September 20, 2001

Mr. J. V. Parrish
Chief Executive Officer
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Richland, WA 99352-0968

SUBJECT: SITE-SPECIFIC WORKSHEETS FOR USE IN THE NUCLEAR REGULATORY COMMISSION'S SIGNIFICANCE DETERMINATION PROCESS (TAC NO. MA6544)

Dear Mr. Parrish:

Enclosed please find the Risk-Informed Inspection Notebook which incorporates the updated Significance Determination Process (SDP) Phase 2 Worksheets that inspectors will be using to characterize and risk-inform inspection findings. This document is one of the key implementation tools of the reactor safety SDP in the reactor oversight process and will also be publically available through the Nuclear Regulatory Commission (NRC) external website at http://www.nrc.gov/NRC/IM/index.html.

The 1999 Pilot Plant review effort clearly indicated that significant site-specific design and risk information was not captured in the Phase 2 worksheets forwarded to you last spring. Subsequently a site visit was conducted by the NRC to verify and update plant equipment configuration data and to collect site-specific risk information from your staff. The enclosed document reflects the results of this visit.

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

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

Sincerely,

/RA/

Jack Cushing, Project Manager, Section 2
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-397

Enclosure: SDP Phase 2 Worksheets

cc w/encl: See next page

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Enclosure: SDP Phase 2 Worksheets

cc w/encl: See next page

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RISK-INFORMED INSPECTION NOTEBOOK FOR

COLUMBIA GENERATING STATION

BWR-5, GE, WITH MARK II CONTAINMENT

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NOTICE

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

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ABSTRACT

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

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

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

CONTENTS

TABLES

Page

FIGURES

Page

1. INFORMATION SUPPORTING SIGNIFICANCE DETERMINATION PROCESS (SDP)

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

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

Table 1, Categories of Initiating Events, is used to obtain the estimated likelihood rating for applicable initiating events for the plant for different exposures times for degraded conditions. This Table follows the format of the Table 1 contained in SECY-99-007A. Initiating events are grouped in frequency bins covering one order of magnitude. The table includes the initiating events that should be considered for the plant and for which SDP worksheets are provided. Categorization of the following initiating events is based on industry-average frequency: transients (Reactor Trip) (TRANS); transients without power conversion system (TPCS); large, medium, and small loss of coolant accidents (LLOCA, MLOCA, and SLOCA); inadvertent or stuck open relief valve (IORV or SORV); anticipated transients without scram (ATWS); interfacing systems LOCA (ISLOCA) and LOCA outside containment (LOC). The frequency of the remaining initiating events vary significantly from plant to plant, and accordingly, they are categorized using the plant-specific frequency obtained from the licensee. These initiating events include loss of offsite power (LOOP) and special initiators caused by loss of support systems.

The Initiator and System Dependency Table shows the major dependencies between frontline and support systems, and identifies their involvement in different types of initiators. This table identifies the most risk-significant systems; it is not an exhaustive nor comprehensive compilation of the dependency matrix, as shown in Probabilistic Risk Assessments (PRAs). This table is used to identify the SDP worksheets to be evaluated, corresponding to inspection findings on systems and components.

To evaluate the impact of an inspection finding on the core-damage scenarios, we developed the SDP worksheets. They contain two parts. The first part identifies the functions, the systems, and the combinations thereof that can perform mitigating functions, the number of trains in each system, and the number of trains required (success criteria) for each the initiator. It also characterizes the mitigation capability in terms of the available hardware (e.g., 1 train, 1 multi-train system) and the operator action involved. The second part of the SDP worksheet contains the core-damage accident sequences associated with each initiator; these sequences are based on

SDP event trees. In the parentheses next to each of the sequences the corresponding event tree branch number(s) representing the sequence is included. Multiple branch numbers indicate that the different accident sequences identified by the event tree are merged into one through the Boolean reduction.

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

For the special initiators, we considered those plant-specific initiators whose contribution to the plant's core damage frequency (CDF) is non-negligible and/or have the potential to be a significant contributor to CDF given an inspection finding on system trains and components. We defined a set of criteria for their inclusion to maintain some consistency across the plants. These conditions are as follows:

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

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

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

1. Transients with power conversion system (PCS)available, called Transients (Reactor trip) (TRANS),
2. Transients without PCS available, called Transients w/o PCS (TPCS),
3. Small Loss of Coolant Accident (SLOCA),
4. Inadvertent or Stuck-open Power Operated Relief Valve (IORV or SORV),
5. Medium LOCA (MLOCA),
6. Large LOCA (LLOCA),
7. Loss of Offsite Power (LOOP)
8. Anticipated Transients Without Scram (ATWS).

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

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

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

The worksheet for the LOOP may include LOOP with emergency AC power (EAC) available and LOOP without EAC, i.e., Station Blackout (SBO). LOOP with partial availability of EAC, i.e., LOOP with loss of a bus of EAC, is covered in a separate worksheet to avoid making the LOOP worksheet too large. LOOP with stuck open SORV is also covered in a separate worksheet, when applicable. In some plants, LOOP with failure of 1 EAC bus and LOOP with stuck-open SORV are large contributors to the plant's core damage frequency (CDF).

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

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

1. Event trees and sequences were developed such that the worksheet contains all the major accident sequences identified by the plant-specific IPEs or PRAs. The special initiators modeled for a plant is based on a review of the special initiators included in the plant IPE/PRA and the information provided by the licensee.

2. The event trees and sequences for each plant took into account the IPE/PRA models and event trees for all similar plants. Any major deviations in one plant from similar plants typically are noted at the end of the worksheet.

3. The event trees and the sequences were designed to capture core-damage scenarios, without including containment-failure probabilities and consequences. Therefore, branches of event trees that are only for the purpose of a Level II PRA analysis are not considered. The resulting sequences are merged using Boolean logic.

4. The simplified event-trees focus on classes of initiators, as defined above. In so doing, many separate event trees in the IPEs often are represented by a single tree. For example, some

IPEs define four or more classes of LOCAs rather than the three classes considered here. The sizes of LOCAs for which high-pressure injection is not required are some times divided into two classes; the only difference between them being the need for reactor scram in the smaller break size. Some consolidation of transient event tree may also be done besides defining the special initiators following the criteria defined above.

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

The four sections that follow include the Categories of Initiating Events Table, Initiators and System Dependency Table, SDP Worksheets, and the SDP Event Trees for the Columbia Generating Station.

1.1 INITIATING EVENT LIKELIHOOD RATINGS

Table 1 presents the applicable initiating events for this plant and their estimated likelihood ratings corresponding to the exposure time for degraded conditions. The initiating events are grouped into rows based on their frequency. As mentioned earlier, loss of offsite power and special initiators are assigned to rows using the plant-specific frequency obtained from individual licensees. For other initiating events, industry-average values are used, as per SECY-99-007A.

Table 1 Categories of Initiating Events for Columbia Generating Station

Row	Approximate Frequency	Example Event Type	Estimated Likelihood Rating		
I	> 1 per 1-10 yr	Reactor Trip, Loss of Power Conversion System (TPCS - Loss of condenser, Closure of MSIVs, or Loss of feedwater)	A	B	C
II	1 per 10-10^{2} yr	Loss of offsite power (LOOP), Inadvertent or stuck open SRVs (SORV)	B	C	D
III	1 per 10^{2} - 10^{3} yr	Loss of plant or turbine service water (LOSW), Loss of 125 VDC Div. 1 or Div. 2 (LODC1, LODC2)	C	D	E
IV	1 per 10^{3} - 10^{4} yr	Small LOCA (RCS rupture), Medium LOCA (RCS rupture),	D	E	F
V	1 per 10^{4} - 10^{5} yr	Large LOCA (RCS rupture), ATWS	E	F	G
VI	less than 1 per 10^{5} yr	ISLOCA	F	G	H
			> 30 days	**3-30 days**	**< 3 days**
			Exposure Time for Degraded Condition		

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).

2. The PSA LOOP initiating event frequency is 3.6 E-2 events per reactor year.

3. The PSA initiating event frequency for IORV/SORV is 5.8 E-2 events per reactor year.

4. The PSA initiating event frequency for loss of plant or turbine service water, LOSW, is 1.3 E-3 events per reactor year.

5. The PSA initiating event frequency for loss of 125 VDC, Div. 1 is 3.0 E-3 events per reactor year. The frequency for LODC Div. 2 is the same.

6. The PSA initiating event frequency for loss of Containment Instrument Air (CIA) is 1.3 E-3 events per reactor year.

7. The PSA initiating event frequency for Loss of an AC bus varies from 2 to 4 E-4 events per reactor year. The sequence frequency for this initiator is 7E-9 events per reactor year and contributes less than 0.1% of internal events CDF.

1.2 INITIATORS AND SYSTEM DEPENDENCY

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

Table 2 Initiators and System Dependency Table for Columbia Generating Station

Affected Systems		Major Components	Support Systems	Initiating Event Scenarios
Code	Name			
PCS	Power Conversion System	9 MDP, 2 TDP, MOV, 4 TBVs, condenser	AC, DC, TSW, CAS, CIA	TRANS, SLOCA, SORV
HPCS	High Pressure Core Spray	1 MDP, MOV, Div. 3 EDG	AC, DC, act, RBEC, SW, CSTS	All
RCIC	Reactor Core Isolation Cooling	1 TDP, MOV	DC, act, CSTS	TRANS, TPCS, SLOCA, SORV, LOOP, LODC2, LOSW
ADS/SRVs	Automatic Depressurization System/Safety Relief Valves	18 SRVs (7 ADS valves), AOV	DC, act, CIA	All but LLOCA
LPCI	Low Pressure Coolant Injection	3 MDP, MOV	AC, DC, act, SW, RBEC	All
RHR	Residual Heat Removal (Containment Spray or SP Cooling mode)	2 MDP, MOV, 2 HX	AC, DC, RBEC, SW	All
LPCS	Low Pressure Core Spray	1 MDP, MOV	AC, DC, act, RBEC, SW	All but LODC1
AC	AC Power (non-EDG)	Breakers	DC	All
EDG	AC power (EDGs) Div. I & II	2 Engine-Generators	DC, SW	LOOP
FO xfer	Fuel Oil Transfer	MDP	AC, DC, act	LOOP

Table 2 (Continued)

Affected Systems		Major Components	Support Systems	Initiating Event Scenarios
Code	Name			
DC	DC power	10 safety-related (SR) Batteries, 10 SR Chargers	None	All
act	Instrumentation / Actuation	Instrumentation	DC, AC	All
CSTS	Condensate Storage & Transfer System	2 CSTs, 3 MDP, valves	AC, DC, CAS	All
RPT	Recirculation Pump Trip	Instrumentation	AC, DC	ATWS
SLC	Standby Liquid Control	2 MDP, MOV, explosive valves	AC	ATWS
CIA	Containment Instrument Air	Accumulators, valves	AC, TSW, CAS, CN (containment N_2 inerting)	All but LLOCA
CAS	Control & Service Air	4 compressors, valves, accumulators	AC, TSW	TRANS, SLOCA, SORV
RBEC (or RHVAC)	Reactor Bldg. Emergency Cooling	Fan coolers, valves	AC, SW, act	All
RCC	Reactor Closed Cooling Water	3 MDP, MOV, 3 HX	AC, DC, TSW	TRANS, SLOCA, SORV
TSW	Plant or Turbine Service Water	2 MDP, MOV, cooling tower	AC, DC, act	LOSW
SW	Standby Service Water	3 MDP, MOV, 2 spray ponds	AC, DC	All

Table 2 (Continued)

Affected Systems		Major Components	Support Systems	Initiating Event Scenarios
Code	Name			
VS	Vapor Suppression for Early Containment Control (EC)	Suppression Pool (SP), Vacuum breakers downcomers	None	MLOCA & LLOCA
CV	Containment Venting	AOV	AC, CAS	All
FP	Fire protection water pumps	2 MDP, 2 diesel-driven pump, MOV	AC or FP diesel	None

<u>Notes</u>:

1. Information herein was developed from the WNP-2 IPE, Rev. 1 dated July, 1994 including responses to RAIs, dated October 20, 1995. This IPE uses the small ET, large fault trees approach. Information was also provided by the licensee in reviewing the draft inspection notebook and this included excerpts from the WNP-2 PSA, Rev. 2. The WNP-2 baseline IPE core damage frequency (CDF) from internal events is 1.75 X 10^{-5} events/Rx year. The PSA baseline IPE core damage frequency (CDF) from internal events is 2.365 X 10^{-5} events/Rx year. The dominant contributor to the PSA is LOOP/SBO at 48.9%. Internal flooding contributes 12.5% and is not addressed by this notebook.

