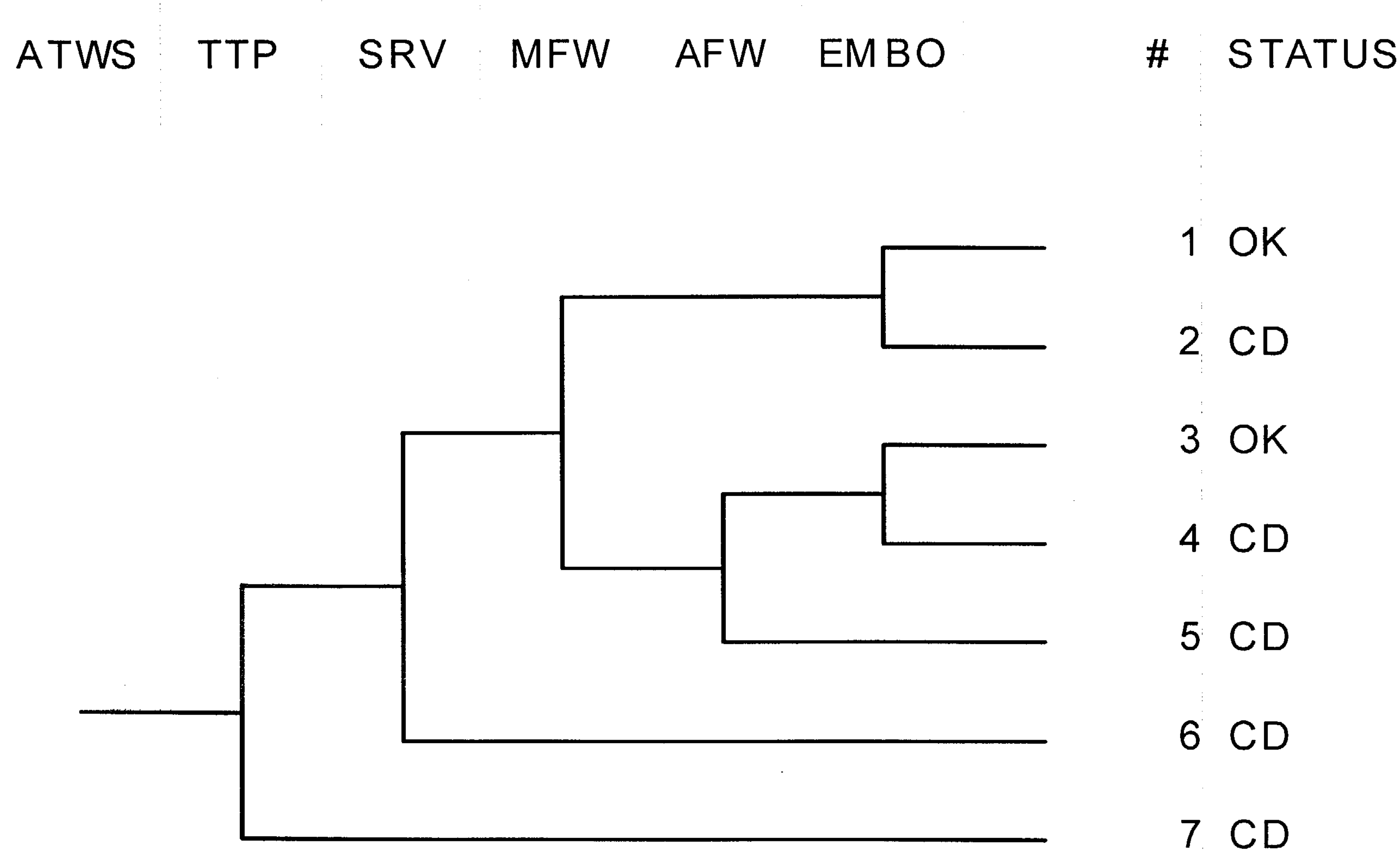

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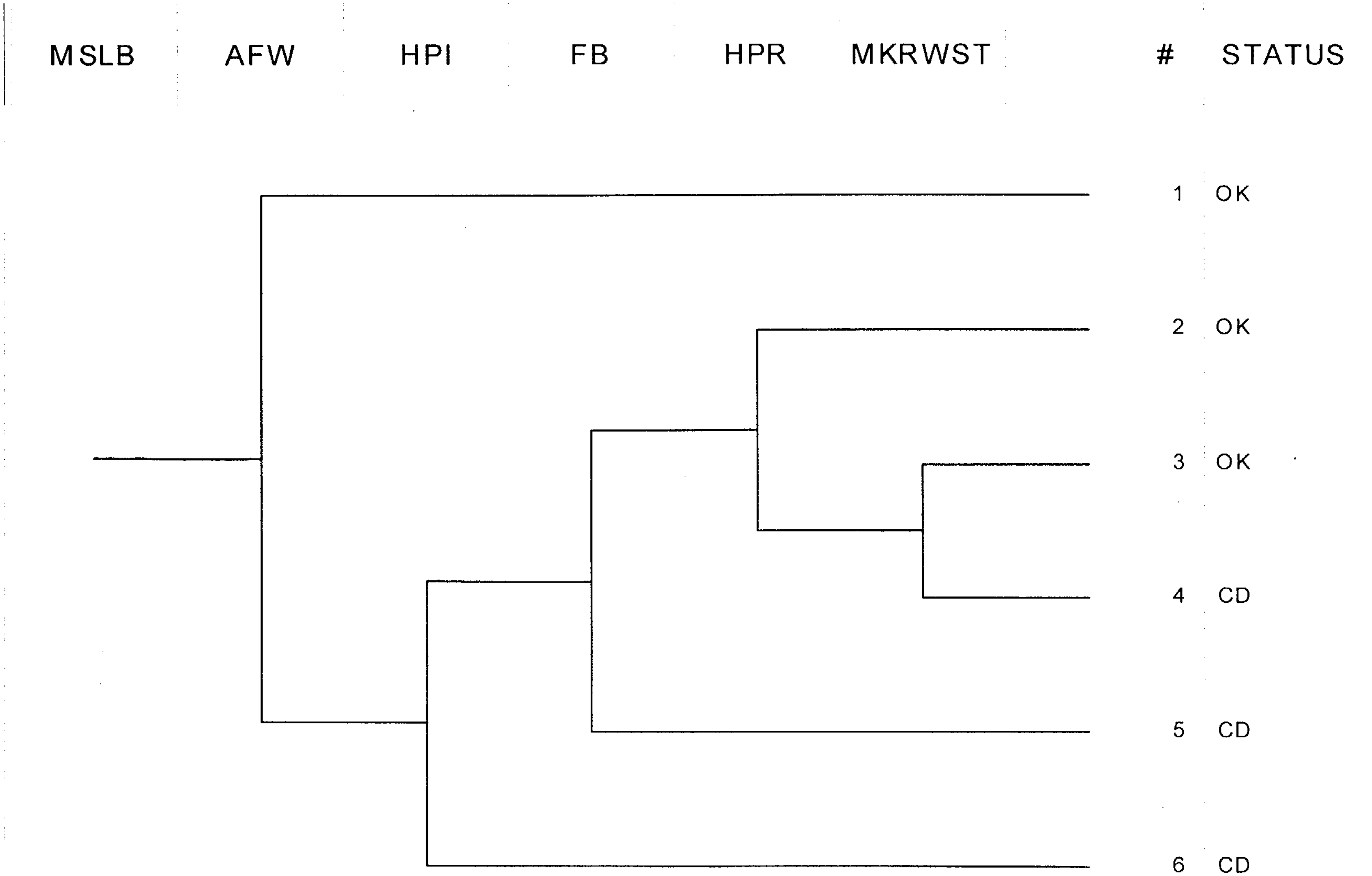

