September 27, 2001

Mr. W. R. McCollum, Jr.
Vice President, Oconee Site
Duke Energy Corporation
7800 Rochester Highway
Seneca, SC 29672

SUBJECT: OCONEE NUCLEAR STATION, UNITS 1, 2 AND 3 RE: SITE-SPECIFIC WORKSHEETS FOR USE IN THE NUCLEAR REGULATORY COMMISSION'S SIGNIFICANCE DETERMINATION PROCESS (TAC NO. MA6544)

Dear Mr. McCollum:

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 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, Nuclear Reactor Regulation. We will continue to assess SDP accuracy and update the document based on continuing experience.

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

Sincerely,

/RA/

Leonard N. Olshan, Senior Project Manager, Section 1
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-269, 50-270, and 50-287

Enclosures: As Stated

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RISK-INFORMED INSPECTION NOTEBOOK FOR

OCONEE NUCLEAR STATION

UNITS 1, 2, AND 3

PWR, B&W, TWO-LOOP PLANT WITH LARGE DRY CONTAINMENT

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Prepared for

U. S. Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Division of Systems Analysis and Regulatory Effectiveness

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 Oconee Nuclear Station, Units 1, 2 and 3 .

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

FIGURES

1. INFORMATION SUPPORTING SIGNIFICANCE DETERMINATION PROCESS (SDP)

SECY-99-007A (NRC, March 1999) describes the process for making a Phase 2 evaluation of the inspection findings. 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 Oconee Nuclear Station, Units 1, 2 and 3.

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 Oconee Nuclear Station, Units 1, 2 and 3

Row	Approximate Frequency	Example Event Type	Estimated Likelihood Rating		
I	> 1 per 1-10 yr	Reactor Trip (TRANS), Loss of Power Conversion System (TPCS), Loss of Offsite Power (LOOP)	**A**	**B**	**C**
II	1 per 10-10^{2} yr		**B**	**C**	**D**
III	1 per 10^{2} - 10^{3} yr	Steam Generator Tube Rupture (SGTR), Stuck open PORV/SRV (SORV), Small LOCA including RCP seal failures (SLOCA), MSLB (outside containment), Loss of Instrument Air (LIA), Loss of Low Pressure Service Water (LLPSW), Loss of 4KV Bus 3TC(LBUS3TC), Loss of 4KV Bus 3TD(LBUS3TD), Loss of 4KV Bus 3TE(LBUS3TE)	**C**	**D**	**E**
IV	1 per 10^{3} - 10^{4} yr	Medium LOCA (MLOCA)	**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, Interfacing System LOCA (ISLOCA)	**F**	**G**	**H**
			> 30 days	**3-30 days**	**< 3 days**
			Exposure Time for Degraded Condition		

Note:

1. The SDP worksheets for ATWS core damage sequences assume that the ATWS is not recoverable by manual actuation of the reactor trip function. Thus, the ATWS frequency to be used by these worksheets must represent the ATWS condition that can only be mitigated by the systems shown in the worksheet (e.g., boration). Any inspection finding that represents a loss of capability for manual reactor trip for a postulated ATWS scenario should be evaluated by a risk analyst to consider the probability of a successful manual trip.

1.2 INITIATORS AND SYSTEM DEPENDENCY

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

Table 2 Initiators and System Dependency for Oconee Nuclear Stations[(1)]

Affected Systems	Major Components	Support Systems	Initiating Event
Core Flood Tanks (CFTs)	Two Core flood tanks	None	LLOCA
AC Power System	AC Power Distribution and AC Instrument Power	HVAC, DC	All
EFW	Two MDPs	Air System (IA, or Aux. Air), LPSW, 4160 V-AC, 600 V-AC, 208 V-AC, 125 V-DC	All except MLOCA and LLOCA
	One TDP	Air System (IA, or Aux. Air), LPSW or HPSW, 125 V-DC (but could continue operation upon loss of DC)	
	UST (Upper Surge Tank)	Make up from: Demineralized water, CST, or Condenser hotwell, Air System (IA, or Auxiliary Air)	
Standby Shutdown Facility (SSF) Auxiliary Service Water (ASW)	One ASW pump, shared between three units, for decay heat removal	Lake water through the two (2/4) CCW (Condenser Circulating Water) Pumps Manual Operation from Switchgear Panel Opening of ADVs to depressurize, AC, DC SSF diesel generator	All except ATWS, MLOCA, and LLOCA
Condenser Circulating Water (CCW)	4 pumps	IA, 4160 V-AC, HPSW (pump cooling)	All

Table 2 (Continued)

Affected Systems	Major Components	Support Systems	Initiating Event
LPSW	Three trains shared by units 1 and 2. Unit 3 has a two train system taking suction from CCW cross connect line to Units 1 and 2. The unit 3 trains have a common discharge header	IA, CCW, 4160 V-AC, 600 V-AC, 208 V-AC, 120 V-AC, 125 V-DC	LLPSW
Component Cooling Water (CC)	Two pump trains	LPSW,600 V-AC, 208 V-AC, 125 V-DC	All except LIA
HPSW	Two 6000 gpm pumps and one 500 gpm Jocky Pump	Unit 2 CCW (required for 6000 gpm pumps), Unit 1 4160 V-AC, Unit 1 600 V-AC, Unit 1 208 V-AC, Unit 1120 V-AC, Unit 1 125 V-DC	All
Condensate / MFW	Three Condensate Booster pumps and 3 hotwell pumps Two TDMFW Pumps	IA, Aux. IA, Recirculation Cooling Water (RCW) for pump bearing cooling, 4160 V-AC, 600 V-AC, 208 V-AC, 250 V-DC, 125 V-DC	TRANS, SGTR, LLPSW, LBUS3TC, LBUS3TD, LBUS3TE
HPI/CVCS	Two HPI trains (three pumps)	LPSW or HPSW, 4160 V-AC, 600 V-AC, 208 V-AC, 125 V-DC, ESAS, BWST	All except LLOCA and LLPSW
DC Power System	Buses, Three battery chargers (two in operation normally), and two batteries (1850 amp-hour, each could provide loads for one hour)	HVAC; Loss of HVAC in equipment room could cause CCF of inverters, chargers, and breakers. This is treated as a special initiator in IPE	All

Table 2 (Continued)

Affected Systems	Major Components	Support Systems	Initiating Event
Emergency AC	Two main feeder bus provide power to three redundant eng. safeguard switchgear buses. 2 Keowee Hydro Units either through under ground or overhead path	DC, ESAS	LOOP
	One SSF DG dedicated to SSF ASW pump, associated water jacket pump, HVAC, battery, start air, and fuel oil system	None	All except ATWS, MLOCA, and LLOCA
Reactor Coolant Makeup (RCM) pump	1 pump for RCP seal injection	SSF DG	LOOP, LIA
Instrument Air (IA) and Auxiliary Instrument Air (AIA)	IA: Four air compressors, one primary and three backup AIA: Three air compressors	HPSW, LPSW, Recirculation Cooling Water (RCW, cools 3 backup instrument air compressors and 2 service air compressors and after coolers, no impact on AIA), 4160 V-AC, 600 V-AC, 120 V-AC	LIA
Main Steam	Per SG: Two ADVs, eight safety valves, four main steam stop valves, and four turbine bypass valves (air operated)	125 V-DC, IA, AIA	All except MLOCA and LLOCA
Pressurizer Pressure Relief	Two Safety valves and one PORV with associated block valve	600 V-AC (block valve), 125 V-DC (PORV), IA (needed for the auxiliary prizer spray valve)	All except MLOCA and LLOCA

Table 2 (Continued)

Affected Systems	Major Components	Support Systems	Initiating Event
RCP	Seals (Bingham)	1 / 2 HPI trains (3 pumps) or 1/1 SSF RCM pump for seal injection or 1 / 2 CC train for seal cooling	SLOCA
LPI/RHR	2 RHR/LPI pumps and heat exchanger are normally aligned with the third pump valved out and load shed	LPSW, 4160V-AC, 600 V-AC, 208 V-AC, 125 V-DC, ESAS	All except ATWS and LLPSW
Recirculation Cooling Water (RCW)	Two parallel loops normally isolated from each other. One loop supplies shared station loads, unit 1 and 2 loads and secondary loads on unit 3. The other loop supplies cooling for unit 3 primary loads.	AC, DC, CCW	TRANS, SGTR, LLPSW, LIA
BWST Makeup	One concentrated boric acid storage tank (CAST), two RC bleed hold tanks(RC BHUTs), one CAST pump, two RC bleed transfer pumps (BTPs)	AC, DC	SGTR

Note:

1. Plant internal event CDF = 1.8 E-5/yr, Fire 2.2E-5/yr, and Seismic 5.0E-5/yr. The information provided in this document are from Oconee unit 3 but they could be used for Units 1 and 2, except for initiating events LLPSW, LBUS3TC, LBUS3TD, and LBUS3TE. Unit 3 has a dedicated two train LPSW system, while units 1 and 2 share a 3 train LPSW system.

1.3 SDP WORKSHEETS

This section presents the SDP worksheets to be used in the Phase 2 evaluation of the inspection findings for the Oconee Nuclear Station, Units 1, 2, and 3. The SDP worksheets are presented for the following initiating event categories:

1. Transients (Reactor Trip) (TRANS)
2. Transients without PCS (TPCS)
3. Small LOCA (SLOCA)
4. Stuck-open PORV (SORV)
5. Medium LOCA (MLOCA)
6. Large LOCA (LLOCA)
7. Loss of Offsite Power (LOOP)
8. Steam Generator Tube Rupture (SGTR)
9. Anticipated Transients without Scram (ATWS)
10. Main Steam Line Break (MSLB)
11. Loss of Instrument Air (LIA)
12. Loss of Low Pressure Service Water (LLPSW)
13. Loss of 4KV Bus 3TC (LBUS3TC)
14. Loss of 4KV Bus 3TD (LBUS3TD)
15. Loss of 4KV Bus 3TE (LBUS3TE)
16. Interfacing System LOCA (ISLOCA)

Table 3.1 SDP Worksheet for Oconee Nuclear Station, Units 1, 2, and 3 — 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)	1/2 MFW trains and 1/3 Condensate booster pumps to 1/2 SG (operator action = 2) (1)
Secondary Heat Removal (EFW)	1/2 MDEFW trains (1 multi-train system) or 1 TDEFW train (1 ASD train)
Alternate Sec. Heat Removal (ASW)	1/1 SSF ASW pump (operator action = 2) (2)
Primary bleed (FB)	1/2 SRVS to open or 1/1 PORV open (operator action = 2) (3)
Early Inventory, HPI Injection (EIHP)	1/2 HPI trains injecting to 2 out of 4 RCS from BWST or operator starts and aligns the third pump (1 multi-train system) (3)
High Pressure Recirculation (HPR)	1/2 HPI trains taking suction from 1/2 LPI trains (operator action = 3) (4)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1. TRANS - PCS - EFW - ASW - HPR (5)			
2 TRANS- PCS - EFW - ASW - EIHP (6)			.
3 TRANS - PCS - EFW - ASW - FB (7)			

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

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

Notes:

1. The IPE does not document the HEP associated with the operator actions needed to maintain PCS operation. The geometric mean of the HEPs associated with recovery of PCS in different transients, 2.7E-2, is used.

2. Based on the utility provided worksheet, the HEP for failure of the operator to manually align the ASW pump is 3.1E-2.

3. The IPE does not document the HEP for feed and bleed. The IPE analysis shows that SRV and PORV will be demanded by the pressure in Reactor Building upon failure of secondary heat removal. A generic credit of 2 based on the HEPs of B&W plants is used. The third HPI pump requires operator to start and align. The HEP is 0.1 (event LLPOP3CREC on page 5.7-10.) A credit of 1 should be used.

4. Based on the utility provided worksheet, the human error probability (HEP) for switch over to recirculation is 2.2E-03. The third LPI pump can be manual started and aligned. The HEP for operator failure to do so is 0.1, (Event LLPOP3CREC on page 5.7-10)

Table 3.2 SDP Worksheet for Oconee Nuclear Station, Units 1, 2, and 3 — 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:
Secondary Heat Removal (EFW)	1/2 MDEFW trains (1 multi-train system) or 1 TDEFW train (1 ASD train) and steam relief through 1/4 ADVs or 1/16 safety valves
Alternate Sec. Heat Removal (ASW)	1/1 SSF ASW pump (operator action = 2) (1) and steam relief through 1/4 ADVs or 1/16 safety valves
Primary bleed (FB)	1/2 SRVS to open or 1/1 PORV open (operator action = 2) (2)
Early Inventory, HPI Injection (EIHP)	1/2 HPI trains injecting to 2 out of 4 RCS from BWST or operator starts and aligns the third pump(1 multi-train system) (2)
High Pressure Recirculation (HPR)	1/2 HPI trains taking suction from 1/2 LPI trains (operator action = 3) (3)

Circle Affected Functions	Recovery of Failed Train	Remaining Mitigation Capability Rating for Each Affected Sequence	Sequence Color
1. TPCS - EFW - ASW - HPR (4)			
2 TPCS - EFW - ASW - EIHP (5)			
3 TPCS - EFW - ASW - FB (6)			

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

Notes:

1. Based on the utility provided worksheet, the HEP for failure of the operator to manually align the ASW pump is 3.1E-2.