2. The 'Initiating Event Scenarios' column provides a guide as to which worksheets contain credit for a particular system. The ISLOCA/LOC worksheet is not referenced in this column.

3. There may be some partial or delayed dependencies not directly displayed. See Table 3.2.3 of the IPE for these details.

4. Where we have indicated AC in the support system column, this means that power can be supplied by one or both of the EDG System or the non-EDG AC power system. Typically for Columbia the safety-related AC equipment can be supplied by either, while the non-safety can only be supplied by non-EDG power. The EDGs are only specifically credited in the LOOP Event Tree.

5. AC power, Div. 1 (SM-7) and Div. 2 (SM-8), supply the two divisions of emergency equipment. Div. 3 (SM-4) supplies HPCS and its auxiliaries.

6. For CGS, one stuck open SRV is the equivalent of a small LOCA.

Table 2 (Continued)

7. The Power Conversion System (PCS) at Columbia consists of the following main equipment: 3 condensate pumps, 3 condensate booster pumps, 2 Turbine Driven RFW pumps, 4 steam lines, 2 steam jet air ejectors, 3 Circulating Water pumps, and hotwell makeup from the CST.

8. CGS has 4 turbine bypass valves (TBVs) with a capacity of 25%. The battery duration on an SBO is 3 hours without load shedding and 6 hours with load shed.

9. The CN system (containment N_2 inerting) supplies N_2 to the CIA system and its accumulators but CN itself is not safety related.

10. The CIA system supplies N_2 to containment components (such as the SRVs and the inboard MSIVs).

11. The standby service water (SW) system has a loop A and a loop B pump, and a HPCS SW pump. The SW B header can be cross-tied to the discharge of the B RHR heat exchanger for injection to the reactor.

12. There are three safety related DC systems at CGS: 24 VDC (Div. 1 & 2) for instrumentation; 125 VDC (Div. 1, 2, & 3) for emergency AC and for ESF systems; and 250 VDC (one division) for RCIC, the main turbine, & reactor feedwater.

13. RHR can provide suppression pool cooling (SPC), containment spray cooling (CSC) to the drywell, and CSC to the suppression pool.

14. The CSTS can provide injection water from the CST for RCIC, HPCS, & RHR.

15. Systems not credited: Fire protection water can be cross-tied to the suction of condensate pump 2A, but no credit is taken in the IPE due to timing constraints. No credit is taken in the IPE for CRD pump injection. The SDC mode of RHR is not credited in the IPE.

16. The RBEC system (also called (RHVAC) is only used in emergencies, and supplies cooling to 14 rooms housing critical equipment, including: RHR, LPCS, HPCS, RCIC, and AC & DC electrical MCCs.

17. For containment venting CGS uses the 24" containment purge lines. They can vent from the drywell or the suppression pool through the 24" butterfly isolation valves.

1.3 SDP WORKSHEETS

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

1. Transients (Reactor Trip) (TRANS)
2. Transients without PCS (TPCS)
3. Small LOCA (SLOCA)
4. Inadvertent or Stuck Open Relief Valve (SORV)
5. Medium LOCA (MLOCA)
6. Large LOCA (LLOCA)
7. Loss of Offsite Power (LOOP)
8. Anticipated Transients without Scram (ATWS)
9. Loss of 125 VDC, Division 1 (LODC1)
10. Loss of 125 VDC, Division 2 (LODC2)
11. Loss of Turbine Service Water (LOSW)
12. ISLOCA and LOCA Outside Containment (LOC)

Table 3.1 SDP Worksheet for Columbia Generating Station — Transients (Reactor Trip) (TRANS)

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Power Conversion System (PCS)	1/3 condensate pumps, 1/3 condensate booster pumps, 1/2 TD-RFW pumps, 1/4 steam lines, 1/2 steam jet air ejectors, 1/3 CW pump, and/or hotwell makeup from CST (operator action = 3)
High Pressure Core Spray (HPCS)	HPCS (1 single train)
Reactor Core Isolation Cooling (RCIC)	RCIC (1 ASD train)
Depressurization (DEP)	3/7 ADS valves manually opened (operator action = 3)
Low Pressure Injection (LPI)	1/3 RHR pumps in 1/3 trains in LPCI mode (1 multi-train system) or 1/1 LPCS pump in 1/1 train (1 single train)
Containment Heat Removal (CHR)	1/2 RHR pumps and 1/2 HXs in 1/2 trains in SPC mode (1 multi-train system)
Containment Venting (CV)	Containment venting from wetwell or drywell (operator action = 1)
Late Depressurization and Injection (LDEP)	3/7 ADS valves manually opened and the B SW pump cross-tied to the B RHR loop for injection to reactor vessel (operator action = 1)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 TRANS - PCS - CHR - CV (4, 8,11)			
2 TRANS - PCS - HPCS - CHR - LDEP (7)			
3 TRANS - PCS - HPCS - RCIC - LPI (12)			
4 TRANS - PCS - HPCS - RCIC - DEP (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.

<u>Notes</u>:

(1) The CGS PSA HEP for use of RFW following a turbine trip in 5 E-3. CGS also models recovery of PCS for use in CHR. We have captured all use of PCS in the PCS function in this worksheet.

(2) As with other BWR-5 and BWR-6 plants, we have credited CGS with having the capability for HPCS, LPCS, and LPCI to pump and inject saturated water from the SP. We have not credited RCIC with the capability to do this. Thus, we have split the HPI function into HPCS and RCIC.

(3) The PSA HEP for DEP (non-ATWS) is 1.7 E-4.

(4) The PSA HEP for CV is 6 E-2, therefore we have applied a credit of 1 for this operator action.

(5) Because RCIC cannot pump saturated water, after a successful CV, late DEP and injection is necessary. CGS models the SW crosstie to RHR injection with LPI rather than with late injection (LI) as is more common. We have credited this in LI, as with other BWRs in the inspection notebooks. The PSA HEP for SW cross-tie to RHR loop B is 0.1.

Table 3.2 SDP Worksheet for Columbia Generating Station — Transients without PCS (TPCS)

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

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
High Pressure Core Spray (HPCS)	HPCS (1 single train)
Reactor Core Isolation Cooling (RCIC)	RCIC (1 ASD train)
Depressurization (DEP)	3/7 ADS valves manually opened (operator action = 3)
Low Pressure Injection (LPI)	1/3 RHR pumps in 1/3 trains in LPCI mode (1 multi-train system) or 1/1 LPCS pump in 1/1 train (1 single train)
Containment Heat Removal (CHR)	1/2 RHR pumps and 1/2 HXs in 1/2 trains in SPC mode (1 multi-train system)
Containment Venting (CV)	Containment venting from wetwell or drywell (operator action = 1)
Late Depressurization and Injection (LDEP)	3/7 ADS valves manually opened and the B SW pump cross-tied to the B RHR loop for injection to reactor vessel (operator action = 1)

Circle Affected Functions	Recovery of Failed Train	Remaining Mitigation Capability Rating for Each Affected Sequence	Sequence Color
1 TPCS - CHR - CV (3, 7,10)			
2 TPCS - HPCS - CHR - LDEP (6)			
3 TPCS - HPCS - RCIC - LPI (11)			
4 TPCS - HPCS - RCIC - DEP (12)			

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

<u>Notes</u>:

(1) This event tree and worksheet is for Transient (without PCS). It includes MSIV closure, Loss of FW, and loss of main condenser. Additionally, loss of containment instrument air (CIA) or loss of containment nitrogen (CN) can also be evaluated using this worksheet. A loss of these systems causes the inboard MSIVs to close and a loss of some capability of the ADS (however, local accumulators still permit operation of ADS). It is assumed that no aspects of the PCS are available for safety functions during the transients evaluated in this event tree and worksheet. In the PSA MSIV closure constitutes 9.3% of CDF, turbine trip 7.7%, loss of condenser 3.7%, loss of RFW 3.5% for a total TPCS contribution of about 25%.

(2) The PSA HEP for DEP (non-ATWS) is 1.7 E-4.

(3) As with other BWR-5 and BWR-6 plants, we have credited CGS with having the capability for HPCS, LPCS, and LPCI to pump and inject saturated water from the SP. We have not credited RCIC with the capability to do this. Thus, we have split the HPI function into HPCS and RCIC.

(4) The PSA HEP for CV is 6 E-2, therefore we have applied a credit of 1 for this operator action.

(5) Because RCIC cannot pump saturated water, after a successful CV, late DEP and injection is necessary. CGS models the SW crosstie to RHR injection with LPI rather than with late injection (LI) as is more common. We have credited this in LI, as with other BWRs in the inspection notebooks. The PSA HEP for SW cross-tie to RHR loop B is 0.1.

Table 3.3 SDP Worksheet for Columbia Generating Station — Small LOCA (SLOCA)

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Power Conversion System (PCS)	1/3 condensate pumps, 1/3 condensate booster pumps, 1/2 TD-RFW pumps, 1/4 steam lines, 1/2 steam jet air ejectors, 1/3 CW pump, and/or hotwell makeup from CST (operator action = 2)
High Pressure Core Spray (HPCS)	HPCS (1 single train)
Reactor Core Isolation Cooling (RCIC)	RCIC (1 ASD train)
Depressurization (DEP)	3/7 ADS valves manually opened (operator action = 3)
Low Pressure Injection (LPI)	1/3 RHR pumps in 1/3 trains in LPCI mode (1 multi-train system) or 1/1 LPCS pump in 1/1 train (1 single train)
Containment Heat Removal (CHR)	1/2 RHR pumps and 1/2 HXs in 1/2 trains in SPC mode (1 multi-train system)
Containment Venting (CV)	Containment venting from wetwell or drywell (operator action = 1)
Late Depressurization and Injection (LDEP)	3/7 ADS valves manually opened and the B SW pump cross-tied to the B RHR loop for injection to reactor vessel (operator action = 1)

Circle Affected Functions	**Recovery or Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 SLOCA - PCS - CHR - CV (4, 8,11)			
2 SLOCA - PCS - HPCS - CHR - LDEP (7)			
3 SLOCA - PCS - HPCS - RCIC - LPI (12)			
4 SLOCA - PCS - HPCS - RCIC - DEP (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.

<u>Notes</u>:

(1) An SLOCA in the CGS IPE is a break for diameter between one inch and four inches.

(2) The CGS PSA HEP for use of RFW following a turbine trip in 5 E-3. CGS also models recovery of PCS for use in CHR. We have captured all use of PCS in the PCS function in this worksheet.

(3) As with other BWR-5 and BWR-6 plants, we have credited CGS with having the capability for HPCS, LPCS, and LPCI to pump and inject saturated water from the SP. We have not credited RCIC with the capability to do this. Thus, we have split the HPI function into HPCS and RCIC.

(4) The PSA HEP for DEP (non-ATWS) is 1.7 E-4.

(5) The PSA HEP for CV is 6 E-2, therefore we have applied a credit of 1 for this operator action.

(6) Because RCIC cannot pump saturated water, after a successful CV, late DEP and injection is necessary. CGS models the SW crosstie to RHR injection with LPI rather than with late injection (LI) as is more common. We have credited this in LI, as with other BWRs in the inspection notebooks. The PSA HEP for SW cross-tie to RHR loop B is 0.1.