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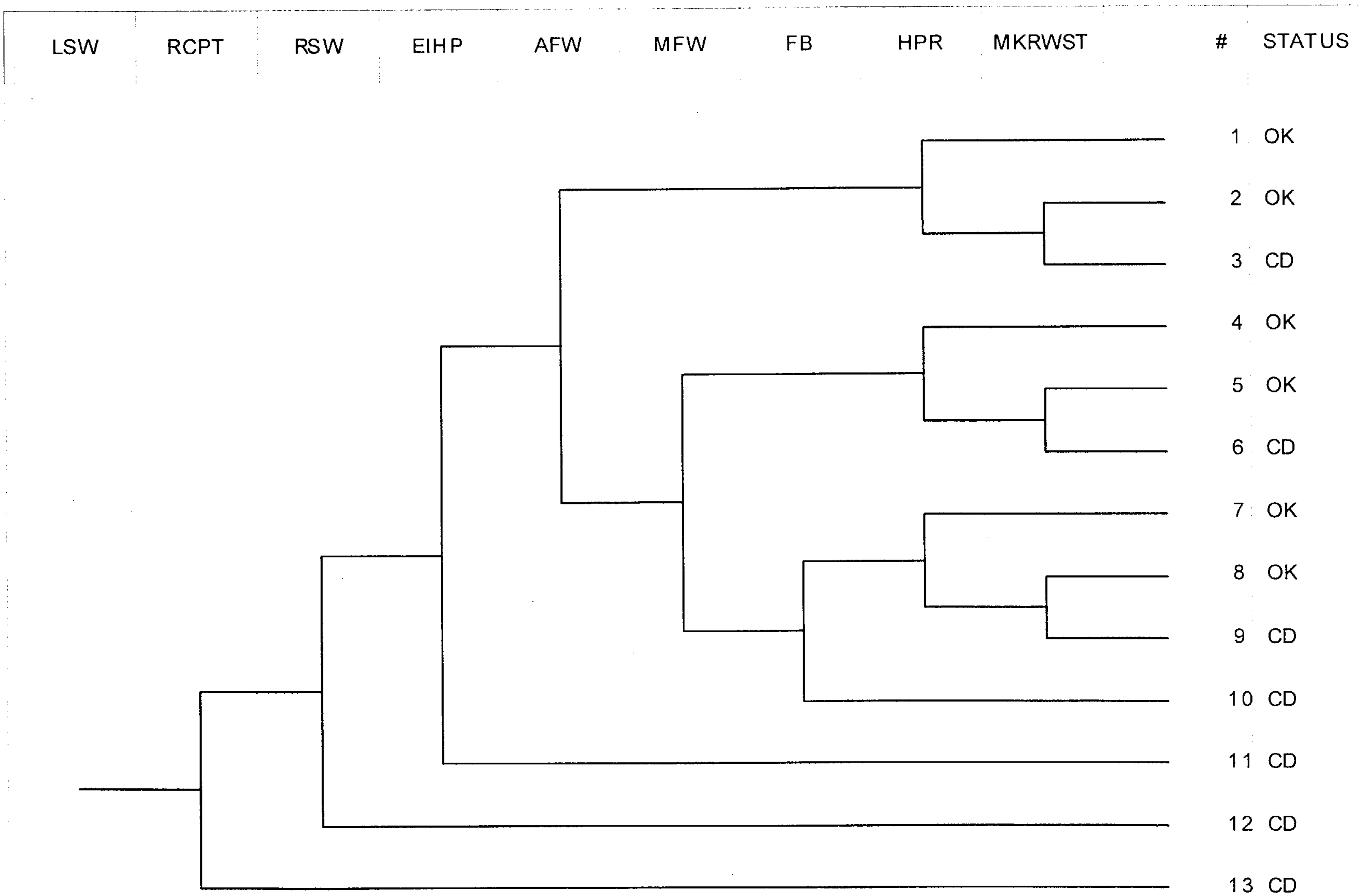