2. The IPE does not document the HEP for feed and bleed. The IPE analysis shows that SRV and PORV will be demanded by the pressure in Reactor Building upon failure of secondary heat removal. A generic credit of 2 based on the HEPs of B&W plants is used. The third HPI pump requires operator to start and align. The HEP is 0.1 (event LLPOP3CREC on page 5.7-10.) A credit of 1 should be used.

3. Based on the utility provided worksheet, the human error probability (HEP) for switch over to recirculation is 2.2E-03. The third LPI pump can be manual started and aligned. The HEP for operator failure to do so is 0.1, (Event LLPOP3CREC on page 5.7-10)

Table 3.3 SDP Worksheet for Oconee Nuclear Station, Units 1, 2, and 3 — Small LOCA <1.5" (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:**
Early Inventory, HPI Injection (EIHP)	1/2 HPI trains injecting to 2 out of 4 RCS from BWST or operator starts and aligns the third pump (1 multi-train system) (1)
Secondary Heat Removal (EFW)	1/2 MDEFW trains (one multi-train system) or one TDEFW train (one ASD train), or 1/1 SSF ASW pump (operator action = 2) (2) and steam relief through 1/4 ADVs or 1/16 safety valves
Primary bleed (FB)	1/2 SRVs to open or 1/1 PORV open (operator action = 2) (3)
High Pressure Recirculation (HPR)	1/2 HPI trains taking suction from 1/2 LPI trains (operator action = 3) (4)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 SLOCA - HPR (2,4)			
2 SLOCA - EFW - FB (5)			
3 SLOCA - EIHP (6)			

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

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

Notes:

1. The third HPI pump requires operator to start and align. The HEP for operator failure to do so is 0.1 (event LLPOP3CREC on page 5.7-10.) A credit of 1 should be used.

2. Based on the utility provided worksheet, the HEP for failure of the operator to manually align the ASW pump is 3.1E-2.

3. The IPE does not document the HEP for feed and bleed. The IPE analysis shows that SRV and PORV will be demanded by the pressure in Reactor Building upon failure of secondary heat removal. A generic credit of 2 based on the HEPs of B&W plants is used. The third HPI pump requires operator to start and align. The HEP is 0.1 (event LLPOP3CREC on page 5.7-10.) A credit of 1 should be used.

4. Based on the utility provided worksheet, the human error probability (HEP) for switch over to recirculation is 2.2E-03. The third LPI pump can be manual started and aligned. The HEP for operator failure to do so is 0.1, (Event LLPOP3CREC on page 5.7-10)

Table 3.4 SDP Worksheet for Oconee Nuclear Station, Units 1, 2, and 3 — Stuck Open PORV (SORV)

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Isolation of Small LOCA (BLK)	Closure of the block valve if open (operator action = 1) [1]
Early Inventory, HPI Injection (EIHP)	1/2 HPI trains injecting to 2 out of 4 RCS from BWST or operator starts and aligns the third pump (1 multi-train system) [2]
Secondary Heat Removal (EFW)	1/2 MDEFW trains (one multi-train system) or one TDEFW train (one ASD train), or 1/1 SSF ASW pump (operator action = 2) [3] and steam relief through 1/4 ADVs or 1/16 safety valves
Primary bleed (FB)	Operator conducts feed and bleed using the stuck open PORV (operator action = 2) [4]
High Pressure Recirculation (HPR)	1/2 HPI trains taking suction from 1/2 LPI trains (operator action = 3) [5]

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 SORV - BLK - HPR (3,6)			
2 SORV - BLK - EIHP (4,8)			
3 SORV - BLK - EFW - FB (7)			

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

Notes:

1. The stuck open SRV can not be isolated however the stuck open PORV can be isolated. The associated human error probability assigned in the IPE is 0.1 (Event RRC0004DHE on page 5.7-16). A stuck open PORV results in a small LOCA, while a stuck open SRV results in a MLOCA. This event tree models a stuck open PORV.

2. The third HPI pump requires operator to start and align. The HEPfor operator failure to do so is 0.1 (event LLPOP3CREC on page 5.7-10.) A credit of 1 should be used.

3. Based on the utility provided worksheet, the HEP for failure of the operator to manually align the ASW pump is 3.1E-2.

4. The IPE does not document the HEP for feed and bleed. The IPE analysis shows that SRV and PORV will be demanded by the pressure in Reactor Building upon failure of secondary heat removal. A generic credit of 2 based on the HEPs of B&W plants is used. The third HPI pump requires operator to start and align. The HEP is 0.1 (event LLPOP3CREC on page 5.7-10.) A credit of 1 should be used.

5. Based on the utility provided worksheet, the human error probability (HEP) for switch over to recirculation is 2.2E-03. The third LPI pump can be manual started and aligned. The HEP for operator failure to do so is 0.1, (Event LLPOP3CREC on page 5.7-10)

Table 3.5 SDP Worksheet for Oconee Nuclear Station, Units 1, 2, and 3 — Medium LOCA <4" (MLOCA)

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Early Inventory, HP Injection (EIHP)	1/2 HPI trains injecting to two out of four RCS from BWST or operator starts and aligns the third pump (one multi-train system) [1]
High Pressure Recirculation (HPR)	1/2 HPI trains taking suction from 1/2 LPI trains (operator action = 3) [1, 2]

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

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

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

Notes:

1. The third HPI pump requires operator to start and align. The HEP is 0.1 (event LLPOP3CREC on page 5.7-10.) A credit of 1 should be used.
2. Based on the utility provided worksheet, the human error probability (HEP) for switch over to recirculation is 2.2E-03. The third LPI pump can be manual started and aligned. The HEP is 0.1, (Event LLPOP3CREC on page 5.7-10)

Table 3.6 SDP Worksheet for Oconee Nuclear Station, Units 1, 2, and 3 — Large LOCA >4" (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:**		
Core Flood Tank (CFT)	1/1 remaining CFT inject to vessel (one train)		
Early Inventory, LP Injection (EILP)	1/2 LPI trains inject to vessel (operator action = 3) (1) (2)		
Low Pressure Recirculation (LPR)	1/2 LPI trains in recirculation mode (operator action = 2) (3)(4)		
Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 LLOCA - LPR (2)			
2 LLOCA - EILP (3)			
3 LLOCA - CFT (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.

Notes:

1. The operator has to throttle the LPI flow in 10 minutes to prevent pump run out. The HEP is 1.E-3 (Event LLPVATHDHE on page 5.7-12).

2. On loss of LPI there are possibilities for recovery actions if the HPI pumps is operating these are: alignment of the spare LPI pump in 15 minutes, or to perform manual valve operation from the control room if the loss of LPI is due to failure of the needed valves to open. These recovery actions even though discussed have not been credited in the IPE.

3. Operator has to do switch over in 30 minutes. The value of HEP used in IPE is 1.0E-3 (Event TLLSLPRDHE on page 5.7-19), which is lower than the generic credit of 2 based on the HEPs of B&W plants. In this work sheet, the generic credit is used.

4. The containment heat removal function is assumed to be performed by the LPR and the associated heat exchanger. Failure of LPR therefore indicates failure of containment heat removal as well.

Table 3.7 SDP Worksheet for Oconee Nuclear Station, Units 1, 2, and 3 — 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 Keowee Hydro Units through underground path (one train) (1)
Availability of SSF Systems (SSF)	Availability of SSF DG , SSF ASW pump, and SSF RCM RCP injection (operator action = 1) (2)
Stuck Open PORV (SORV)	1/1 PORV closes (1 train) or Operator closes the block valve (operator action = 1) (3)
Stuck Open PORV (SORV2)	1/1 PORV closes (1 train)
Secondary Heat Removal (EFW)	1/2 MDEFW trains (1 multi-train system) or 1 TDEFW train (1 ASD train)
Turbine-driven EFW Pump (TDEFW)	1/1 TDEFW train (one ASD train) and steam relief through 1/16 safety valves
Recovery of AC Power in < 1 hrs (REC1)	Recovery of an AC source including the closure of 4.16 KV breakers (operator action = 1) (4)
Recovery of AC Power in < 5 hrs (REC5)	Recovery of an AC source including the closure of 4.16 KV breakers (operator action = 2) (5)
Secondary Heat Removal (EFW)	1/2 MDEFW trains (1 multi-train system) or 1 TDEFW train (1 ASD train) and steam relief through 1/4 ADVs or 1/16 safety valves
Alternate Sec. Heat Removal (ASW)	1/1 SSF ASW pump (operator action = 2) (6) and steam relief through 1/4 ADVs or 1/16 safety valves
Primary bleed (FB)	1/2 SRVS or 1/1 PORV opens (operator action = 2) (7)
Primary bleed (FB2)	Operator conducts feed and bleed using the stuck open PORV (operator action = 2) (7)
Early Inventory, HPI Injection (EIHP)	1/2 HPI trains injecting to 2 out of 4 RCS from BWST or operator starts and aligns the third pump(1 multi-train system) (7)
High Pressure Recirculation (HPR)	1/2 HPI trains taking suction from 1/2 LPI trains (operator action = 3) (8)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1. LOOP - EFW - ASW - HPR (1)			

2 LOOP - EFW - ASW - EIHP (1)			
3 LOOP - EFW - ASW - FB (1)			
4 LOOP SORV - HPR (3,6)			
5 LOOP - SORV - EIHP (4,8)			
6 LOOP - SORV - EFW - FB2 (7)			
7 LOOP - EAC - SSF - REC1 - HPR (12) (AC recovered in five hours, seal LOCA)			
8 LOOP - EAC - SSF - REC1 - EIHP (13) (AC recovered in five hours, seal LOCA)			
9 LOOP - EAC - SSF - REC5 (14) (SBO, Seal LOCA)			
7 LOOP - EAC - SSF - TDEFW - REC1 (19) (Seal LOCA)			
8 LOOP - EAC - SSF - TDEFW - EIHP (18) (AC recovered in one hour, seal LOCA)			

9 LOOP - EAC - SSF - TDEFW - FB (17) (AC recovered in one hour, seal LOCA)			
10 LOOP - EAC - SSF - TDEFW - HPR (16) (AC recovered in one hour, seal LOCA)			
11 LOOP - EAC SORV2 (20)			
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 considered three types of LOOP events with different impacts on the plant. In this work sheet, the LOOP initiating events are combined into a single event and represented by the impacts of severe weather. The LOOP has a frequency of 9E-02 per year, and causes loss of grid and the over head path from Keowee.

2. The availability of SSF systems the DG, RCM pump, and ASW pump could provide a means to go to safe shutdown. For the sake of simplicity for the work sheets, these function are all combined under SSF heading. The combined required operator actions therefore is assigned a probability of 0.1. This may not exactly reflect the plant risk profile but is considered sufficient for the purpose of screening.

3. The stuck open SRV can not be isolated however the stuck open PORV can be isolated. The associated human error probability assigned in the IPE is 0.1 (Event RRC0004DHE on page 5.7-16).

4. The failure to recover AC Power in < 1 hrs (REC1) and failure of secondary heat removal is assumed to reflect the core damage with RCP seal LOCA. The IPE uses different HEPs for different conditions depending on the availability of secondary cooling and Keowee Hydro failure modes. The HEPs are in the range of 0.57 and 0.05. A generic credit of 1 is used in this work sheet. This assumption could be conservative in light of the new Bingham RCP seals.

5. The failure to recover AC Power in < 5 hrs (REC5) and availability of secondary heat removal is assumed to reflect the core damage with RCP seal LOCA without timely injection. The HEP is 3.1E-2. A generic credit of 2 is used for this event. This assumption could be conservative in light of the new Bingham RCP seals.

6. Based on the utility provided worksheet, the HEP for failure of the operator to manually align the ASW pump is 3.1E-2.

7. The IPE does not document the HEP for feed and bleed. The IPE analysis shows that SRV and PORV will be demanded by the pressure in Reactor Building upon failure of secondary heat removal. A generic credit of 2 based on the HEPs of B&W plants is used. The third HPI pump requires operator to start and align. The HEP is 0.1 (event LLPOP3CREC on page 5.7-10.) A credit of 1 should be used.