Table 3.4 SDP Worksheet for Columbia Generating Station — Inadvertent or Stuck Open Relief Valve (SORV)

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

<u>Safety Functions Needed</u>:	<u>Full Creditable Mitigation Capability for Each Safety Function:</u>
Power Conversion System (PCS)	1/3 condensate pumps, 1/3 booster pumps, 1/2 RFW pumps, 1/4 steam lines, 1/2 steam jet air ejectors, 1/3 CW pump, hotwell makeup from CST (operator action = 2)
High Pressure Core Spray (HPCS)	HPCS (1 single train)
Reactor Core Isolation Cooling (RCIC)	RCIC (1 ASD train)
Depressurization (DEP)	3/7 ADS valves manually opened (operator action = 3)
Low Pressure Injection (LPI)	1/3 RHR pumps in 1/3 trains in LPCI mode (1 multi-train system) or 1/1 LPCS pump in 1/1 train (1 single train)
Containment Heat Removal (CHR)	1/2 RHR pumps and 1/2 HXs in 1/2 trains in SPC mode (1 multi-train system)
Containment Venting (CV)	Containment venting from wetwell or drywell (operator action = 1)
Late Depressurization and Injection (LDEP)	3/7 ADS valves manually opened and the B SW pump cross-tied to the B RHR loop for injection to reactor vessel (operator action = 1)

<u>Circle Affected Functions</u>	<u>Recovery or Failed Train</u>	<u>Remaining Mitigation Capability Rating for Each Affected Sequence</u>	<u>Sequence Color</u>
1 SORV - PCS - CHR - CV (4, 8,11)			
2 SORV - PCS - HPCS - CHR - LDEP (7)			
3 SORV - PCS - HPCS - RCIC - LPI (12)			
4 SORV - PCS - HPCS - RCIC - DEP (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) An inadvertent or stuck open relief valve (SORV) at CGS is evaluated very similarly to the SLOCA and using a similar event tree.

(2) The CGS PSA HEP for use of RFW following a turbine trip is 5 E-3. CGS also models recovery of PCS for use in CHR. We have captured all use of PCS in the PCS function in this worksheet.

(3) As with other BWR-5 and BWR-6 plants, we have credited CGS with having the capability for HPCS, LPCS, and LPCI to pump and inject saturated water from the SP. We have not credited RCIC with the capability to do this. Thus, we have split the HPI function into HPCS and RCIC.

(4) The PSA HEP for DEP (non-ATWS) is 1.7 E-4.

(5) The PSA HEP for CV is 6 E-2, therefore we have applied a credit of 1 for this operator action.

(6) Because RCIC cannot pump saturated water, after a successful CV, late DEP and injection is necessary. CGS models the SW crosstie to RHR injection with LPI rather than with late injection (LI) as is more common. We have credited this in LI, as with other BWRs in the inspection notebooks. The PSA HEP for SW cross-tie to RHR loop B is 0.1.

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

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>
Early Containment Control (EC)	Passive operation of SP, 1 of 2 vacuum breakers in 9 of 9 lines remain closed and drywell floor seal intact (1 multi-train system)
High Pressure Core Spray (HPCS)	HPCS (1 single train)
Depressurization (DEP)	2/7 ADS valves manually opened (operator action = 3)
Low Pressure Injection (LPI)	1/3 RHR pumps in 1/3 trains in LPCI mode (1 multi-train system); or 1/1 LPCS pump in 1/1 train (1 single train); or 1/3 condensate pumps injecting in 1/2 trains (operator action = 2); or B SW pump cross-tied to the B RHR loop for injection to reactor vessel (operator action = 1)
Containment Heat Removal (CHR)	1/2 RHR pumps and 1/2 HXs in 1/2 trains in SPC mode (1 multi-train system)
Containment Venting (CV)	Containment venting from wetwell or drywell (operator action = 1)

<u>**Circle Affected Functions**</u>	<u>**Recovery or Failed Train**</u>	<u>**Remaining Mitigation Capability Rating for Each Affected Sequence**</u>	<u>**Sequence Color**</u>
1 MLOCA - CHR - CV (3, 6)			
2 MLOCA - HPCS - LPI (7)			
3 MLOCA - HPCS - DEP (8)			
4 MLOCA - EC (9)			

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

Notes:

(1) An MLOCA in the CGS IPE is a break for diameter between four inches and six inches.

(2) EC is not in the CGS MLOCA ET, but we assume that it will be the same as the generic BWR MLOCA and as the CGS LLOCA. Therefore it is kept here.

(3) As with other BWR-5 and BWR-6 plants, we have credited CGS with having the capability for HPCS, LPCS, and LPCI to pump and inject saturated water from the SP. RCIC is not credited for an MLOCA at CGS.

(4) The PSA HEP for DEP (non-ATWS) is 1.7 E-4.

(5) The PSA HEP for CV is 6 E-2, therefore we have applied a credit of 1 for this operator action.

(6) The PSA HEP for SW cross-tie to RHR loop B is 0.1.

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

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Early Containment Control (EC)	Passive operation of SP, 1 of 2 vacuum breakers in 9 of 9 lines remain closed and drywell floor seal intact (1 multi-train system)
Low Pressure Injection (LPI)	1/3 RHR pumps in 1/3 trains in LPCI mode (1 multi-train system) or 1/1 LPCS pump in 1/1 train (1 single train) or HPCS pump (1 single train)
Containment Heat Removal (CHR)	1/2 RHR pumps and 1/2 HXs in 1/2 trains in SPC mode (1 multi-train system)
Containment Venting (CV)	Containment venting from wetwell or drywell (operator action = 1)

Circle Affected Functions	**Recovery or Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 LLOCA - CHR - CV (3)			
2 LLOCA - LPI (4)			
3 LLOCA - EC (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) A LLOCA in the CGS IPE is a break diameter greater than six inches.

(2) As with other BWR-5 and BWR-6 plants, we have credited CGS with having the capability for HPCS, LPCS, and LPCI to pump and inject saturated water from the SP. RCIC is not credited for a LLOCA at CGS.

(3) The PSA HEP for CV is 6 E-2, therefore we have applied a credit of 1 for this operator action.

(4) CGS also separately models steamline break outside of containment as a slightly different LLOCA ET.

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

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Emergency Power (EAC)	1/2 EDGs (1 multi-train system)
Recovery of LOOP in 30 mins (RLOOP30M)	No credit
Recovery of LOOP in 3 hours (RLOOP3H)	Recovery of either offsite power or EAC in 3 hours (operator action = 1)
Recovery of LOOP in 6 hours (RLOOP6H)	Recovery of either offsite power or EAC in 6 hours (operator action = 1)
Recovery of LOOP in 24 hours (RLOOP24H)	Recovery of either offsite power or EAC in 24 hours (operator action = 2)
High Pressure Core Spray (HPCS)	HPCS (1 single train)
Reactor Core Isolation Cooling (RCIC)	RCIC (1 ASD train)
DC Load Shed (DC)	Load shed of non-essential DC loads and open doors to RCIC room for ventilation (operator action = 2)
Depressurization (DEP)	3/7 ADS valves manually opened (operator action = 3)
Low Pressure Injection (LPI)	1/3 RHR pumps in 1/3 trains in LPCI mode (1 multi-train system) or 1/1 LPCS pump in 1/1 train (1 single train)
Containment Heat Removal (CHR)	1/2 RHR pumps and 1/2 HXs in 1/2 trains in SPC mode (1 multi-train system)
Containment Venting (CV)	Containment venting from wetwell or drywell (operator action = 1)
Late Depressurization and Injection (LDEP)	3/7 ADS valves manually opened and the B SW pump cross-tied to the B RHR loop for injection to reactor vessel (operator action = 1)

Circle Affected Functions	**Recovery or Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1LOOP - CHR - CV (1, 2, 5, 10, 15)			
2 LOOP - HPCS - CHR - LDEP (1, 2, 9, 14)			
3 LOOP - HPCS - RCIC - LPI (1, 2)			

4 LOOP - HPCS - RCIC - DEP (1, 2)			
5 LOOP - EAC - RLOOP24H (6)			
6 LOOP - EAC - HPCS - RLOOP6H (11)			
7 LOOP - EAC - HPCS - DC - RLOOP3H (16)			
8 LOOP - EAC - RLOOP30 M - HPCS - RCIC (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. In the PSA SBO is 48.9% of internal events CDF. Non-SBO LOOP accounts for 4.4%.

2. CGS models recovery of Off-Site Power (OSP) at several times: 30 minutes, 3 hours, 6 hours, and 24 hours. For the SBO case, the 30 min. time is important on failure of all HPI. The 3 hour time is important for RCIC operation due to battery depletion. This occurs on an SBO with failure of HPCS and initial operation of RCIC. If DC loads are successfully shed, and the RCIC room doors opened for ventilation, then this time is extended to 6 hours. The CGS PSA event tree shows that the plant can last 24 hours on an SBO with successful HPCS. They require recovery of OSP within 24 hours, if HPCS is successful.

3. The CGS PSA event tree models recovery of both offsite power and EAC at different times. We have simplified the ET by combining these into one event, and have included the recovery of either in our definition of RLOOP above. Successful recovery of offsite power or EAC (RLOOP) at CGS is a human action quantified as follows:
   The PSA HEP for RLOOP in 30 min is 0.61
   The PSA HEP for RLOOP in 3 hours is 0.28
   The PSA HEP for RLOOP in 6 hours is 0.11
   The PSA HEP for RLOOP in 24 hours is 0.022

4. If HPCS fails and we depend on RCIC for HPI, then RCIC can last 3 hours without DC load shedding and 6 hours with successful load shedding. The PRA HEP for shedding DC loads from 250 VDC is 1 E-2.

5. CGS takes credit for recovery/use of the PCS and turbine bypass for CHR purposes late in LOOP sequences, but the NRC generically does not credit PCS for LOOP scenarios in the inspection notebooks.

6. Because RCIC cannot pump saturated water, after a successful CV, late DEP and injection is necessary. CGS models the SW crosstie to RHR injection with LPI rather than with late injection (LI) as is more common. We have credited this in LI, as with other BWRs in the inspection notebooks. The PSA HEP for SW cross-tie to RHR loop B is 0.1.

Table 3.8 SDP Worksheet for Columbia Generating Station — Anticipated Transients without Scram (ATWS)

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Overpressure Protection (OVERP)	17/18 SRVs (1 multi-train system)
Recirculation Pump Trip (RPT)	Manual or automatic trip of recirculation pumps (1 multi-train system)
Reactivity Control (SLC)	Initiate 2/2 SLC pumps (operator action = 1)
Inhibit ADS & Level Control (INH/LC)	Operator inhibits ADS and controls RV level at the top of the active fuel (TAF) (operator action = 1)
High Pressure Core Spray (HPCS)	HPCS (1 single train)
Depressurization (DEP)	3/7 ADS valves manually opened (operator action = 3)
Low Pressure Injection (LPI)	1/3 RHR pumps in 1/3 trains in LPCI mode (1 multi-train system); or 1/1 LPCS pump in 1/1 train (1 single train); or B SW pump cross-tied to the B RHR loop for injection to reactor vessel (operator action = 1)
Containment Heat Removal (CHR)	1/2 RHR pumps and 1/2 HXs in 1/2 trains in SPC mode (1 multi-train system)
Containment Venting (CV)	Containment venting from wetwell or drywell (operator action = 1)

Circle Affected Functions	**Recovery or Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 ATWS - CHR - CV (3, 6)			
2 ATWS - HPCS - LPI (7)			
3 ATWS - HPCS - DEP (8)			
4 ATWS - SLC (9)			

5 ATWS - INH/LC (10)			
6 ATWS - RPT (11)			
7 ATWS - OVERP (12)			

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

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

Notes:

(1) In this worksheet we have combined the ATWS initiator with failure of Alternate Rod Insertion (ARI) and Manual Rod Insertion (MRI). Also, this worksheet conservatively assumes that a loss of PCS transient (e.g., MSIV closure) initiated the ATWS. Therefore, due to these generic NRC assumptions, no credit should be given to the PCS in evaluating findings on this worksheet. In the PSA ATWS constitutes 2% of internal events CDF.

(2) For an ATWS from <25% power, turbine bypass can mitigate the event without SLC (In CGS the TB capacity is 25%). For any MSIV closure ATWS, SLC is required to prevent CD.