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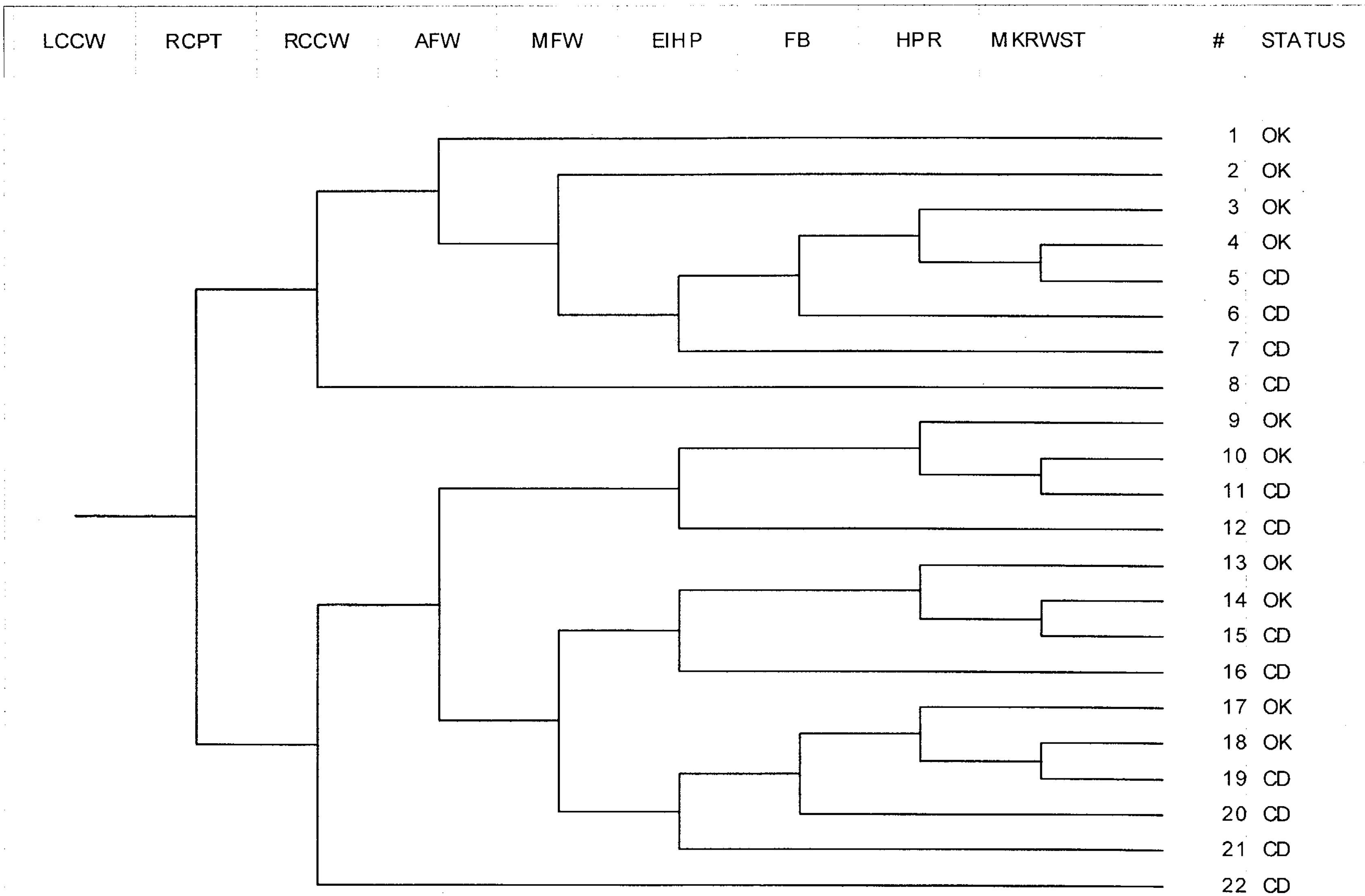