8. Based on the utility provided worksheet, the human error probability (HEP) for switch over to recirculation is 2.2E-03.

Table 3.8 SDP Worksheet for Oconee Nuclear Station, Units 1, 2, and 3 — Steam Generator Tube Rupture (SGTR)

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Power Conversion System (PCS)	1/2 MFW trains and 1/3 Condensate booster pumps to 1/2 SG (operator action = 2) (1)
Secondary Heat Removal (EFW)	1/2 MDEFW trains (one multi-train system) or one TDEFW train (one ASD train) and steam relief through 1/2 ADVs or 1/8 safety valves
Early Inventory, HP Injection (EIHP)	1/2 HPI trains injecting into 2/4 RCS injection nozzles or operator starts and aligns the third pump (one multi-train system) (2)
Pressure Equalization (EQ)	RCS cooldown and depressurization using pressurizer spray (1 train) (3) or RCS depressurization through the 2/2 turbine bypass valves in the unaffected SG (1 train) (4)
Primary Depressurization (DEP)	1/1 PORV open (operator action = 2) (5)
High Pressure Recirculation (HPR)	1/2 HPI trains taking suction from 1/2 LPI trains (operator action = 3) (6)
Decay Heat Removal (DHR)	1/2 LPI trains in DHR mode with a single suction line (1 train) (7)
BWST Makeup (BWSTMU)	Operator provides BWST makeup from concentrate boric tanks or RC bleed holdup tanks using concentrate boric acid pumps or RC bleed transfer pumps (operator action = 1) (8)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 SGTR - EIHP (17)			
2 SGTR - EQ - BWSTMU (4,10)			
3 SGTR - EQ - HPR (5,11)			
4 SGTR - EQ - DEP (6,12)			

5 SGTR - PCS - EFW - BWSTMU (14)			
6 SGTR - PCS - EFW - DEP (16)			
7 SGTR - PCS - EFW - HPR (15)			
Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event: If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use.			

Notes:

1. The IPE does not document the HEP associated with the operator actions needed to maintain PCS operation. The geometric mean of the HEPs associated with recovery of PCS in different transients, 2.7E-2, is used.
2. The third HPI pump requires operator to start and align. The HEPfor failure to do so is 0.1 (event LLPOP3CREC on page 5.7-10.) A credit of 1 should be used.
3. Based on the utility provided worksheet, the human error probability is 2.0E-4. Equipment failure dominates the failure probability.
4. Based on the utility provided worksheet, the human error probability is 2.0E-4. However both human actions in equalization are assumed to be coupled.
5. The human error probability for this operator action is 1E-2 (Event TSGDPO2DHE on page 5.7-21.)
6. Based on the utility provided worksheet, the human error probability (HEP) for switch over to recirculation is 2.2E-03. The third LPI pump can be manual started and aligned. The HEP is 0.1, (Event LLPOP3CREC on page 5.7-10)

7. The IPE does document the HEP associated with this operator action, but limited by hardware failure.
8. The HEP for operator failure to provide makeup to BWST is 5E-2 (event XLPBWSTREC on page 5.7-29).

Table 3.9 SDP Worksheet for Oconee Nuclear Station, Units 1, 2, and 3 — Anticipated Transients Without Scram (ATWS) [(1)]

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Emergency Boration (HPI)	Operator initiate emergency boration with 1/2 HPI trains injecting to two out of four RCS injection nozzles (operator action = 2) [(2)]
Turbine Trip (TTP)	2/2 AMSAC channels (one train)
Primary Relief (SRV)	2/2 SRVs (one train)
Secondary Heat Removal (EFW)	1/2 MDEFW trains (one multi-train system) or one TDEFW train (one ASD train) and steam relief through 1/4 ADVs or 1/16 safety valves

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

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

Note:

1. The moderator temperature coefficient (MTC) for these sequences were assumed to be favorable. Unfavorable MTC would directly lead to core damage.
2. A generic credit of 2, based on the HEPs used in B&W plants, is used.

Table 3.10 SDP Worksheet for Oconee Nuclear Station, Units 1, 2, and 3 — 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

<u>**Safety Functions Needed**</u>:	<u>**Full Creditable Mitigation Capability for Each Safety Function**</u>:
Isolate Faulted SG (ISOSG)	Operator isolates the feed side of the faulted SG (operator action = 2) (1)
Secondary Heat Removal (EFW)	1/2 MDEFW trains (one multi-train system) or one TDEFW train (one ASD train) (2) and steam relief through 1/2 ADVs or 1/8 safety valves
Alternate Secondary Heat Removal (ASW)	1/1 SSF ASW pump (operator action = 2) (3) and steam relief through 1/2 ADVs or 1/8 safety valves
Primary bleed (FB)	1/2 SRVS to open or 1/1 PORV open (operator action = 2) (4)
Early Inventory, HPI Injection (EIHP)	1/2 HPI trains injecting to 2 out of 4 RCS from BWST or operator starts and aligns the third pump(1 multi-train system) (4)
High Pressure Recirculation (HPR)	1/2 HPI trains taking suction from 1/2 LPI trains (operator action = 3) (5)

<u>**Circle Affected Functions**</u>	<u>**Recovery of Failed Train**</u>	<u>**Remaining Mitigation Capability Rating for Each Affected Sequence**</u>	<u>**Sequence Color**</u>
1. MSLB - EFW - ASW - HPR (4)			
2. MSLB - EFW - ASW - FB (5)			
3. MSLB - EFW - ASW - EIHP (6)			
4 MSLB - ISOSG (7)			

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

Notes:

1. The main steam stop valves are located just up stream of the turbine control valves. In a steam line break, they function to isolate the good SG not the affected SG. The steam line from the affected SG can not be isolated. Therefore, only the unaffected SG can be used for decay heat removal. The operator needs to isolate the feedwater side of the faulted SG in order to prevent diversion of the EFW flow and prevent pressurized thermal shock concern. A credit of 2 is assumed for this operator action. Failure to do so is assumed to lead to core damage.

2. One source of supply for the TDEFW pump is lost and operator action may be needed to isolate the TDEFW pump from the broken steam line.

3. Based on the utility provided worksheet, the HEP for failure of the operator to manually align the ASW pump is 3.1E-2. The third LPI pump can be manual started and aligned. The HEP is 0.1, (Event LLPOP3CREC on page 5.7-10)

4. The IPE does not document the HEP for feed and bleed. The IPE analysis shows that SRV and PORV will be demanded by the pressure in Reactor Building upon failure of secondary heat removal. A generic credit of 2 based on the HEPs of B&W plants is used. The third HPI pump requires operator to start and align. The HEP is 0.1 (event LLPOP3CREC on page 5.7-10.) A credit of 1 should be used.

5. Based on the utility provided worksheet, the human error probability (HEP) for switch over to recirculation is 2.2E-03.

Table 3.11 SDP Worksheet for Oconee Nuclear Station, Units 1, 2, and 3 — Loss of Instrument Air: LIA[1]

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Seal Injection (SEALINJ)	1/2 HPI trains injecting to 2 out of 4 RCS from BWST or operator starts and aligns the third pump (1 multi-train system)[2]
Alternate Sec. Heat Removal (ASW)	1/1 SSF ASW pump (operator action = 2)[3] and steam relief 1/16 safety valves
Primary bleed (FB)	1/2 SRVS to open or 1/1 PORV open (operator action = 2)[4]
High Pressure Recirculation (HPR)	1/2 HPI trains taking suction from 1/2 LPI trains (operator action = 1)[5]

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1. LIA - ASW -HPR (3)			
2. LIA - ASW - FB (4)			
3. LIA - SEALINJ (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. Loss of Instrument air Frequency in Oconee IPE is estimated to be 1.4 E-3 per year. The major impact is on loss of MFW, loss of long term operation of EFW due to loss of air operated valves (failure of makeup to UST), isolation of CC from RCP thermal barrier (3CC-8 fails closed), isolation of RCP seal return (valve 3HP21 fails closed), and loss of LPSW flow control valves to RHR hear exchangers. Upon loss of air, seal injection flow path remains open (3HP-31 fails open) with a flow of 45 gpm while seal return path is closed cutting off the 2gpm seal return flow. It is assumed that adequate RCP seal cooling can be maintained as long as a seal injection pump is available.

2. The HEP for operator failure to place RCM in operation is 0.1 (Event NSFORCMDHE on page 5.7-13.)

3. Based on the utility provided worksheet, the HEP for failure of the operator to manually align the ASW pump is 3.1E-2.

4. The IPE does not document the HEP for feed and bleed. The IPE analysis shows that SRV and PORV will be demanded by the pressure in Reactor Building upon failure of secondary heat removal. A generic credit of 2 based on the HEPs of B&W plants is used.

5. Due to the long time available before HPR is needed, a credit of 1 is given to operator manually establish cooling to the RHR heat exchangers. The IPE does not document the HEP associated with this operator action. The third LPI pump can be manual started and aligned. The HEP is 0.1, (Event LLPOP3CREC on page 5.7-10)

Table 3.12 SDP Worksheet for Oconee Nuclear Station, Units 1, 2, and 3 — Loss of Low Pressure Service Water (LLPSW)[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:**
Cross Connection to Unit 1 and 2 LPSW (XLPSW)	Operator local manually open the cross connection valves (1 train) [2]
Power Conversion System (PCS)	1/2 MFW trains and 1/3 Condensate booster pumps to 1/2 SG (operator action = 2) [3]
Secondary Heat Removal (EFW)	One TDEFW train (one ASD train) and steam relief through 1/4 ADVs or 1/16 safety valves
Alternate Secondary Heat Removal (ASW)	1/1 SSF ASW pump (operator action=2) [4] and steam relief through 1/4 ADVs or 1/16 safety valves
High Pressure SW (HPSW)	1/2 6000 gpm pump trains (one multi-train system)
Availability of SSF Systems (SSF)	Availability of SSF DG , SSF ASW pump, and SSF RCM RCP injection (operator action = 1)[5]

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1. LLPSW - XLPSW - PCS - EFW - ASW (5)			
2. LLPSW - XLPSW - HPSW - SSF (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. Loss of LPSW is estimated to be 4.3E-3 in the Oconee IPE. It will cause a reactor trip , loss of MDEFW pump cooling, and LPI coolers (No FB and HPR would be available). The back up system is the HPSW system for HPI pumps and TDEFW pump.

2. The HEP for operator failure to cross connect is 1.E-3 (Event WLSLPSWREC on page 5.7-27.) Hardware failure dominates the failure probability.

3. The IPE does not document the HEP associated with the operator actions needed to maintain PCS operation. The geometric mean of the HEPs associated with recovery of PCS in different transients, 2.7E-2, is used.

4. Based on the utility provided worksheet, the HEP for failure of the operator to manually align the ASW pump is 3.1E-2.

5. The availability of SSF systems the DG, RCM pump, and ASW pump could provide a means to go to safe shutdown. For the sake of simplicity for the work sheets, these function are all combined under SSF heading. The combined required operator actions therefore is assigned a probability of 0.1. This may not exactly reflect the plant risk profile but is considered sufficient for the purpose of screening.

Table 3.13 SDP Worksheet for Oconee Nuclear Station, Units 1, 2, and 3 — Loss of 4KV Bus 3TC (LBUS3TC)[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:**
Restore LPSW (LPSW)	Operator start the standby LPSW pump B (1 train) [2]
Turbine-driven EFW P Pump (TDEFW)	1/1 TDEFW train (one ASD train) and steam relief through 1/4 ADVs or 1/16 safety valves
Secondary Heat Removal (EFW)	1/2 MDEFW trains (1 multi-train system) or 1 TDEFW train (1 ASD train) and steam relief through 1/4 ADVs or 1/16 safety valves
Alternate Sec. Heat Removal (ASW)	1/1 SSF ASW pump (operator action = 2) [3] and steam relief through 1/4 ADVs or 1/16 safety valves
Primary bleed (FB)	1/2 SRVS or 1/1 PORV opens (operator action = 2) [4]
Early Inventory, HPI Injection (EIHP)	1/1 HPI train (2 pumps) injecting to 2 out of 4 RCS from BWST (1 train) [4]
High Pressure Recirculation (HPR)	1/1 HPI train (2 pumps) taking suction from 1/1 LPI train (1 train) [5]

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1. LBUS3TC - EFW - ASW - HPR (4)			
2 LBUS3TC- EFW - ASW - EIHP (5)			.
3 LBUS3TC - EFW - ASW - FB (6)			
4 LBUS3TC - LPSW - TDEFW - ASW (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. The frequency of loss of bus 3TC is 0.008 per year. It causes loss of power to CCW pumps 3A and 3D, hotwell pump 3A, condensate booster pump 3A, HPI pump A, LPI pump A, operating LPSW pump A, etc. It would cause a reactor trip due to low feedwater suction pressure, low condenser vacuum, or power imbalance. The operator has to restart the main feedwater pumps and start the standby LPSW pump B or open the cross connection to Unit 2 CCW header. Without LPSW, TDEFW pump and HPI pumps can be cooled by HPSW.