(3) In the IPE level control low is modeled with Inhibit (INH). In the PSA this action has a failure probability of 9.4 E-2 for MSIV closure scenarios and 4 E-3 for non-MSIV closure.

(4) In PSA the HEP for the action to initiate SLC (on MSIV closure scenarios) is given as 9 E-2. This must occur within 20 minutes per the IPE.

(5) In the IPE, some credit is given for the use of RCIC for HPI. However, most BWRs have found that RCIC does not have sufficient flow rate for an ATWS scenario. Further, in the ATWS event tree for CGS, they credit failure of CHR (but successful CV, with no LI). If RCIC is the HPI source, this would also not seem possible, since RCIC cannot typically pump saturated water. Because of these questions, we have not credited RCIC for HPI here. With sufficient justification, such credit may later be provided.

(6) In the IPE the HEP for injecting with HPI after SLC injection and restoring RV level is given as negligible.

(7) In the PSA the HEP for operator failure to depressurize the RPV during an ATWS is 3E-4.

(8) On an ATWS, CGS credits CV as able to compensate for loss of CHR.

Table 3.9 SDP Worksheet for Columbia Generating Station — Loss of 125 VDC, Division 1 (LODC1)

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
High Pressure Core Spray (HPCS)	HPCS (1 single train)
Reactor Core Isolation Cooling (RCIC)	RCIC lost on LODC1
Depressurization (DEP)	3/7 ADS valves manually opened (operator action = 3)
Low Pressure Injection (LPI)	1/2 RHR pumps in 1/2 trains in LPCI mode (1 multi-train system)
Containment Heat Removal (CHR)	1/1 RHR pump and 1/1 HX in 1/1 train in SPC mode plus 1/2 SW pump (1 single train)
Containment Venting (CV)	Containment venting from wetwell or drywell (operator action = 1)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 LODC1 - CHR - CV (3, 6)			
2 LODC1 - HPCS - LPI (7)			
3 LODC1 - HPCS - DEP (8)			

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

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

Notes:

(1) There are three safety related DC systems at CGS: 24 VDC (Div. 1 & 2) for instrumentation; 125 VDC (Div. 1, 2, & 3) for emergency AC and for ESF systems; and 250 VDC (one division) for RCIC, the main turbine, & reactor feedwater. This worksheet represents loss of Div. 1 of the 125 VDC system. This initiator constitutes 0.8% of internal events core damage frequency in the PSA.

(2) Loss of Div. 1 of 125 VDC causes a loss of control power to: RCIC, LPCS, RHR/LPCI pump A, division 1 of the turbine service water (TSW) system, and 1 of 2 channels of the ADS/SRVs. TSW cools the RFW turbine oil coolers, the condensate pumps, the condensate booster pump lube oil coolers, the circulating water pump, and the mechanical vacuum pump. Thus, loss of DC has the potential to cause loss of TSW, loss of PCS, and a reactor scram. The IPE assumes that the loss of DC does cause these effects. Hence, we have made the same assumptions and have adapted the TPCS worksheet and event tree for use in LODC.

(3) On a loss of Div. 1 or 2 of 125 VDC, the CGS technical specifications require that the bus be re-energized within 2 hours or be in hot shutdown in 12 hours and cold shutdown in the following 24 hours.

(4) The PSA HEP for DEP (non-ATWS) is 1.7 E-4.

(5) As with other BWR-5 and BWR-6 plants, we have credited CGS with having the capability for HPCS, LPCS, and LPCI to pump and inject saturated water from the SP. We have not credited RCIC with the capability to do this. Thus, we have split the HPI function into HPCS and RCIC.

(6) The PSA HEP for CV is 6 E-2, therefore we have applied a credit of 1 for this operator action.

Table 3.10 SDP Worksheet for Columbia Generating Station — Loss of 125 VDC, Division 2 (LODC2)

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>**
High Pressure Core Spray (HPCS)	HPCS (1 single train)
Reactor Core Isolation Cooling (RCIC)	RCIC (1 ASD train)
Depressurization (DEP)	3/7 ADS valves manually opened (operator action = 3)
Low Pressure Injection (LPI)	1/1 RHR pumps in 1/1 trains in LPCI mode (1 single train) or 1/1 LPCS pump in 1/1 train (1 single train)
Containment Heat Removal (CHR)	1/1 RHR pump and 1/1 HX in 1/1 train in SPC mode plus 1/2 SW pump (1 single train)
Containment Venting (CV)	Containment venting from wetwell or drywell (operator action = 1)
Late Depressurization and Injection (LDEP)	3/7 ADS valves manually opened and [1/1 RHR pump in 1/1 train in LPCI mode; or 1/1 LPCS pump in 1/1 train] (operator action = 2)

<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 LODC2 - CHR - CV (3, 7,10)			
2 LODC2 - HPCS - CHR - LDEP (6)			
3 LODC2 - HPCS - RCIC - LPI (11)			
4 LODC2 - HPCS - RCIC - DEP (12)			

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

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

<u>Notes</u>:

(1) There are three safety related DC systems at CGS: 24 VDC (Div. 1 & 2) for instrumentation; 125 VDC (Div. 1, 2, & 3) for emergency AC and for ESF systems; and 250 VDC (one division) for RCIC, the main turbine, & reactor feedwater. This worksheet represents loss of Div. 2 of the 125 VDC system. This initiator constitutes 1.1% of internal events core damage frequency in the PSA.

(2) Loss of Div. 2 of 125 VDC causes a loss of control power to: RHR/LPCI pumps B & C, division 2 of the turbine service water (TSW) system and standby service water (SW) system , and 1 of 2 channels of the ADS/SRVs. TSW cools the RFW turbine oil coolers, the condensate pumps, the condensate booster pump lube oil coolers, the circulating water pump, and the mechanical vacuum pump. Thus, loss of DC has the potential to cause loss of TSW, loss of PCS, and a reactor scram. The IPE assumes that the loss of DC does cause these effects. Hence, we have made the same assumptions and have adapted the TPCS worksheet and event tree for use in LODC.

(3) On a loss of Div. 1 or 2 of 125 VDC, the CGS technical specifications require that the bus be re-energized within 2 hours or be in hot shutdown in 12 hours and cold shutdown in the following 24 hours.

(4) The PSA HEP for DEP (non-ATWS) is 1.7 E-4.

(5) As with other BWR-5 and BWR-6 plants, we have credited CGS with having the capability for HPCS, LPCS, and LPCI to pump and inject saturated water from the SP. We have not credited RCIC with the capability to do this. Thus, we have split the HPI function into HPCS and RCIC.

(6) The PSA HEP for CV is 6 E-2, therefore we have applied a credit of 1 for this operator action.

Table 3.11 SDP Worksheet for Columbia Generating Station — Loss of Turbine Service Water (LOSW)

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
High Pressure Core Spray (HPCS)	HPCS (1 single train)
Reactor Core Isolation Cooling (RCIC)	RCIC (1 ASD train)
Depressurization (DEP)	3/7 ADS valves manually opened (operator action = 3)
Low Pressure Injection (LPI)	1/3 RHR pumps in 1/3 trains in LPCI mode (1 multi-train system) or 1/1 LPCS pump in 1/1 train (1 single train)
Containment Heat Removal (CHR)	1/2 RHR pumps and 1/2 HXs in 1/2 trains in SPC mode plus 1/2 standby SW pumps (1 multi-train system)
Containment Venting (CV)	No credit due to LOSW
Late Depressurization and Injection (LDEP)	3/7 ADS valves manually opened and the B standby SW pump cross-tied to the B RHR loop for injection to reactor vessel (operator action = 1)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 LOSW - CHR (2, 4, 6)			
2 LOSW - HPCS - RCIC - LPI (7)			
3 LOSW - HPCS - RCIC - DEP (8)			

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

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

Notes:

(1) The plant or turbine service water (TSW) system is different from the standby service water system. Loss of TSW causes a loss of cooling to: the Reactor Closed Cooling Water (RCC) System HXs (and hence a loss of the control and service air system), many PCS components (mechanical vacuum pumps, condensate pumps, condensate booster pumps, reactor feed water pump turbines, and circulating water pumps), air compressors, and hence CAS & CV. Therefore, the operators are directed to manually scram the reactor on a loss of TSW. Thus, this initiator is treated similarly to the TPCS initiator.

(2) The contribution to internal events CDF from loss of TSW is 0.3%.

(3) The PSA HEP for DEP (non-ATWS) is 1.7 E-4.

(4) As with other BWR-5 and BWR-6 plants, we have credited CGS with having the capability for HPCS, LPCS, and LPCI to pump and inject saturated water from the SP. We have not credited RCIC with the capability to do this. Thus, we have split the HPI function into HPCS and RCIC.

(5) The PSA HEP for CV is 6 E-2, therefore we have applied a credit of 1 for this operator action.

(6) Because RCIC cannot pump saturated water, after a successful CV, late DEP and injection is necessary. CGS models the SW crosstie to RHR injection with LPI rather than with late injection (LI) as is more common. We have credited this in LI, as with other BWRs in the inspection notebooks. The PSA HEP for SW cross-tie to RHR loop B is 0.1.

Table 3.12 SDP Worksheet for Columbia Generating Station — Interfacing System LOCA (ISLOCA) and LOCA Outside Containment (LOC)

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

Initiation Pathways:	**Mitigation Capability**: **Ensure Component Operability for Each Pathway**
ISLOCA PATHWAYS:	
LPCI Injection Lines	Three LPCI injection lines each with 1 testable check valve (RHR-V-41A, B, & C inside containment) and 1 NC MOV (RHR-V-42 A, B, & C outside containment)
Low Pressure Core Spray Injection Lines	One line with 1 testable check valve (LPCS-V-6 inside containment) and 1 NC MOV (LPCS-V-5 outside containment)
Shutdown cooling suction line	One line with two NC MOVs (RHR-V-9 inside containment and RHR-V-8 outside containment). Line then splits into three trains each with a NC MOV (RHR-V- 6A, 6B, or 67) leading to the three RHR pumps.
Shutdown cooling discharge line	Two shutdown cooling discharge lines each with 1 testable check valve (RHR-V-50 A, & B inside containment) and 1 NC MOV (RHR-V-53 A & B outside containment)
LOC PATHWAYS:	
RCIC steam Line	One line with two NO MOVs (one inside and one outside containment)
RWCU System Lines	Suction line, and 4" discharge line connecting to FW line upstream of 2 FW check valves
Feedwater Lines	Two 24" lines (A & B)each with two check valves (V-10A & V-10B inside containment and V-32A & V-32B outside containment) and a NO MOV (V-65A & V-65B outside containment)
Main Steam Lines	Four steam lines with 2 air-operated, fail-closed, MSIVs per line, closed automatically by the NS[4] system

Circle Affected Component in Pathways	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Pathway**	**Sequence Color**

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

Notes:

(1) The initiation pathways and the applicable components in the pathways are based on the IPE supplemented by generic insights based on NRC studies on ISLOCA

(2) This worksheet contains pathways for both ISLOCA and LOC. Licensees typically analyze these events separately.

(3) ISLOCA lines quantified in the Section 3.1.2.2.5 of the IPE are presented in the top half of the above table.

(4) The CGS IPE models a large LOCA outside containment in an ET and includes breaks in main steam, RFW, & RWCU. RCIC & HPCS breaks were considered to have a very low probability since they are standby systems.