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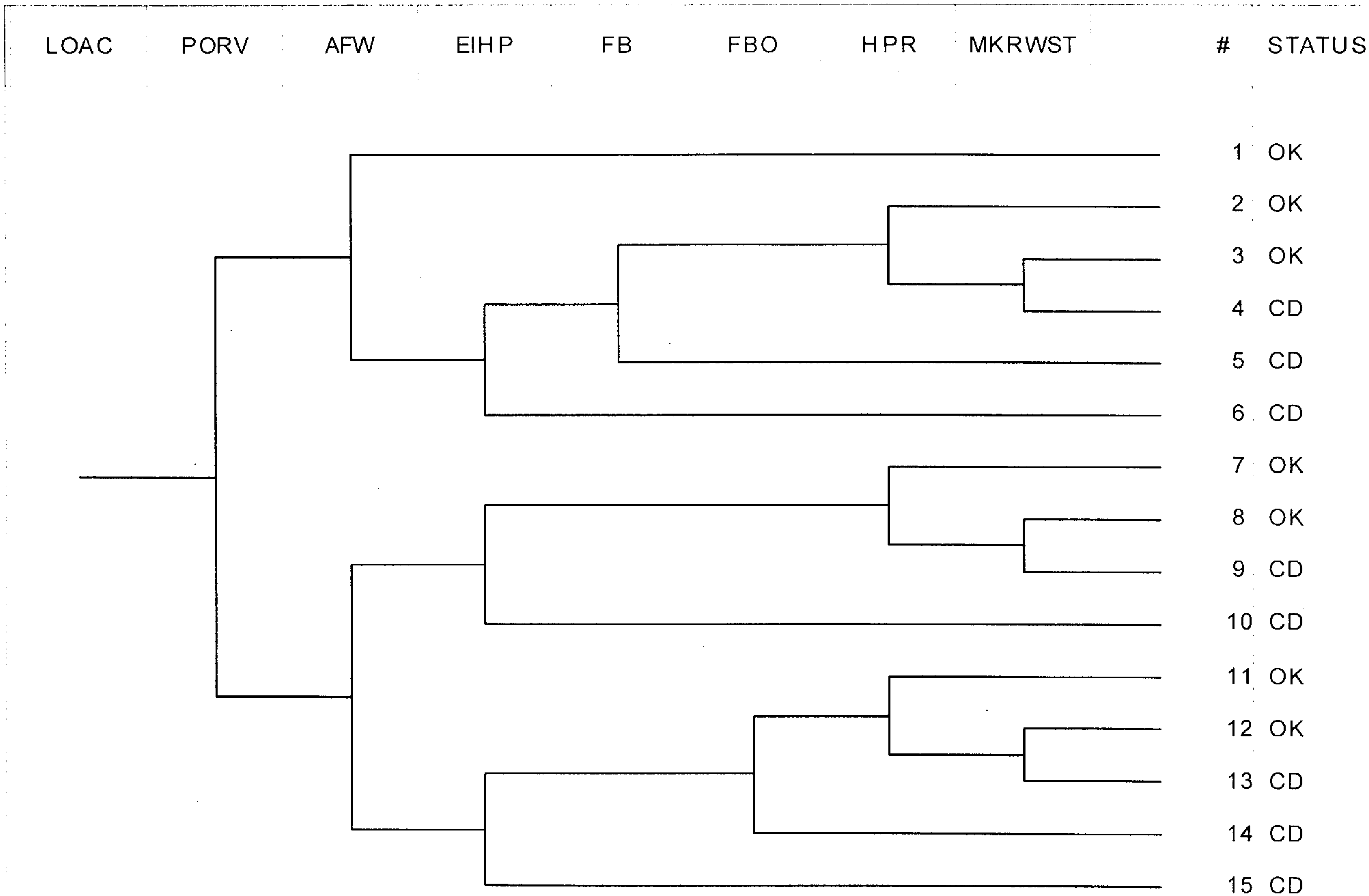