2. Hardware failure dominates the failure probability. The HEP for operator failure to start the standby LPSW pump is 1.E-3 (Event WLSPU3BDHE on page 5.7-28)

3. Based on the utility provided worksheet, the HEP for failure of the operator to manually align the ASW pump is 3.1E-2.

4. The IPE does not document the HEP for feed and bleed. The IPE analysis shows that SRV and PORV will be demanded by the pressure in Reactor Building upon failure of secondary heat removal. A generic credit of 2 based on the HEPs of B&W plants is used. The third HPI pump requires operator to start and align. The HEP is 0.1 (event LLPOP3CREC on page 5.7-10.) A credit of 1 should be used.

5. Hardware failure dominates the failure probability. Based on the utility provided worksheet, the human error probability (HEP) for switch over to recirculation is 2.2E-03. The third LPI pump can be manual started and aligned. The HEP is 0.1, (Event LLPOP3CREC on page 5.7-10)

Table 3.14 SDP Worksheet for Oconee Nuclear Station, Units 1, 2, and 3 — Loss of 4KV Bus 3TD (LBUS3TD)[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 (EFW)	1/1 MDEFW train (1 train) or 1 TDEFW train (1 ASD train) and steam relief through 1/4 ADVs or 1/16 safety valves
Alternate Sec. Heat Removal (ASW)	1/1 SSF ASW pump (operator action = 2) [2] and steam relief through 1/4 ADVs or 1/16 safety valves
Primary bleed (FB)	1/2 SRVS or 1/1 PORV opens (operator action = 2) [3]
Early Inventory, HPI Injection (EIHP)	1/1 HPI train (2 pumps) injecting to 2 out of 4 RCS from BWST (1 train) [3]
High Pressure Recirculation (HPR)	1/1 HPI train (2 pumps) taking suction from 1/1 LPI train (1 train) [4]

Circle Affected Functions	Recovery of Failed Train	Remaining Mitigation Capability Rating for Each Affected Sequence	Sequence Color
1. LBUS3TD - EFW - ASW - HPR (4)			
2 LBUS3TD- EFW - ASW - EIHP (5)			.
3 LBUS3TD - EFW - ASW - FB (6)			

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

Notes:

1. The frequency of loss of bus 3TD is 0.008 per year. It causes loss of power to CCW pumps 3B, hotwell pump 3B, condensate booster pump 3B, EFW pump 3A, HPI pump 3C, LPI pump 3B, standby LPSW pump 3B, etc. It would cause a reactor trip due to low feedwater suction pressure, low condenser vacuum, or power imbalance. It is assumed that LPSW pump A is normally running, and LPSW is unaffected by the initiating event. The operator has to restart the main feedwater pumps.

2. Based on the utility provided worksheet, the HEP for failure of the operator to manually align the ASW pump is 3.1E-2.

3. The IPE does not document the HEP for feed and bleed. The IPE analysis shows that SRV and PORV will be demanded by the pressure in Reactor Building upon failure of secondary heat removal. A generic credit of 2 based on the HEPs of B&W plants is used. The third HPI pump requires operator to start and align. The HEP is 0.1 (event LLPOP3CREC on page 5.7-10.) A credit of 1 should be used.

4. Hardware failure dominates the failure probability. Based on the utility provided worksheet, the human error probability (HEP) for switch over to recirculation is 2.2E-03. The third LPI pump can be manual started and aligned. The HEP is 0.1, (Event LLPOP3CREC on page 5.7-10)

Table 3.15 SDP Worksheet for Oconee Nuclear Station, Units 1, 2, and 3 — Loss of 4KV Bus 3TE (LBUS3TE)[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 (EFW)	1/1 MDEFW train (1 train) or 1 TDEFW train (1 ASD train) and steam relief through 1/4 ADVs or 1/16 safety valves
Alternate Sec. Heat Removal (ASW)	1/1 SSF ASW pump (operator action = 2) [2] and steam relief through 1/4 ADVs or 1/16 safety valves
Primary bleed (FB)	1/2 SRVS or 1/1 PORV opens (operator action = 2) [3]
Early Inventory, HPI Injection (EIHP)	1/2 HPI train (2 pumps) injecting to 2 out of 4 RCS from BWST (1 train) [3]
High Pressure Recirculation (HPR)	1/2 HPI train (2 pumps) taking suction from 1/2 LPI trains (operator action = 3) [4]

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1. LBUS3TD - EFW - ASW - HPR (4)			
2 LBUS3TD- EFW - ASW - EIHP (5)			.
3 LBUS3TD - EFW - ASW - FB (6)			

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

Notes:

1. The frequency of loss of bus 3TE is 0.008 per year. It causes loss of power to CCW pumps 3C, hotwell pump 3C, condensate booster pump 3C, EFW pump 3B, HPI pump 3B, LPI pump 3C, etc. It would cause a reactor trip due to low feedwater suction pressure, low condenser vacuum, or power imbalance. LPSW is unaffected by the initiating event. The operator has to restart the main feedwater pumps.

2. Based on the utility provided worksheet, the HEP for failure of the operator to manually align the ASW pump is 3.1E-2.

3. The IPE does not document the HEP for feed and bleed. The IPE analysis shows that SRV and PORV will be demanded by the pressure in Reactor Building upon failure of secondary heat removal. A generic credit of 2 based on the HEPs of B&W plants is used. The third HPI pump requires operator to start and align. The HEP is 0.1 (event LLPOP3CREC on page 5.7-10.) A credit of 1 should be used.

4. Based on the utility provided worksheet, the human error probability (HEP) for switch over to recirculation is 2.2E-03.

Table 3.16 SDP Worksheet for Oconee Nuclear Station, Units 1, 2, and 3 — Interfacing System LOCA (ISLOCA)(1)

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

<u>Initiating Pathways</u>:	**<u>Mitigation Capability: Ensure Component Operability for Each Pathway</u>:**
DHR Suction Line	Two normally closed and pressure-interlocked MOVs (3LP-1 and 3LP-2)
LPI Injection Line A	Two check valves (3CF-14 and 3LP–48) and a normally closed MOV (3LP-17)
LPI Injection Line B	Two check valves (3CF-12 and 3LP-47) and a normally closed MOV (3LP-18)
Low Pressure Aux. Spray Line	On check valve, two manual valves, and one MOV (3LP-17) to pressurizer

<u>Circle Affected Functions</u>	**<u>Recovery of Failed Train</u>**	**<u>Remaining Mitigation Capability Rating for Each Affected Pathway</u>**	**<u>Sequence Color</u>**

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

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

Note:

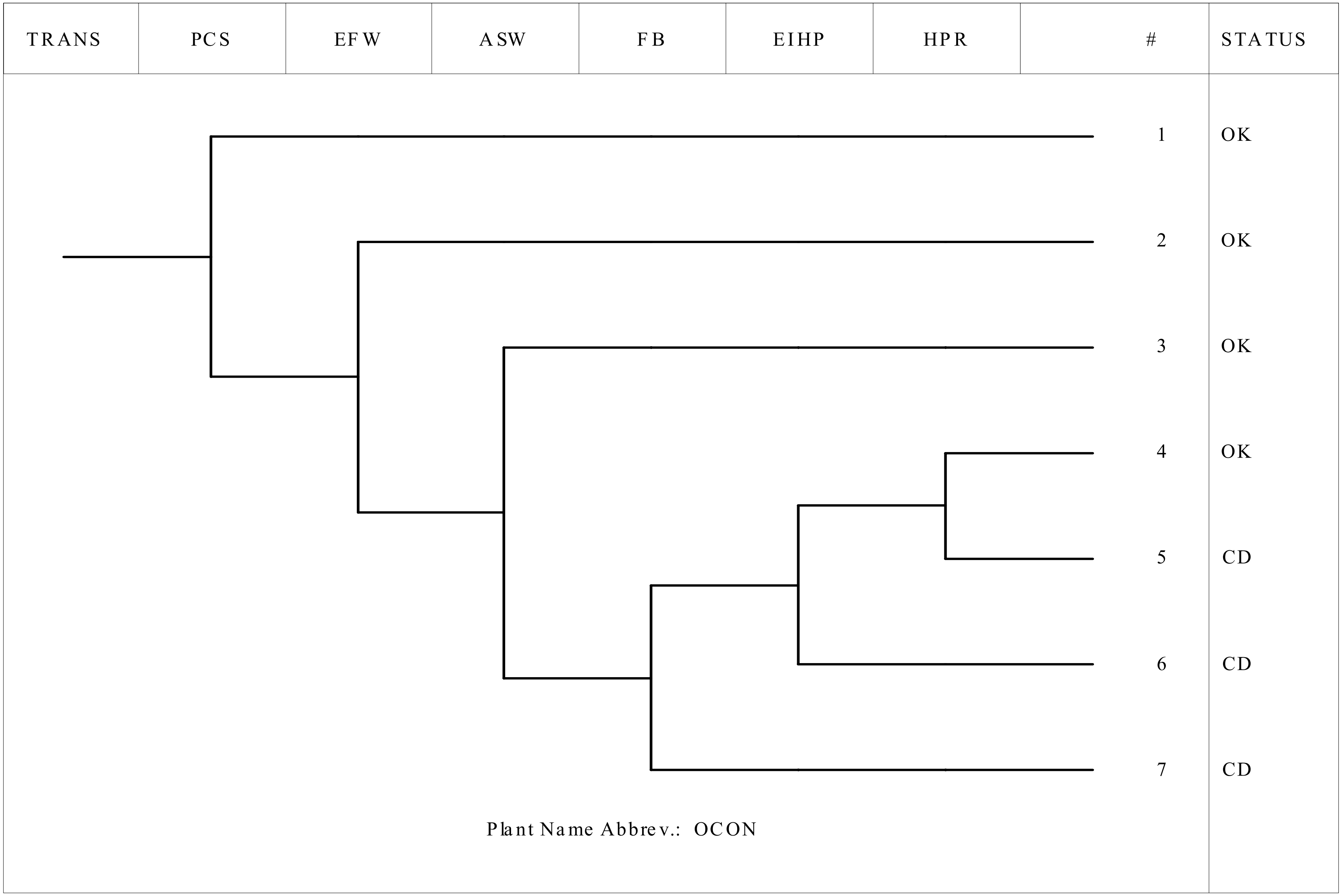
1. The interfacing lines are based on ANO-1 PSA rev. 2 summary. The valve arrangements are taken from the IPE.

1.3 SDP Event Trees

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

The following event trees are included:

1. Transients (Reactor Trip) (TRANS)
2. Transients without PCS (TPCS)
3. Small LOCA (SLOCA)
4. Stuck-open PORV (SORV)
5. Medium LOCA (MLOCA)
6. Large LOCA (LLOCA)
7. Loss of Offsite Power (LOOP)
8. Steam Generator Tube Rupture (SGTR)
9. Anticipated Transients without Scram (ATWS)
10. Main Steam Line Break (MSLB)
11. Loss of Instrument Air (LIA)
12. Loss of Low Pressure Service Water (LLPSW)
13. Loss of 4KV Bus 3TC (LBUS3TC)
14. Loss of 4KV Bus 3TD (LBUS3TD)
15. Loss of 4KV Bus 3TE (LBUS3TE)