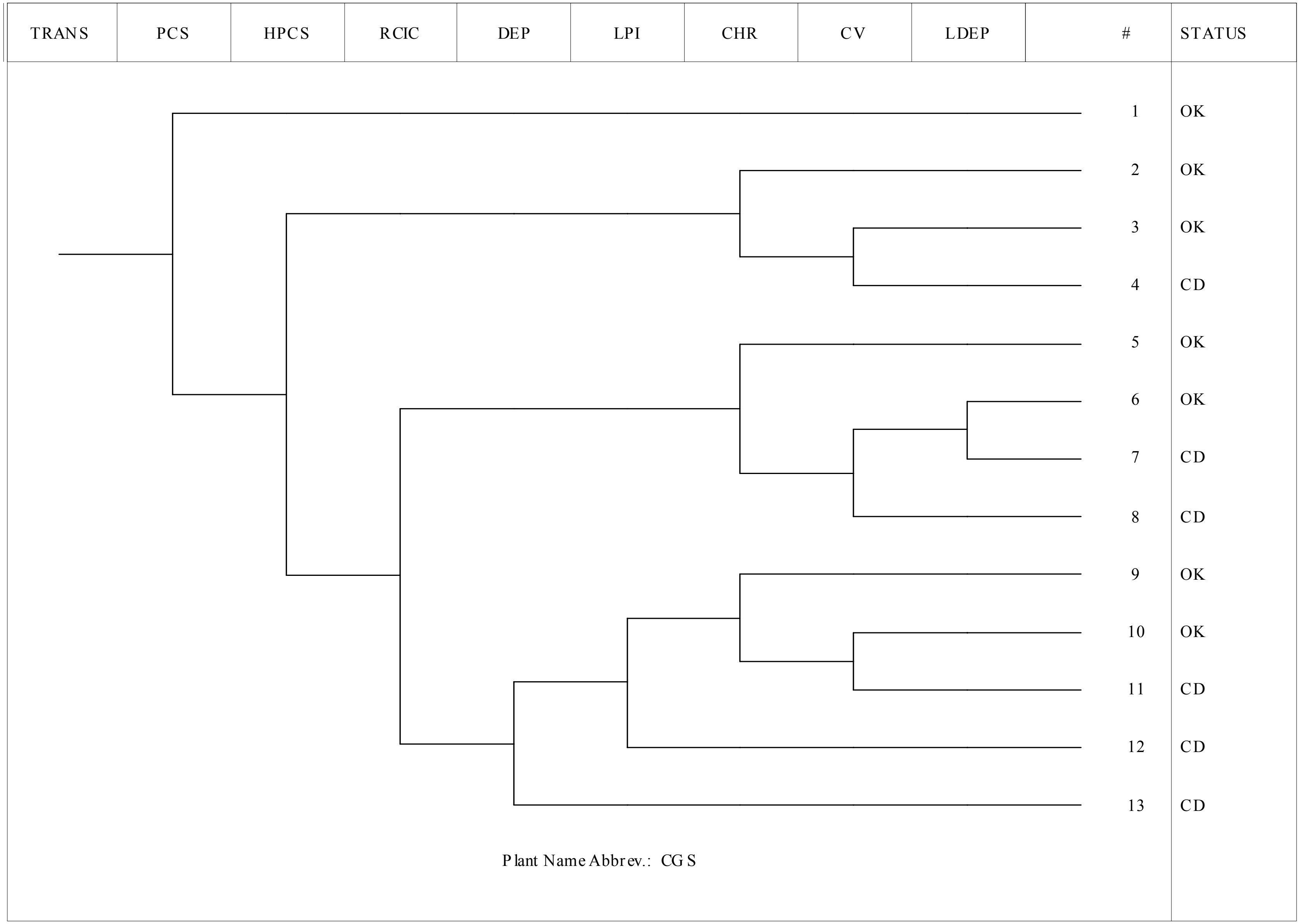
(5) This worksheet is different from the other worksheets, in that ISLOCA is typically an unmitigated initiating event in most PRAs. Therefore the right side of the worksheet contains valves, whose failure may lead to an ISLOCA or LOC rather than mitigating systems to address an event in progress. As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

1.4 SDP Event Trees

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

The following event trees are included:

1. Transients (Reactor Trip) (TRANS)
2. Transients without PCS (TPCS)
3. Small LOCA (SLOCA)
4. Inadvertent or Stuck Open Relief Valve (SORV)
5. Medium LOCA (MLOCA)
6. Large LOCA (LLOCA)
7. Loss of Offsite Power (LOOP)
8. Anticipated Transients without Scram (ATWS)
9. Loss of 125 VDC, Division 2 (LODC2)
10. Loss of 125 VDC, Division 1 (LODC1)
11. Loss of Turbine Service Water (LOSW)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RCIC
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LPI
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CV
LDEP
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12 CD
13 CD
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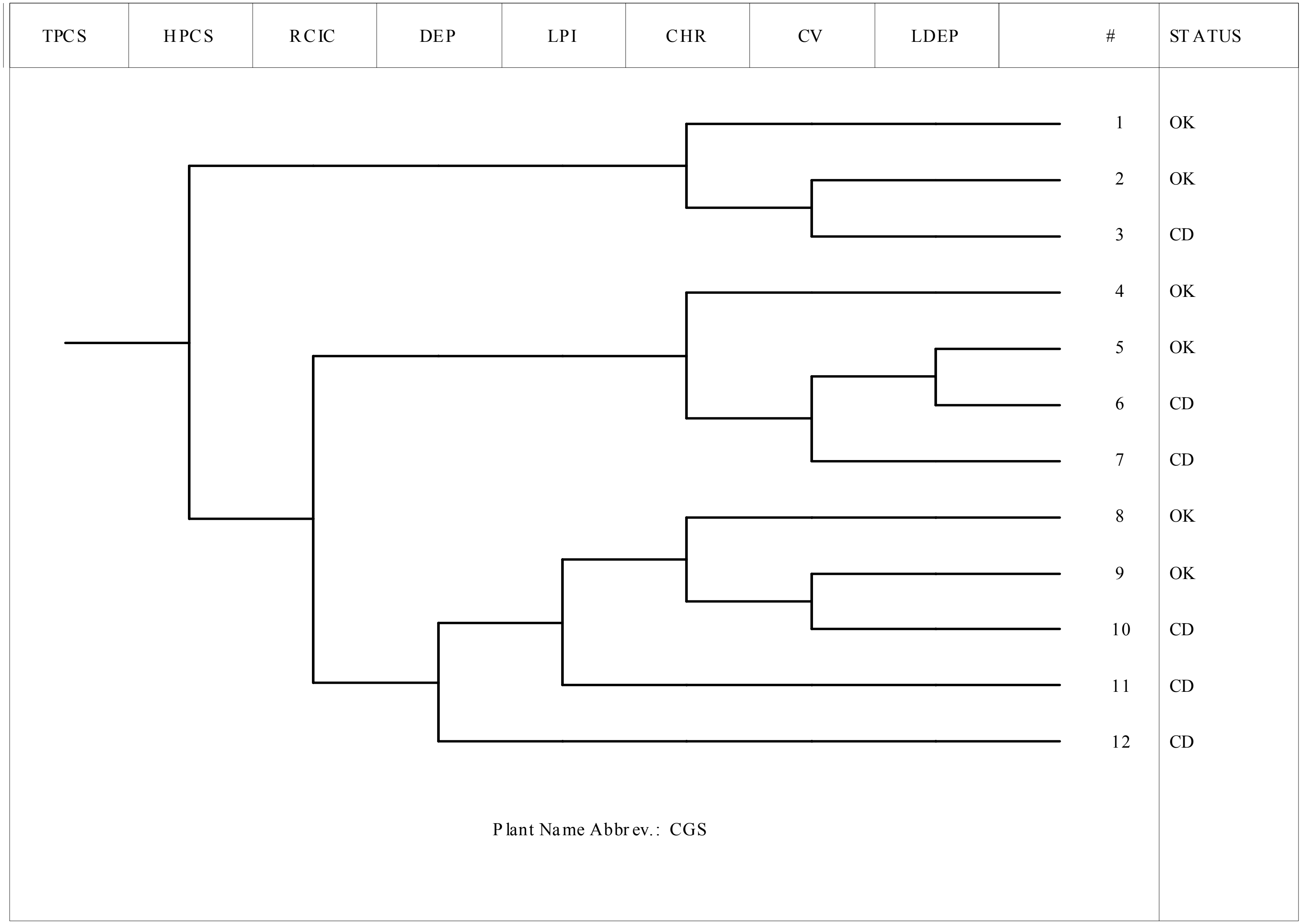
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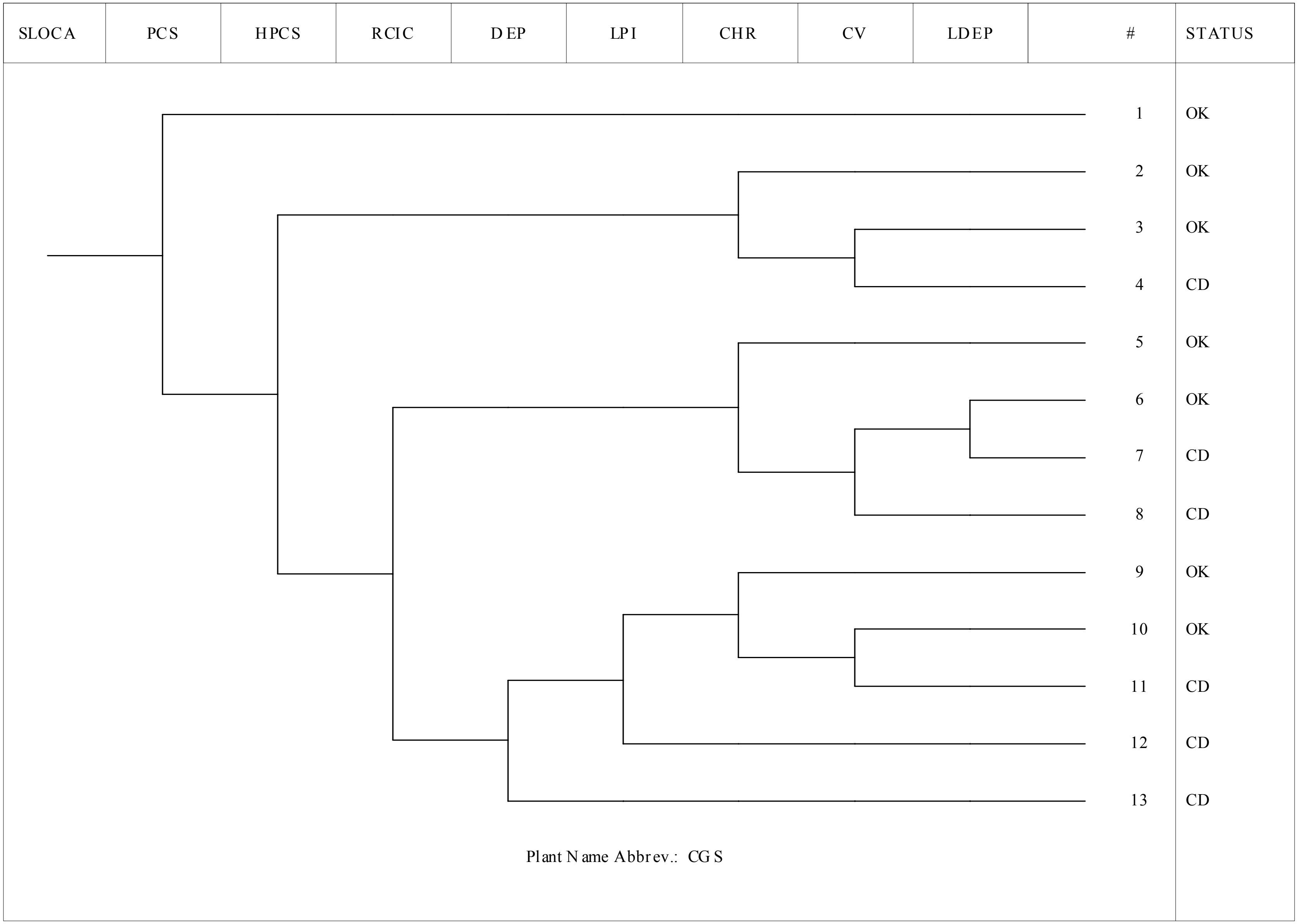