Plant name abbrev.: COPK

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

NRC met with PRA personnel from Comanche Peak. The Licensee provided useful comments on the draft worksheets. The special initiators, plant responses, and the impacts of the initiator were discussed. Other items included in NRC review process were also discussed. Several questions were raised and written responses were received from the licensee after the meeting. The licensee's responses were reviewed and, to the extent possible, incorporated into the SDP worksheets within their framework, scope, and limitations. The licensee's comment and feedback significantly contributed to improving this document.

1) The 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 incorporated.

2) The licensee's comments on the current understanding of success criteria were incorporated in the SDP sheets.

3) The licensee has separate event trees for a small LOCA and a very small LOCA. The licensee considers that small LOCA (break size 2 - 4") is large enough to ensure that the decay heat is removed (IPE, page 3-32). On the other hand, as stated in Section 1 of this document, "Information Supporting Significance Determination Process (SDP)", the SDP only considers three classes of LOCAs (small, medium and large). The definition of SDP's small LOCA requires the removal of decay heat by a system such as AFW or MFW. Accordingly, the licensee's small LOCA is similar to the SDP's medium LOCA (decay heat is removed through the break), and licensee's very small LOCA is similar to the SDP's small LOCA (decay heat is not removed through break, and hence, it has to be removed using a system such as AFW or MFW). A footnote was added in the SDP's worksheets for small LOCA and medium LOCA as a reminder of these relationships.

4) We included the safety function "Makeup to RWST (MKRWST)" in the SDP's event tree and worksheet because we consider that the operators have to align a source of makeup water to the RWST when AFW is unavailable, no pressure equalization is possible, and primary inventory is lost through the break.

5) The information provided by the licensee on ISLOCA paths was used as the basis for the ISLOCA SDP sheet.

6) The IPE (page 3-19) models a loss of HVAC as a loss of the Safety Chilled Water system. The frequency of this event is 7.31E-2 / year. Not enough information was found in the IPE to prepare the SDP's worksheet for this initiator.

7) The remaining comments from the licensee are addressed mainly in Sections 1, "Information Supporting Significance Determination Process (SDP)", and 2.1, "Generic Guidelines and Assumptions (PWRs)" of this document.

REFERENCES

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

2. Texas Utilities Electric Co., "Individual Plant Examination Comanche Peak Steam Electric Station Units 1 and 2," Vol. 1: Front-End Analysis, August, 1992.

3. NRC Memorandum from J. Shackelford, RIV, to J. Ibarra, RES, "SDP Verification Visit to Comanche Peak", April 11, 2000.

We will coordinate our efforts through your licensing or risk organizations as appropriate. If you have questions, please call me at 301-415-1439.

Sincerely,

/RA/

David H. Jaffe, Senior Project Manager, Section 1
Project Directorate IV & Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Enclosure: As stated

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