TRANS
PCS
EFW
ASW
FB
EIHP
HPR
#
STATUS
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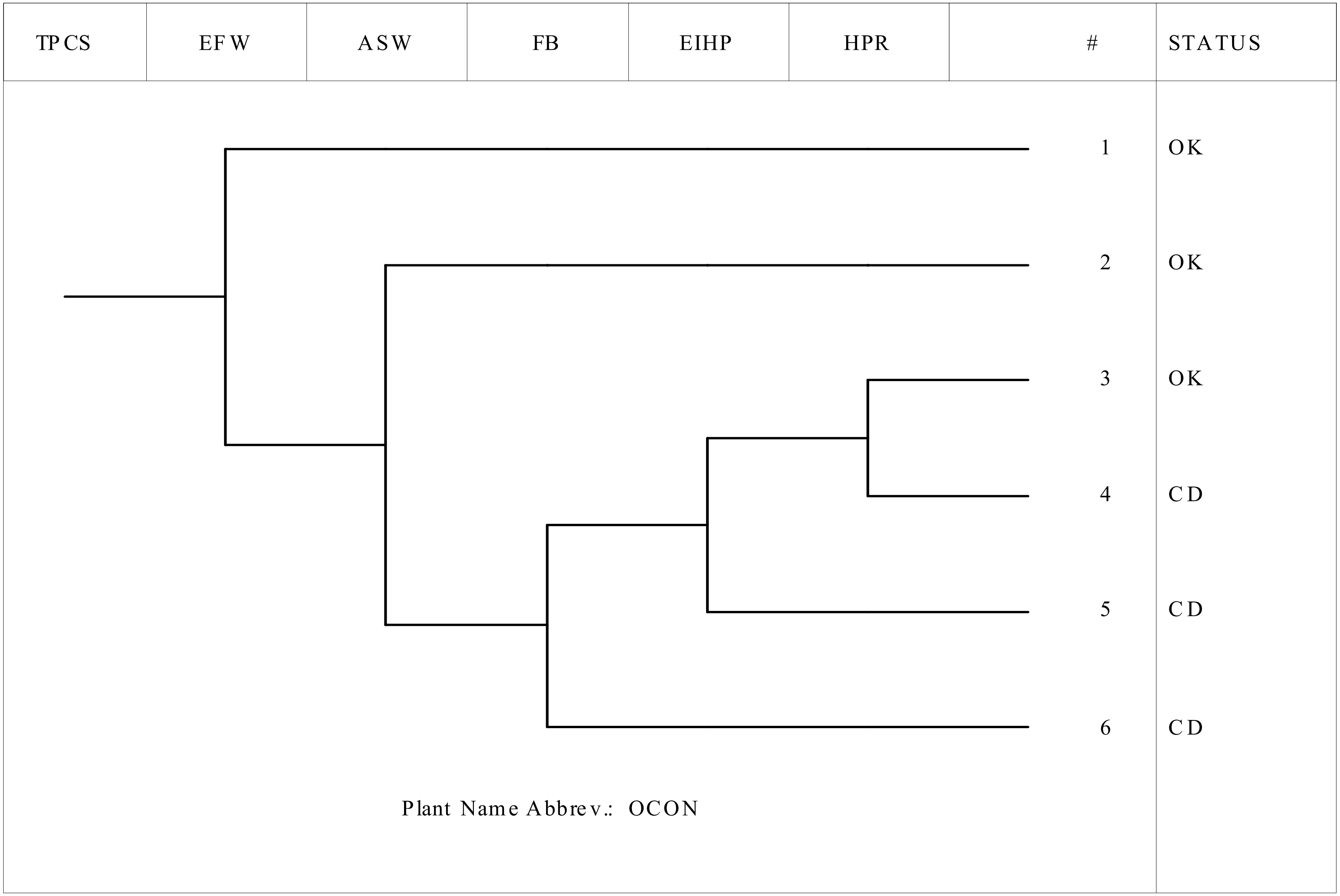
2 OK
3 OK
4 OK
5 CD
6 CD
7 CD
Plant Name Abbrev.: OCON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EFW
ASW
FB
EIHP
HPR
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STATUS
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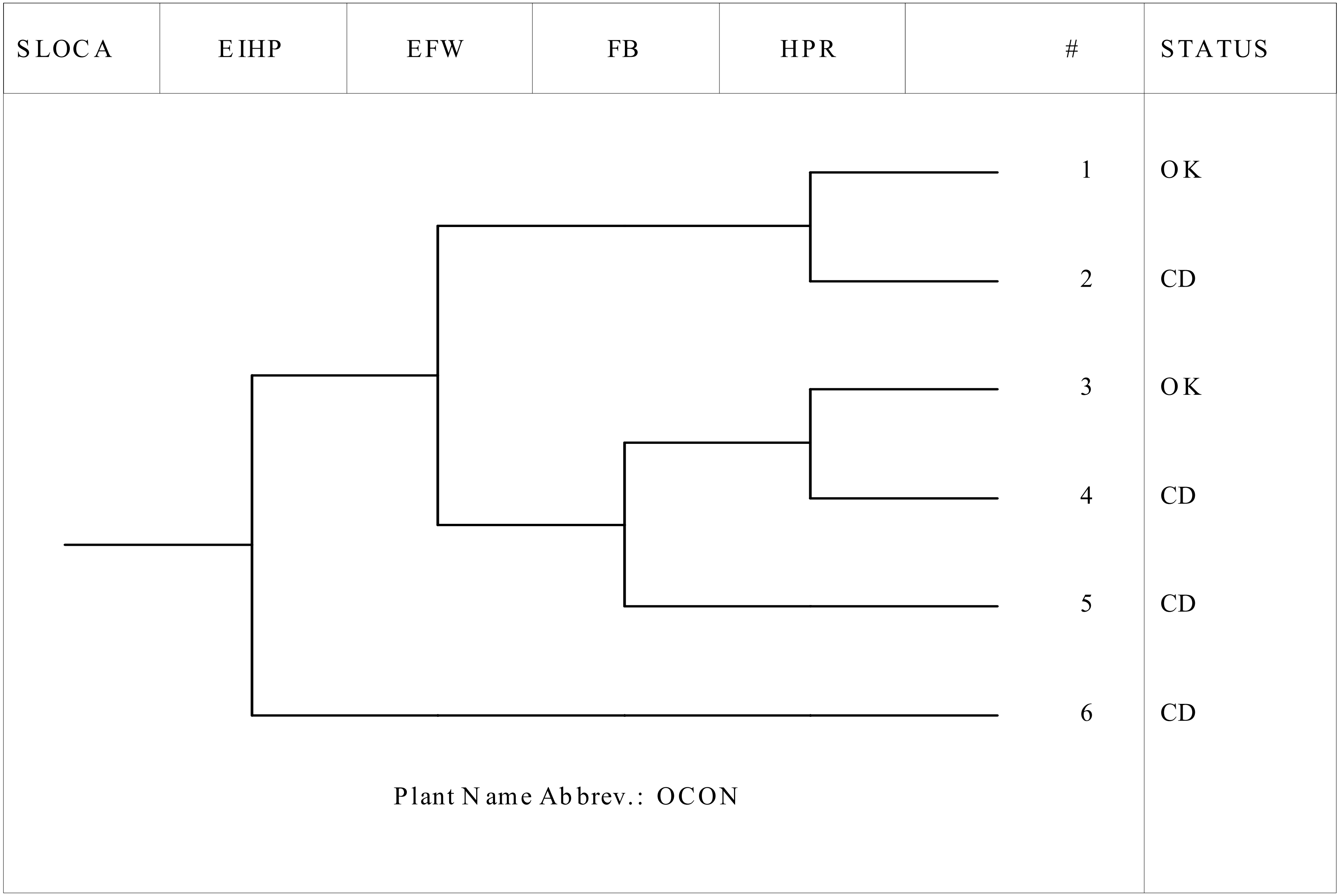
OK
2
OK
3
OK
4
CD
5
CD
6
CD
Plant Name Abbrev.: OCON