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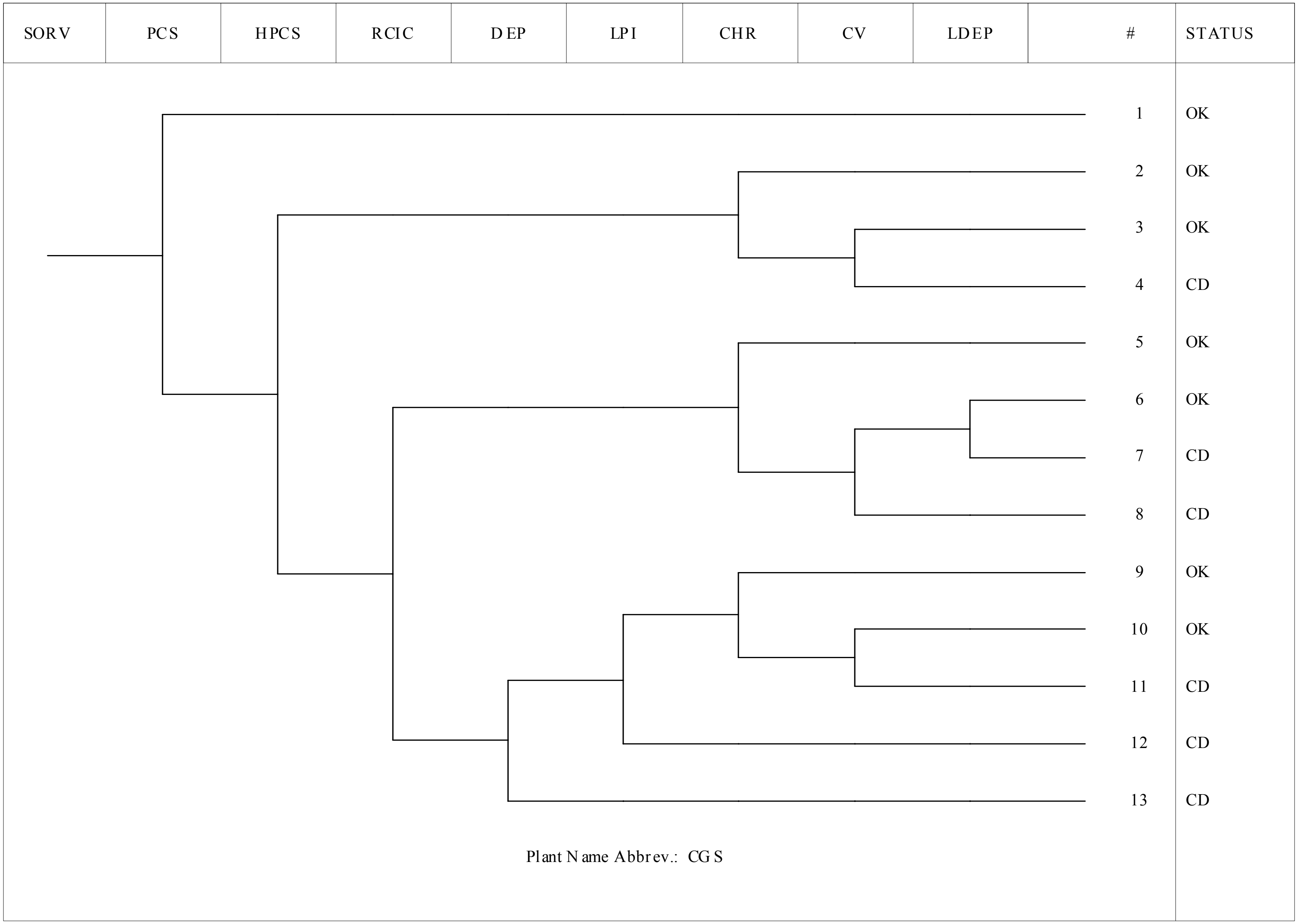
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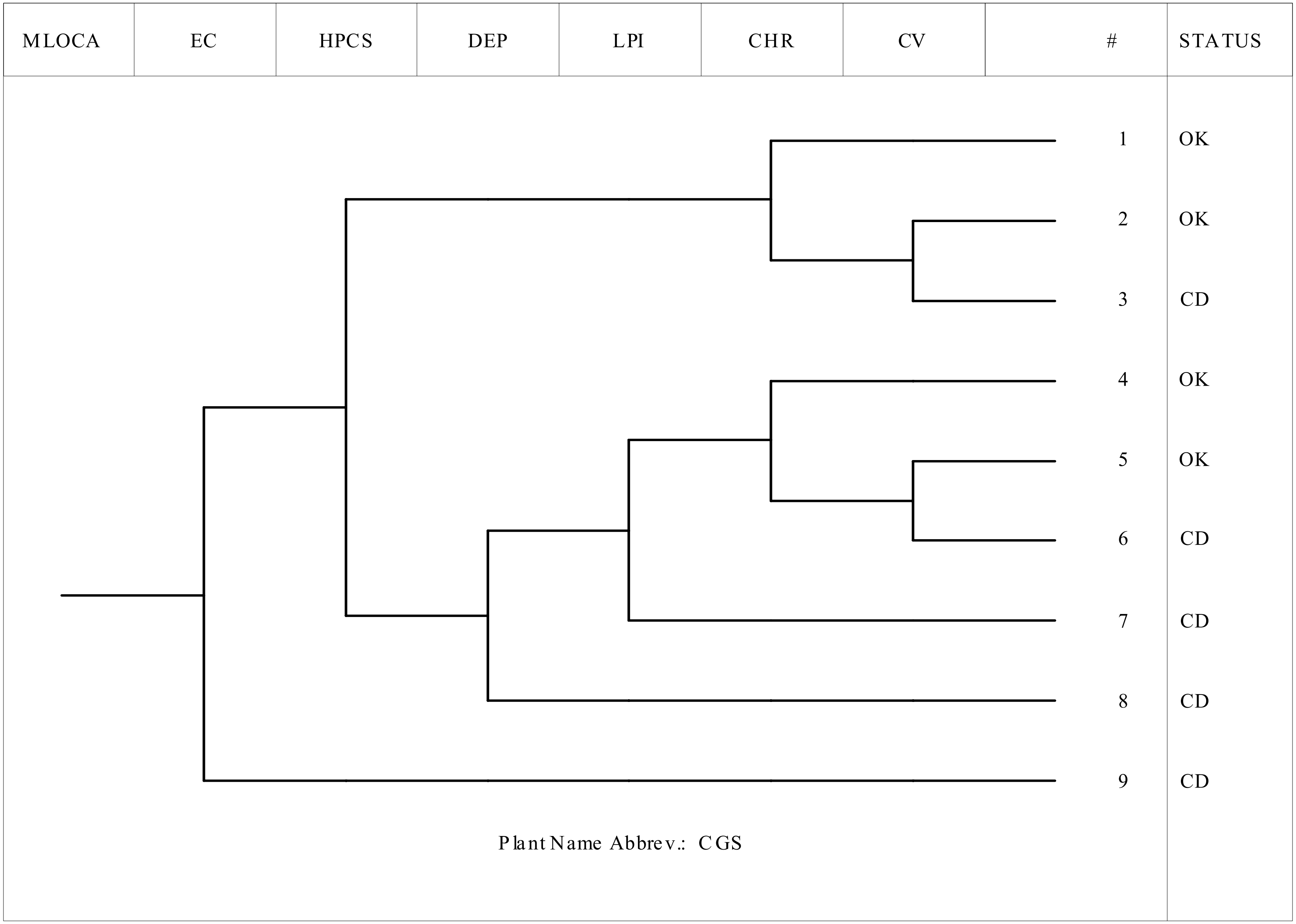
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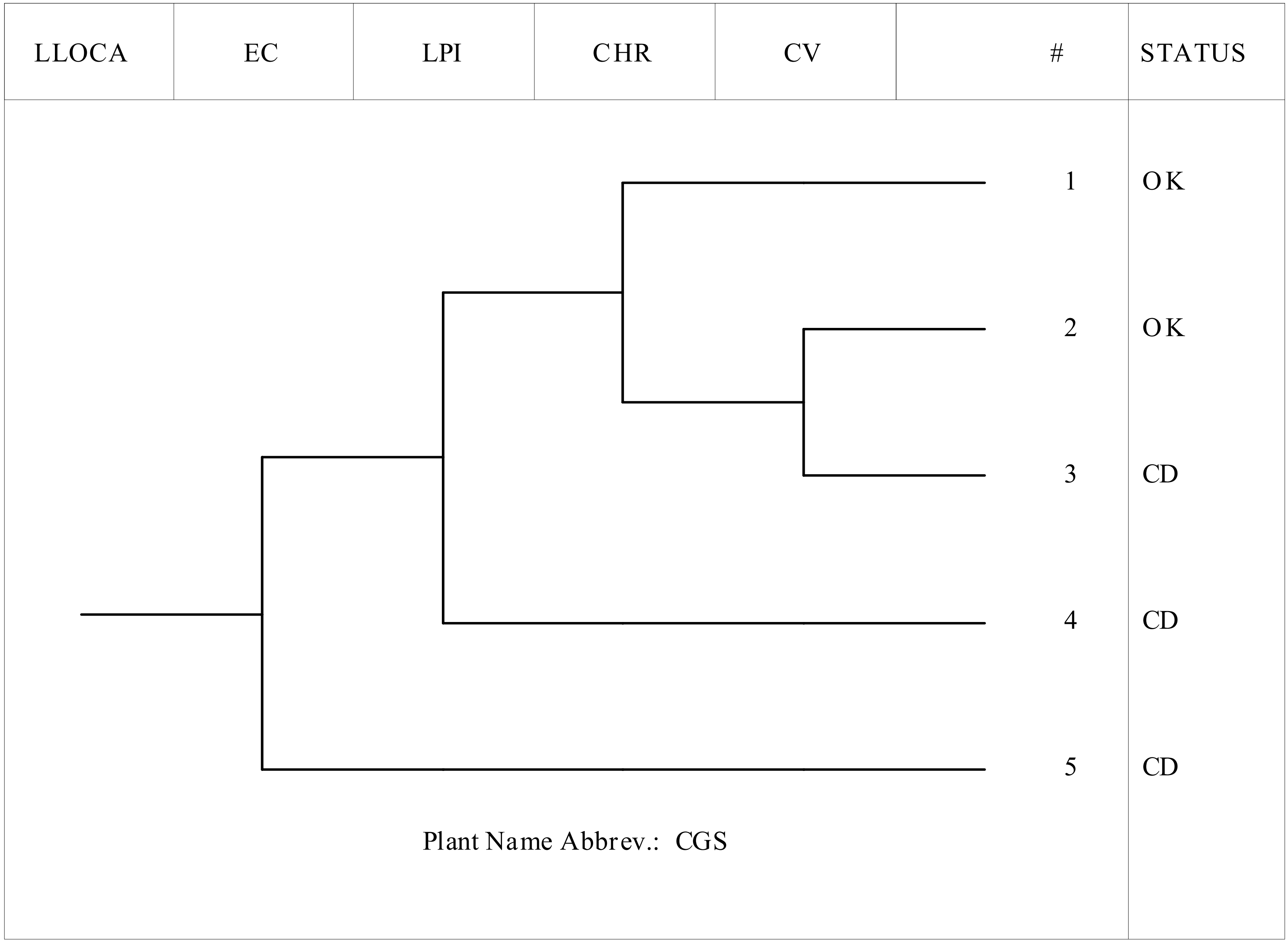
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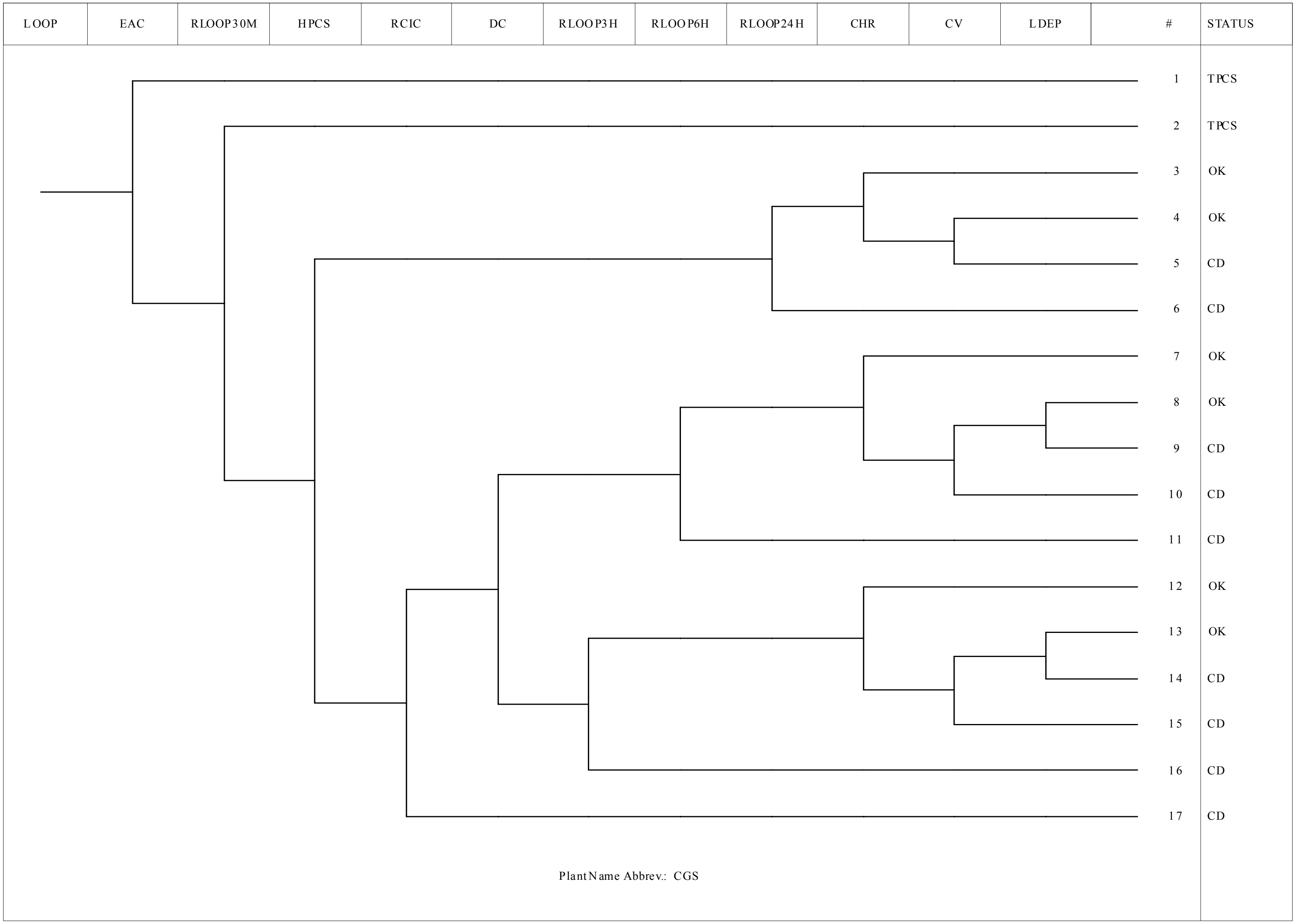
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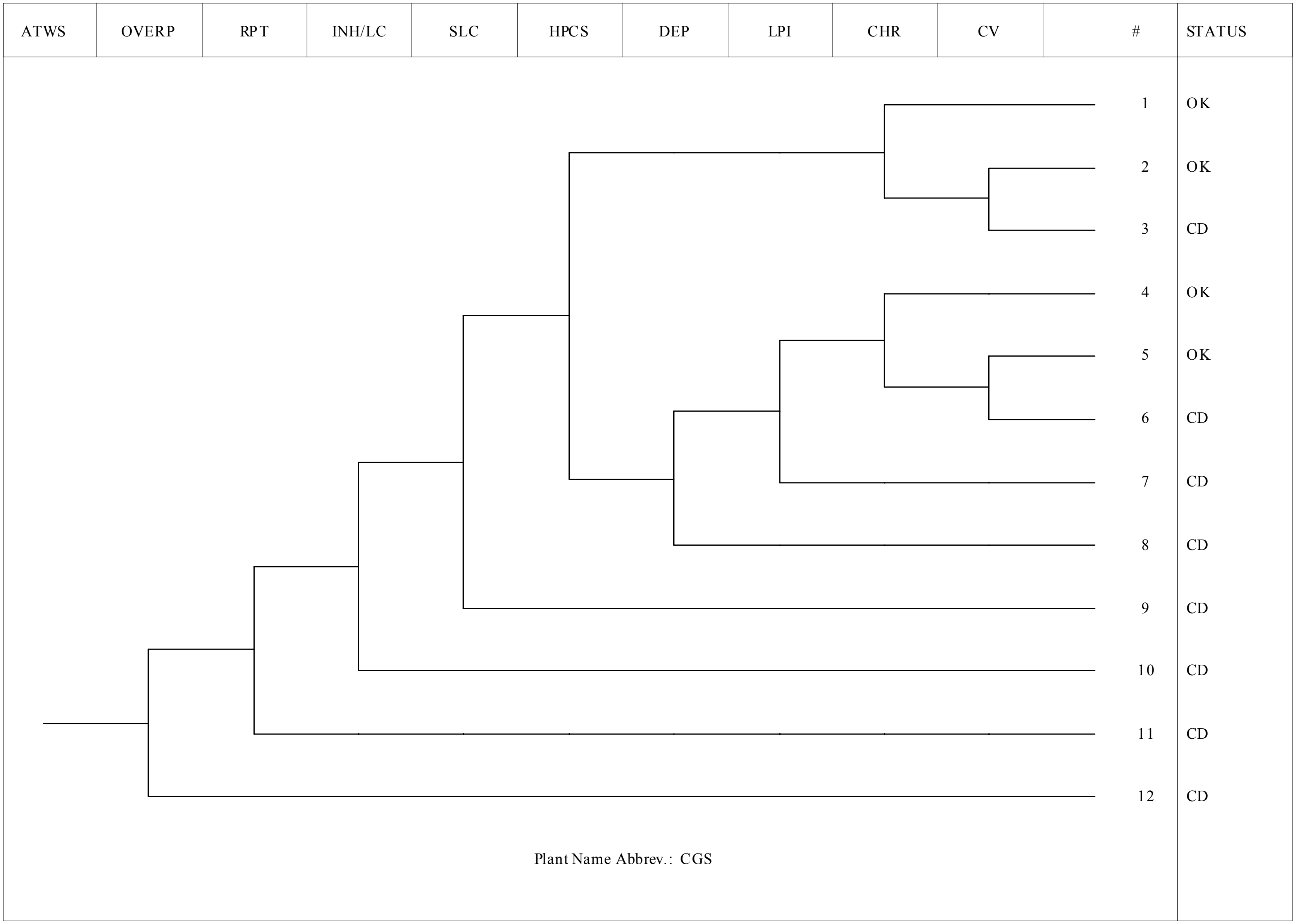
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CV
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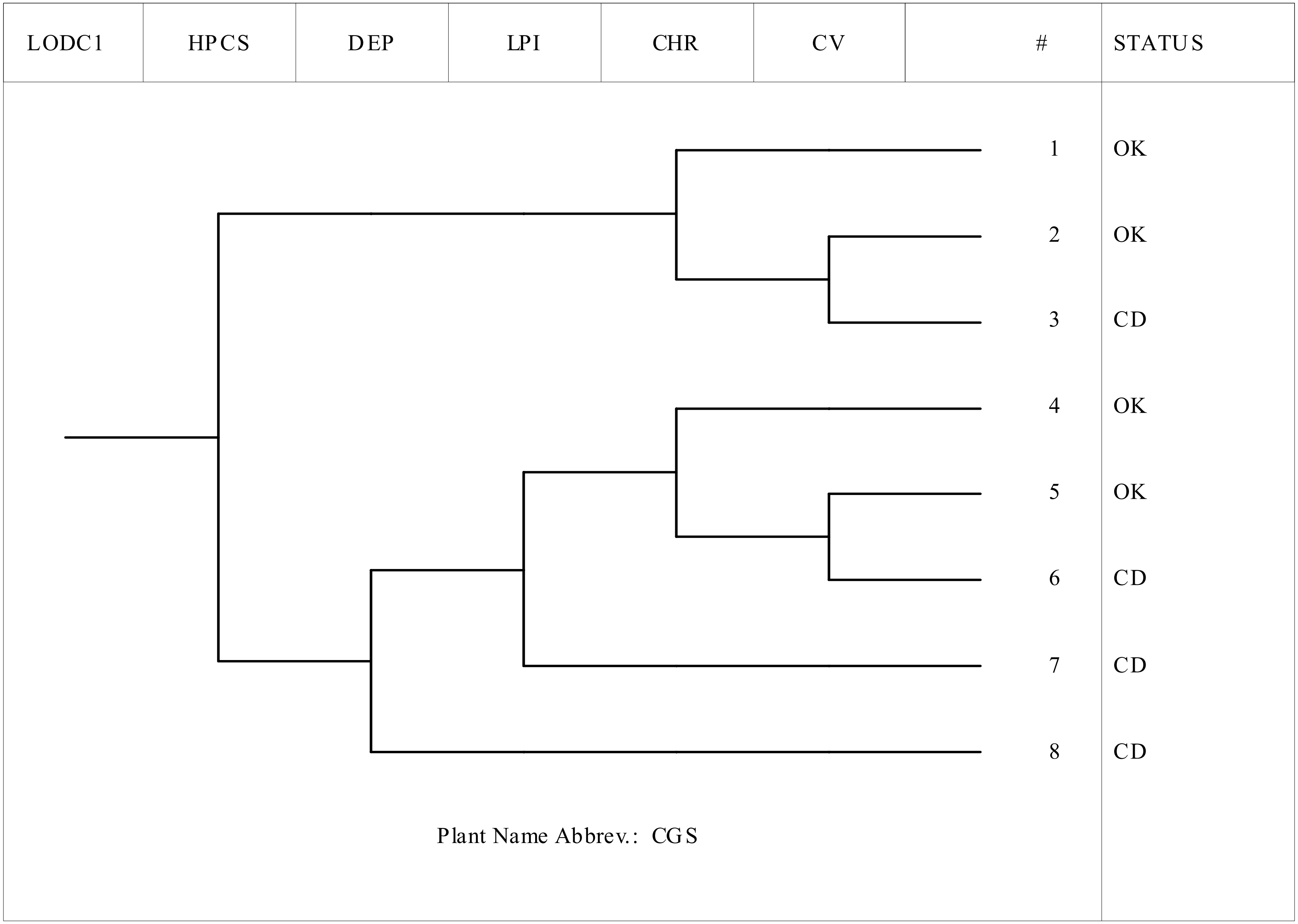
Plant Name Abbrev.: CGS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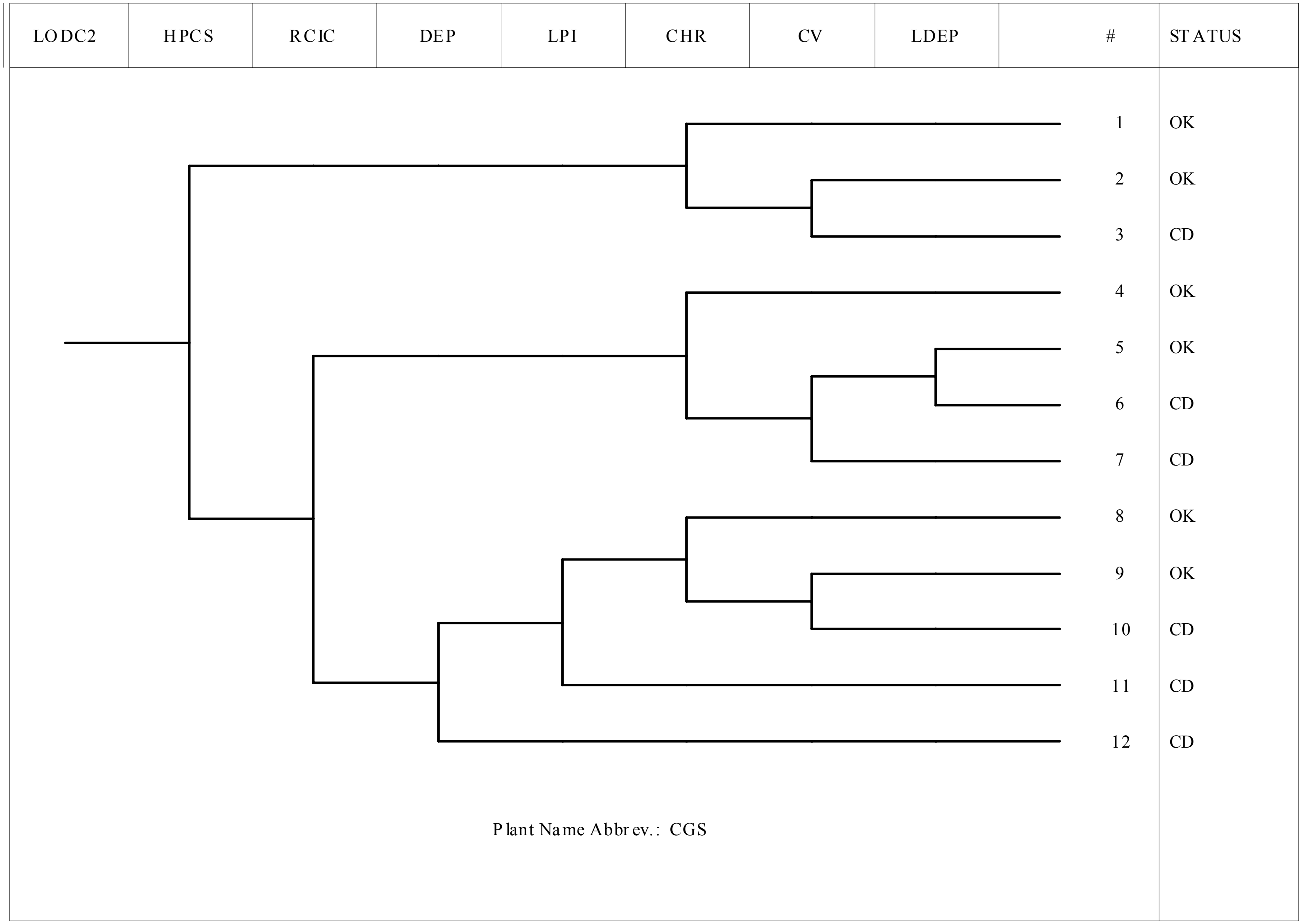
Plant Name Abbrev.: CGS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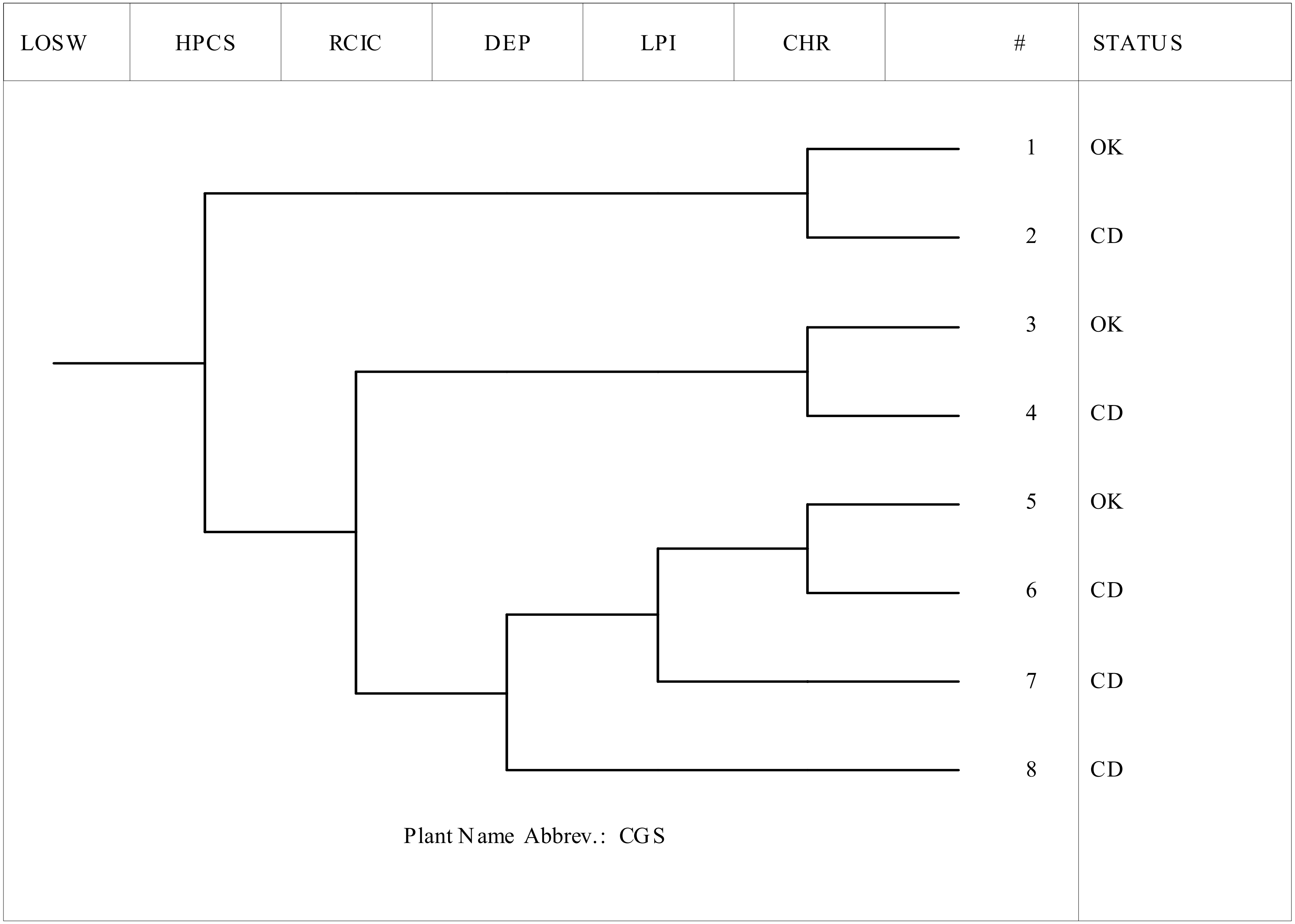
Plant Name Abbrev.: CGS