SLOCA
EIHP
EFW
FB
HPR
#
STATUS
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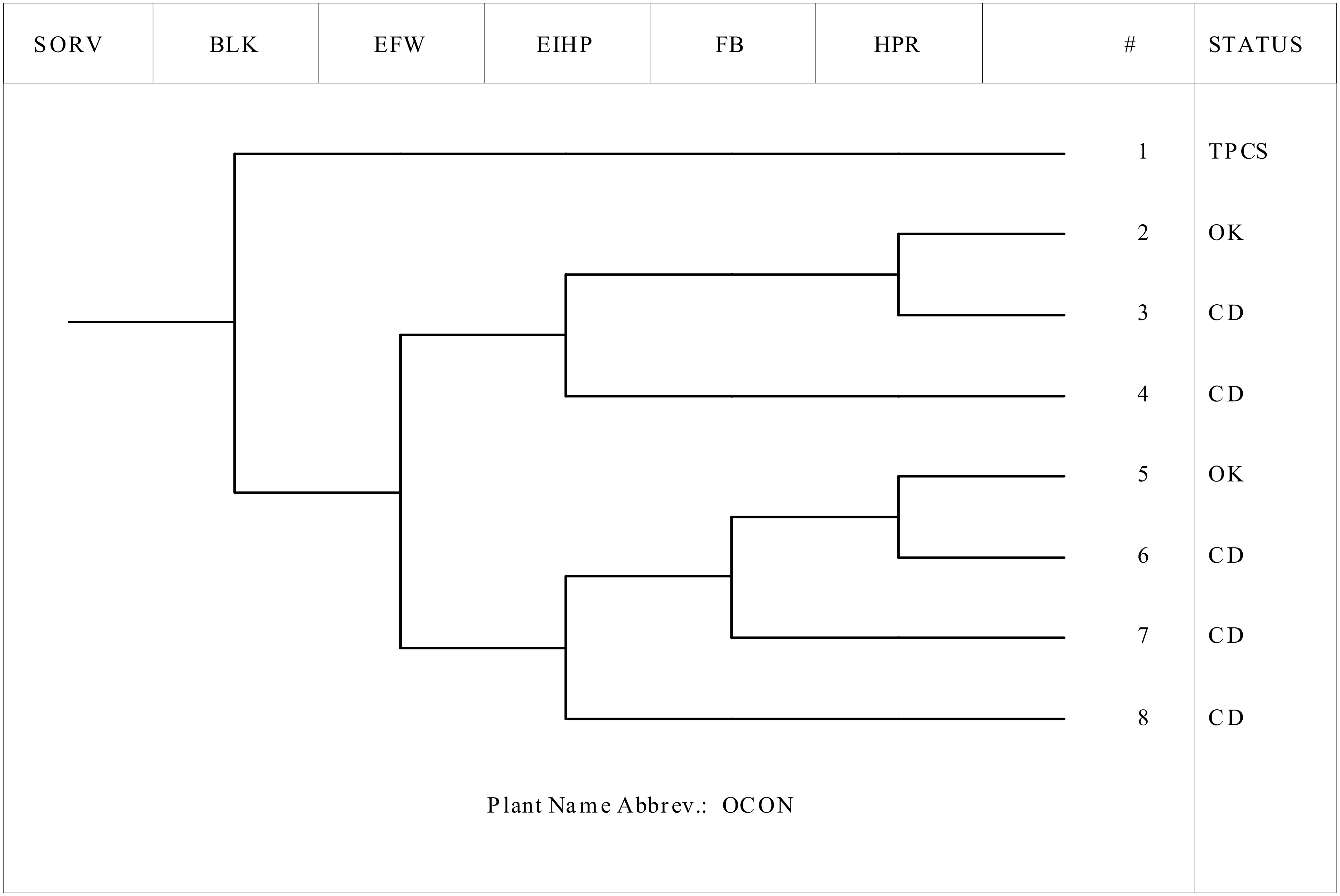
OK
2
CD
3
OK
4
CD
5
CD
6
CD
Plant Name Abbrev.: OCON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BLK
EFW
EIHP
FB
HPR
#
STATUS
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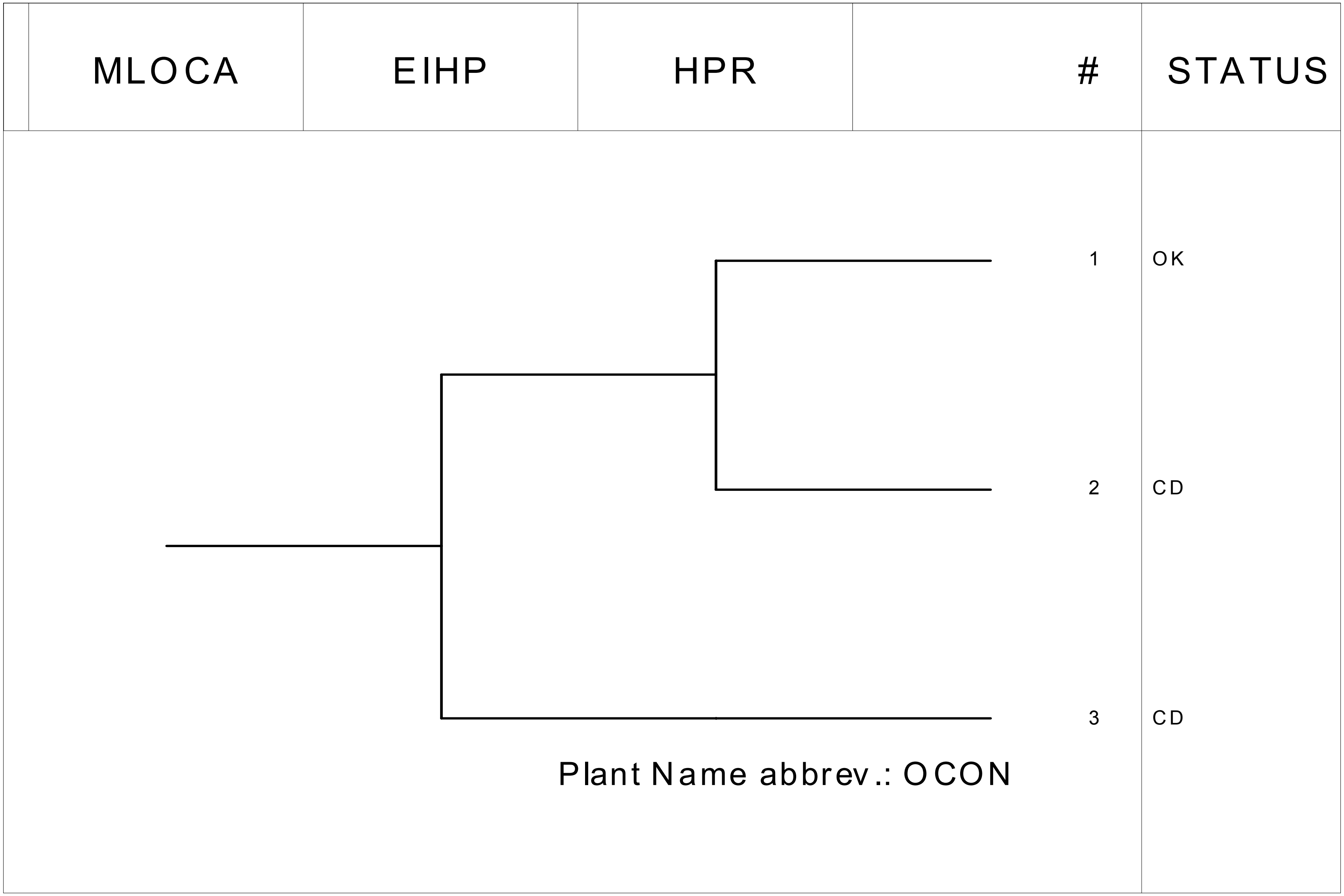
3 CD
4 CD
5 OK
6 CD
7 CD
8 CD
Plant Name Abbrev.: OCON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HPR
#
STATUS
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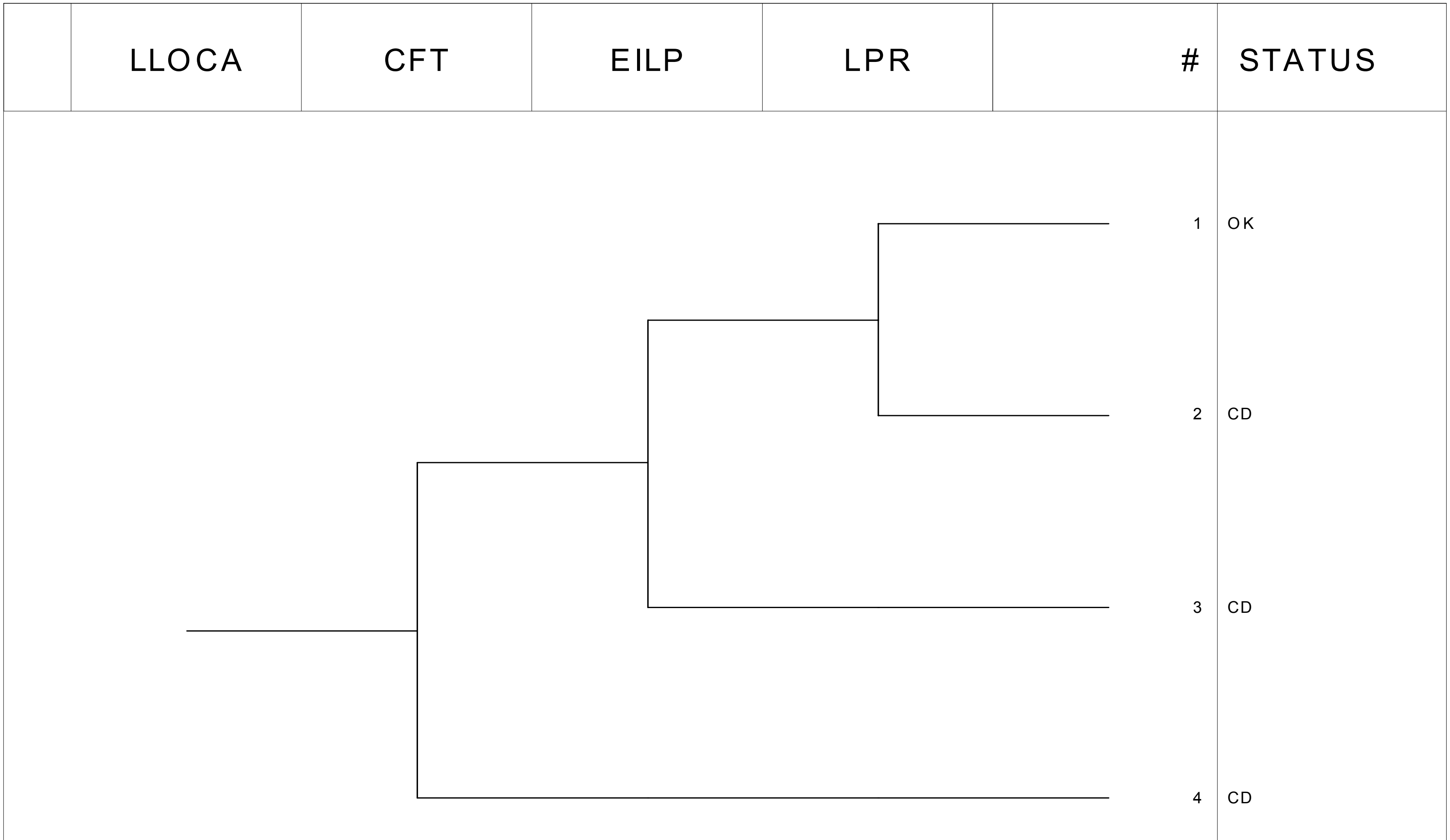
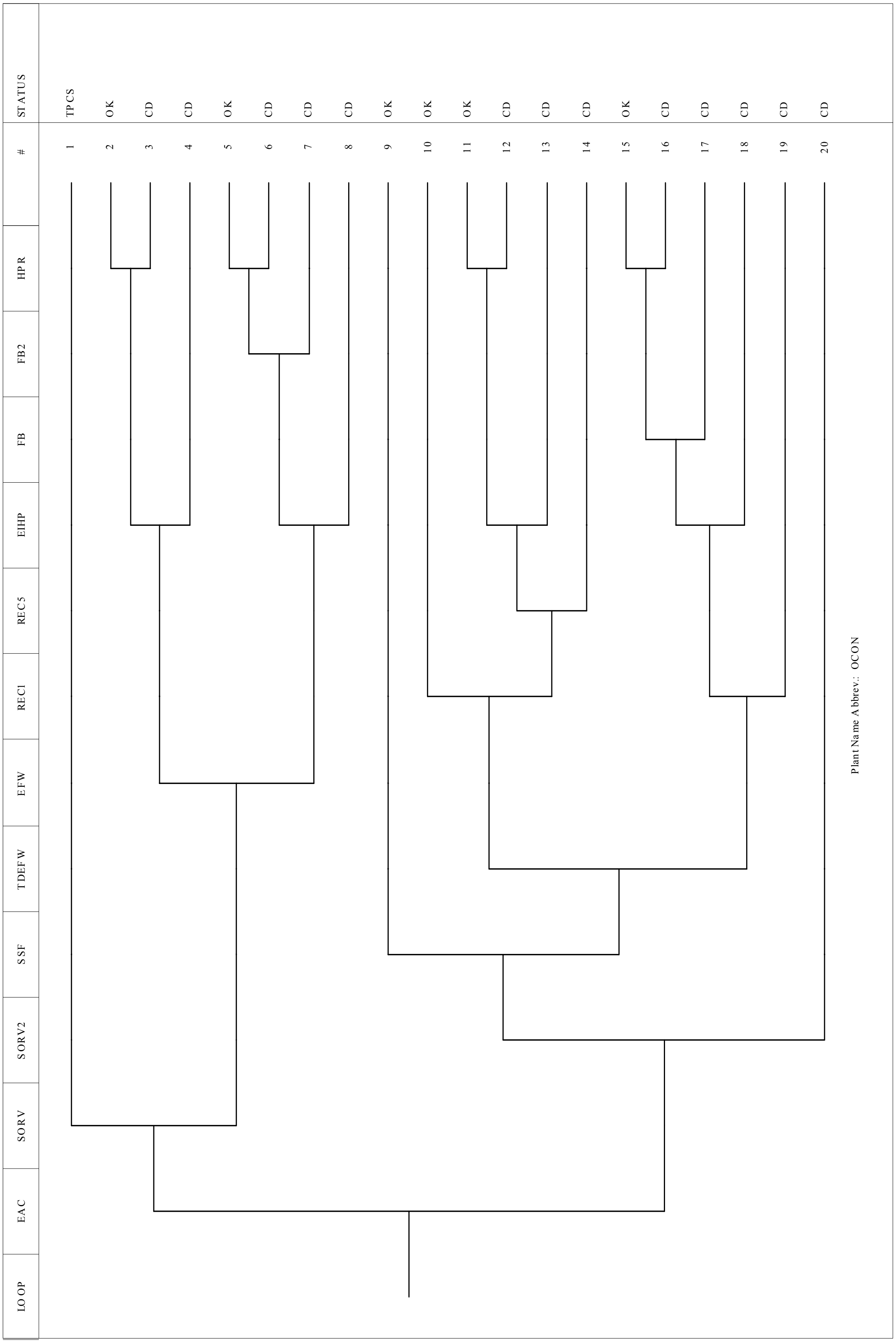
OK
2
CD
3
CD
Plant Name abbrev.: OCON



Plant Name abbrev.: OCON


LOOP
EAC
SORV
SORV2
SSF
TDEFW
EFW
REC1
REC5
EIHP
FB
FB2
HPR
#
STATUS
1 TPCS
2 OK
3 CD
4 CD
5 OK
6 CD
7 CD
8 CD
9 OK
10 OK
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12 CD
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15 OK
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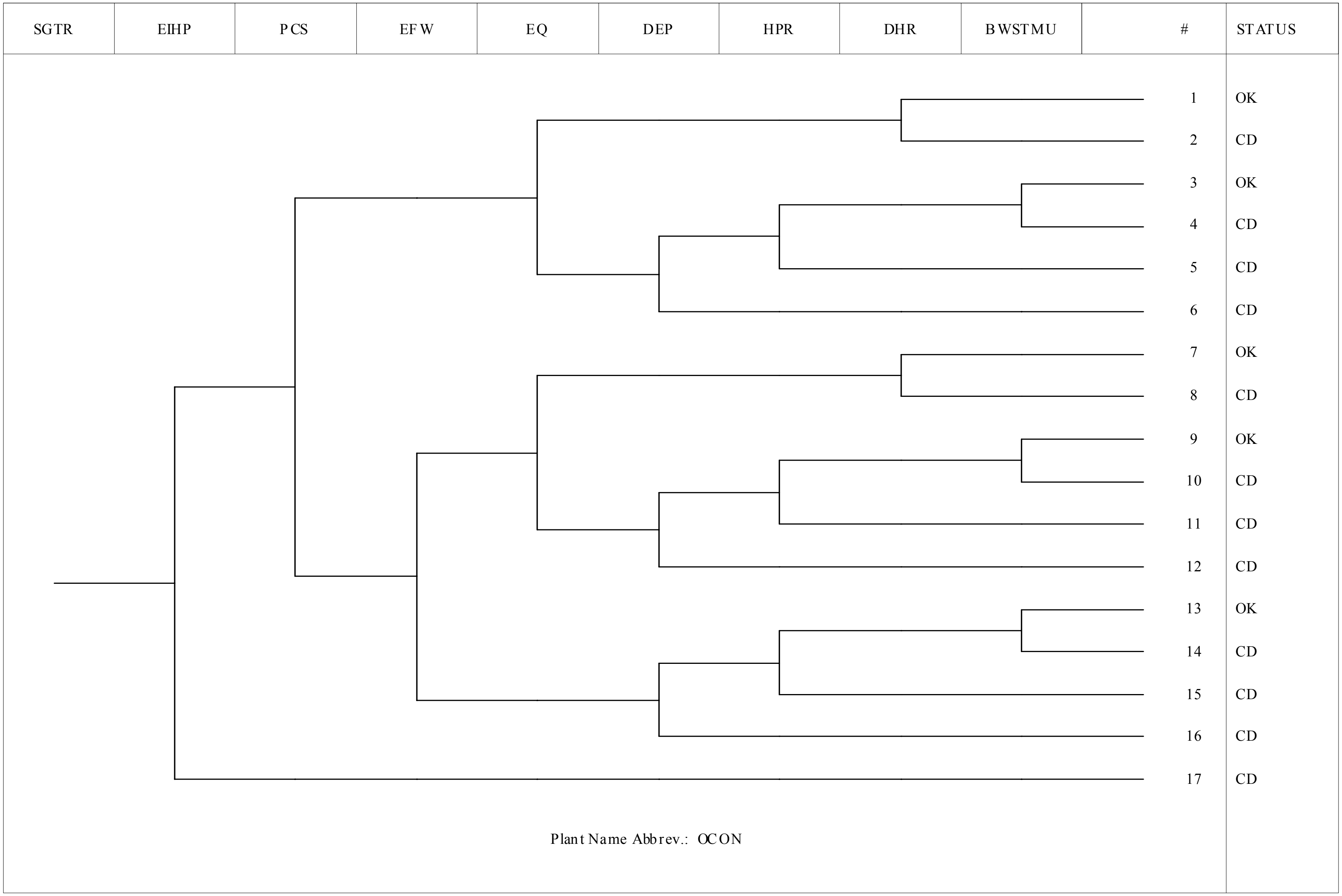
18 CD
19 CD
20 CD
Plant Name Abbrev.: OCON


SGTR
EIHP
PCS
EFW
EQ
DEP
HPR
DHR
BWSTMU
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6 CD
7 OK
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9 OK
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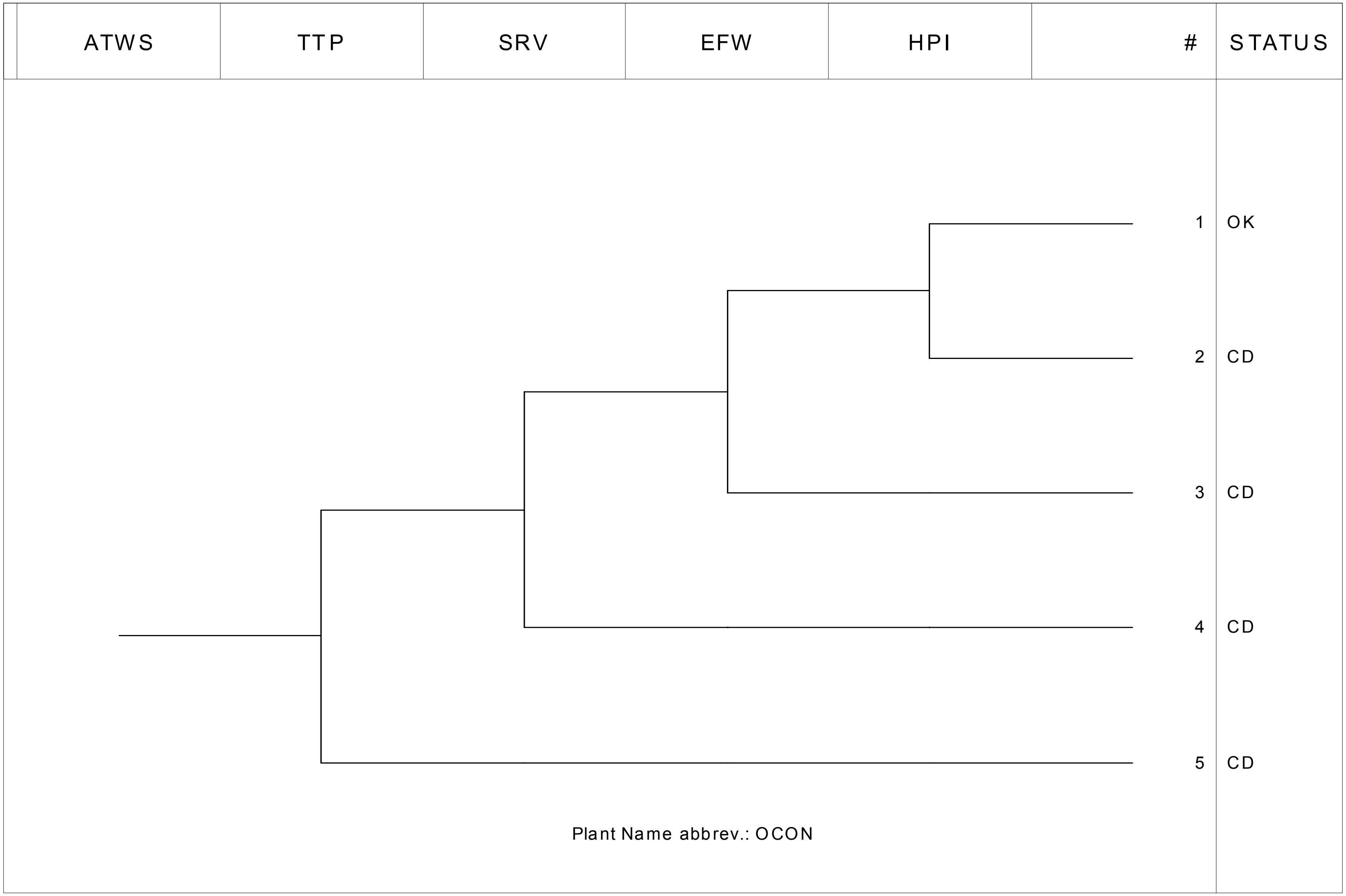
17 CD
Plant Name Abbrev.: OCON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TTP
SRV
EFW
HPI
#
STATUS
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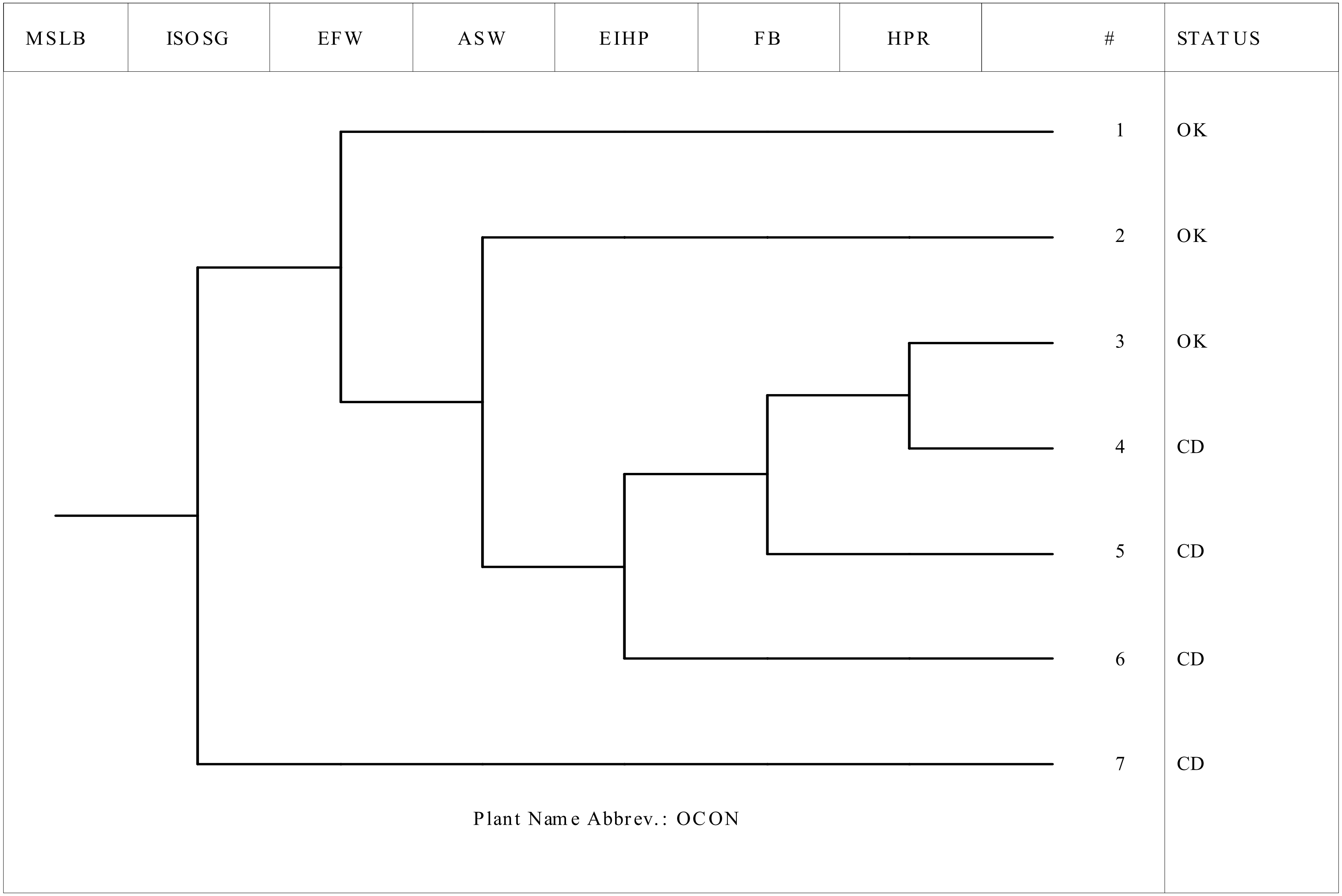
5 CD
Plant Name abbrev.: OCON