Plant Name Abbrev.: CGS

2. RESOLUTION AND DISPOSITION OF COMMENTS

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

2.1 GENERIC GUIDELINES AND ASSUMPTIONS (BWRs)

Initiating Event Likelihood Rating Table

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

Transient (Reactor trip) (TRANS), transients without PCS (TPCS), small, medium, and large LOCA (SLOCA, MLOCA, LLOCA), inadvertent or stuck-open SRVs (IORV), anticipated transients without scram (ATWS), interfacing system LOCA (ISLOCA), and LOCA outside containment (LOC) are assigned into rows based on consideration of industry-average frequency. Plant-specific frequencies can be different, but are not considered. Plant-specific frequencies for LOOP and special initiators are used to assign these initiating events.

2. Inclusion of special initiators:

The special initiators included in the worksheets are those applicable for the plant. A separate worksheet is included for each of the applicable special initiators. The applicable special initiators are primarily based on the plant-specific IPEs. In other words, the special initiator included are those modeled in the IPEs unless it is shown to be a negligible contributor. In some cases, in considering plants of similar design, a particular special initiator may be added for a plant even if it is not included in the IPE if such an initiator is included in other plants of similar design and is considered applicable for the plant. Except for the interfacing system LOCA (ISLOCA) and LOCA outside containment (LOC), if the occurrence of the special initiator results in a core damage, i.e., no mitigation capability exists for the initiating event, then a separate worksheet is not developed. For such cases, the inspection focus is on the initiating event and the risk implication of the inspection finding can be directly assessed. For ISLOCA and LOC, a separate worksheet is included noting the pathways that can lead to these events.

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

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

4. LOCA outside containment (LOC):

A LOCA outside of containment (LOC) can be caused by a break in a few types of lines such as Main Steam or Feedwater. LOC is treated differently among the IPEs. Separate ETs are usually not developed in the IPEs for LOCs. Thus, credit is usually not taken for mitigating actions. LOC sequences typically have a core damage frequency in the E-8 range. As such, LOCs are included together with ISLOCAs in a separate summary type SDP worksheet. Plant specific notes are included to explain how the particular IPE has addressed LOCs.

Initiating Event and System Dependency Table

1. Inclusion of systems under the support system column:

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

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

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

SDP Worksheets and Event Trees

1. Crediting of non-safety related equipment:

SDP worksheets credit or include safety-related equipment and also, non-safety related equipment as used in defining the accident sequences leading to core damage. In defining the success criteria for the functions needed, the components included are typically those covered under the Technical Specifications (TS) and the Maintenance Rule (MR). No evaluation was performed to assure that the components included in the worksheets are covered under TS or MR. However, if a component was included in the worksheet, and the licensee requested its removal, it may not have been removed if it is considered that the components is included in either TS or MR.

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

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

3. Crediting system trains with high unavailability

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

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

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

5. Defining credits for operator actions:

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

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

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

7. Dependency among multiple operator actions:

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

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

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

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

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

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

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

11. Modeling vapor suppression success in different LOCA worksheets:

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

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

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

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

Different capabilities for on-site emergency AC power exist at different plant sites. To treat them consistently across plants, they are typically combined into a single emergency AC (EAC) function. The dedicated EDGs are credited following the standard convention used in the worksheets for equipment (1 dedicated EDG is 1 train; 2 or more dedicated EDGs is 1 multi-train system). The use of the swing EDG or the SBO EDG requires operator action. The full mitigating capability for emergency AC could include dedicated Emergency Diesel Generators (EDG), Swing EDG, SBO EDG, and finally, nearby fossil-power plants. The following guidelines are used in the SDP modeling of the Emergency AC power capability:

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

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

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

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

14. Recovery of losses of offsite power:

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

15. Mitigation capability for containment heat removal:

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

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

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

2.2 RESOLUTION OF PLANT-SPECIFIC COMMENTS

This section documents the comments received on the material included in this report and their resolution.

Table 1.1 and 1.2

Added information on plant specific special initiators.

Added information to major components column.

Modified support systems for a few systems.

Adjusted the initiating events scenarios column based on licensee comments and changes made to worksheets.

Improved discussions of CN, CIA, SW, DC, RHR, CSTS, RBEC, and CRD.

Added information from the licensee's updated PSA, e.g., initiating event frequencies and CDF contributions.

Worksheets and Event Trees

Revised the event trees and worksheets based on information from the PSA.

Modified list of equipment included in the Power Conversion System (PCS).

Adjusted the treatment of the PCS with consideration for generic NRC positions on credit for PCS in BWRs.

Modified the CV & late depressurization / late injection treatment per generic NRC positions and licensee comments.

Updated credit for operator based on PSA HEPs and generic NRC credits, and provided values of HEPs per the PSA.

Dropped full credit for PCS in SLOCA and changed credit for condensate and booster pumps as Alternate injection.

Noted that the vacuum breakers have 2 series valves in each of the 9 lines per licensee comment, which changes the credit to a multi-train system.

Dropped credit for RFW in HPI on the ATWS worksheet.

Made minor editorial changes throughout.

Updated notes on all worksheets.

Modified LOOP worksheet and event tree based on licensee comments and generic NRC LOOP positions.

Added worksheets for TPCS, IORV/SORV, LOCD1, LODC2, LOSW, and ISLOCA.

Added event trees for TPCS, IORV/SORV, LOCD1, LODC2, and LOSW.

REFERENCES

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

2. Washington Public Power Supply System, "Washington Nuclear Plant, Unit 2 – Individual Plant Examination Report, Rev. 1," dated July, 1994.

3. Licensee comments on draft Risk Informed Inspection Notebook for WNP-2 by Dr. L. T. Pong and A. T. Chiang together with excerpts from the WNP-2 PSA Rev. 2.