MSLB
ISOSG
EFW
ASW
EIHP
FB
HPR
#
STATUS
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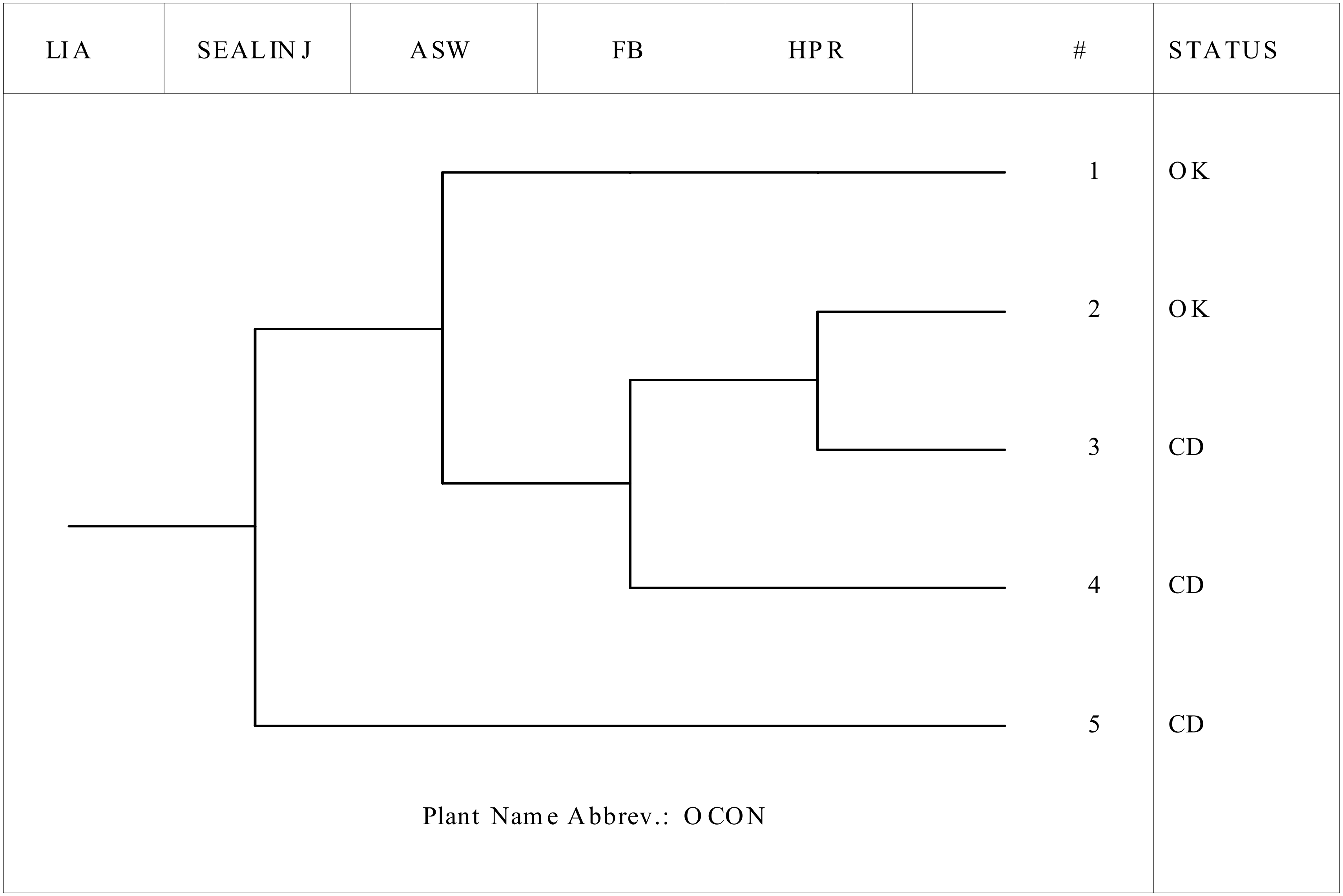
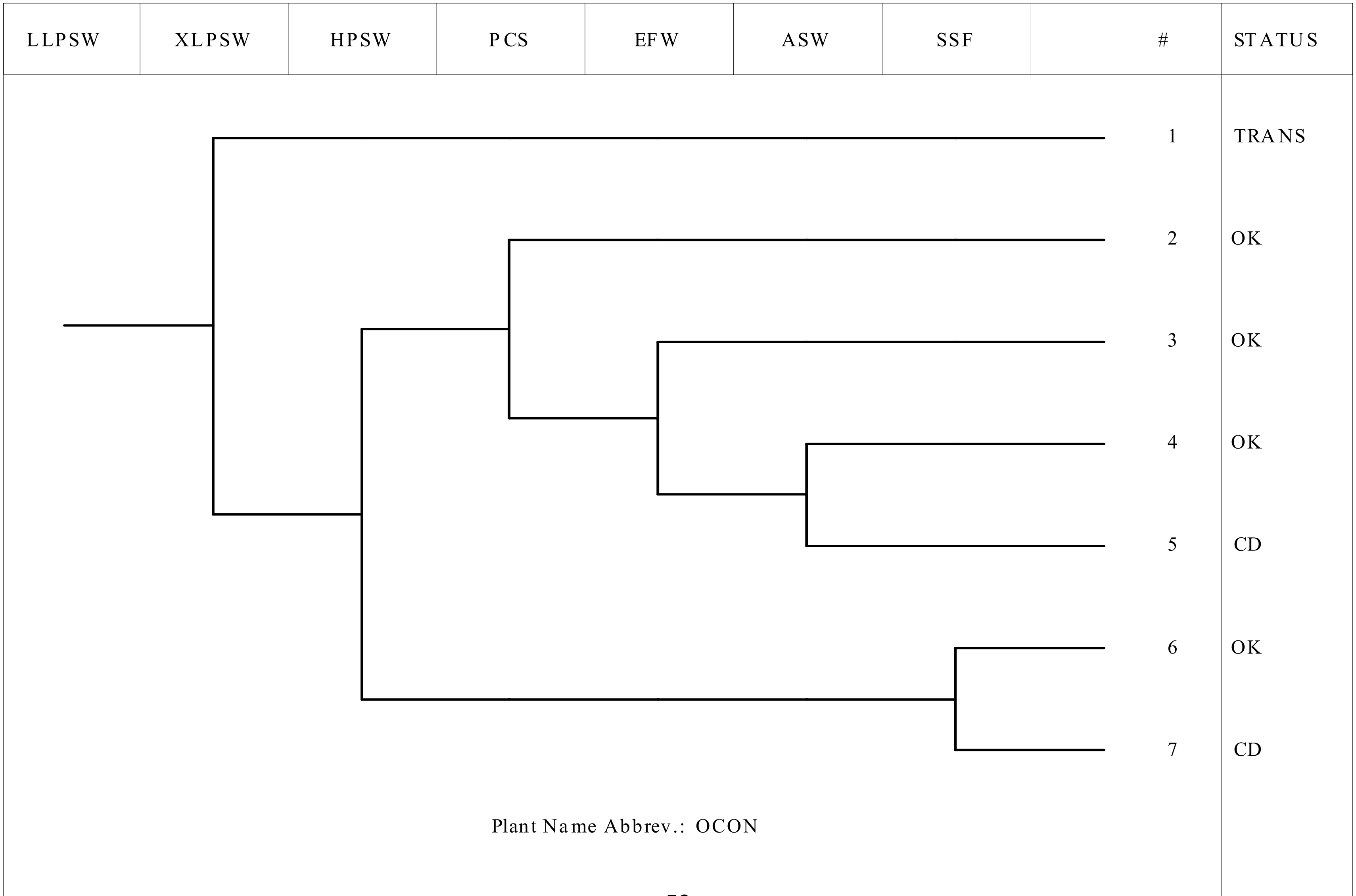
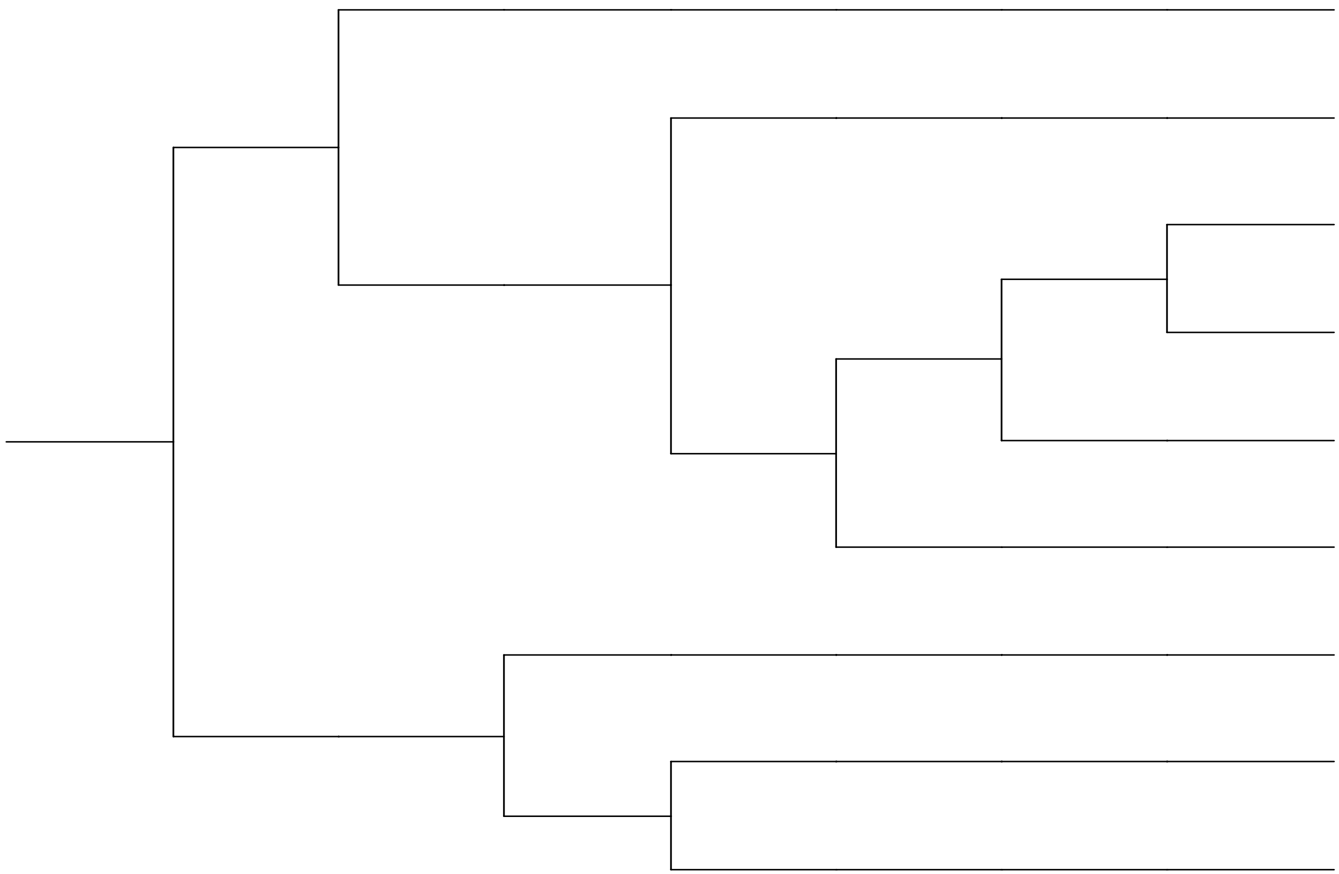
3 OK
4 CD
5 CD
6 CD
7 CD
Plant Name Abbrev.: OCON


LIA
SEALINJ
ASW
FB
HPR
#
STATUS
1
OK
2
OK
3
CD
4
CD
5
CD
Plant Name Abbrev.: OCON


LLPSW
XLPSW
HPSW
PCS
EFW
ASW
SSF
#
STATUS
1
TRANS
2
OK
3
OK
4
OK
5
CD
6
OK
7
CD
Plant Name Abbrev.: OCON

LBUS3TC	LPSW	EFW	TDEFW	ASW	FB	EIHP	HPR	#	STATUS



#	STATUS
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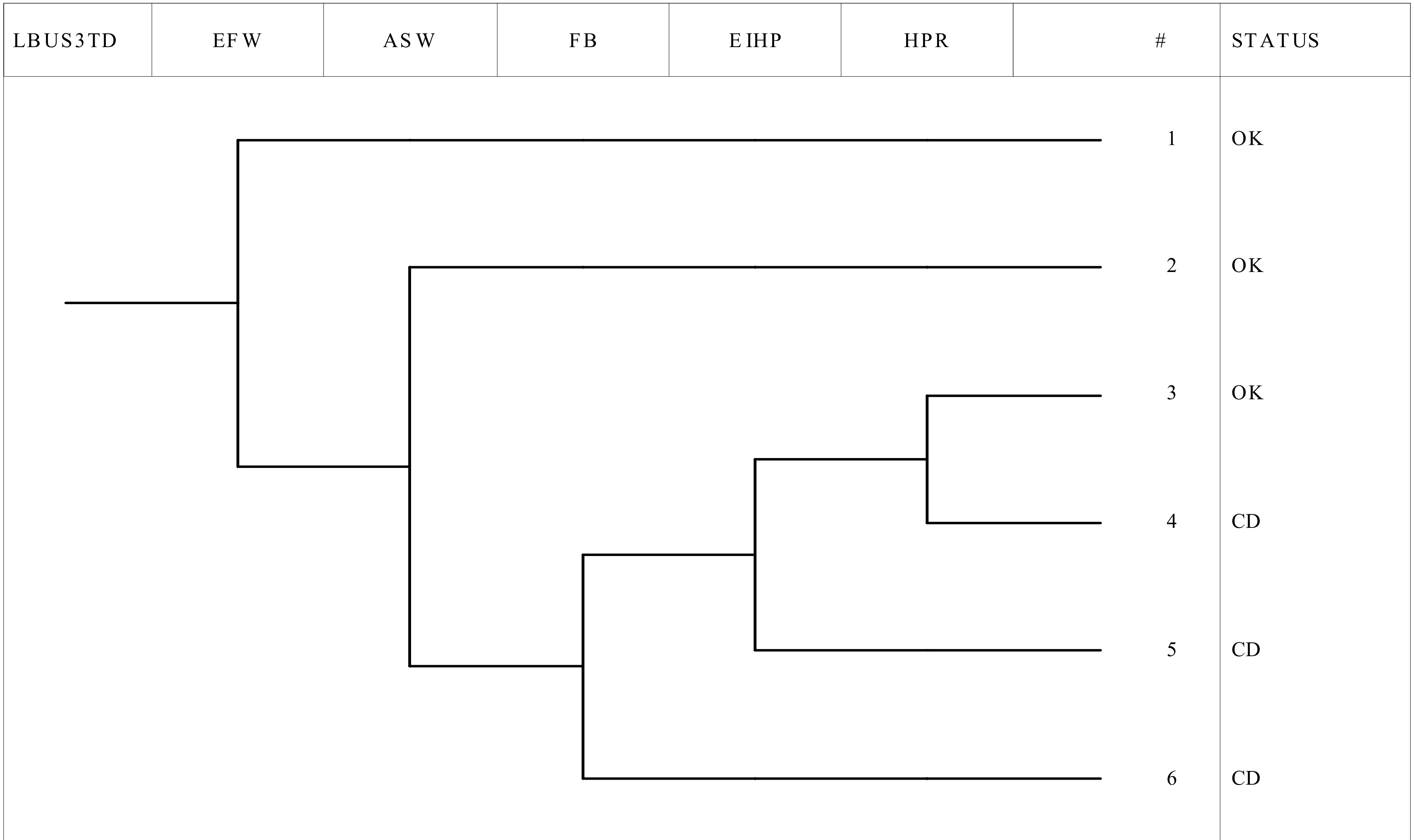
3	OK
4	CD
5	CD
6	CD
7	OK
8	OK
9	CD

Plant Name Abbrev.: OCON



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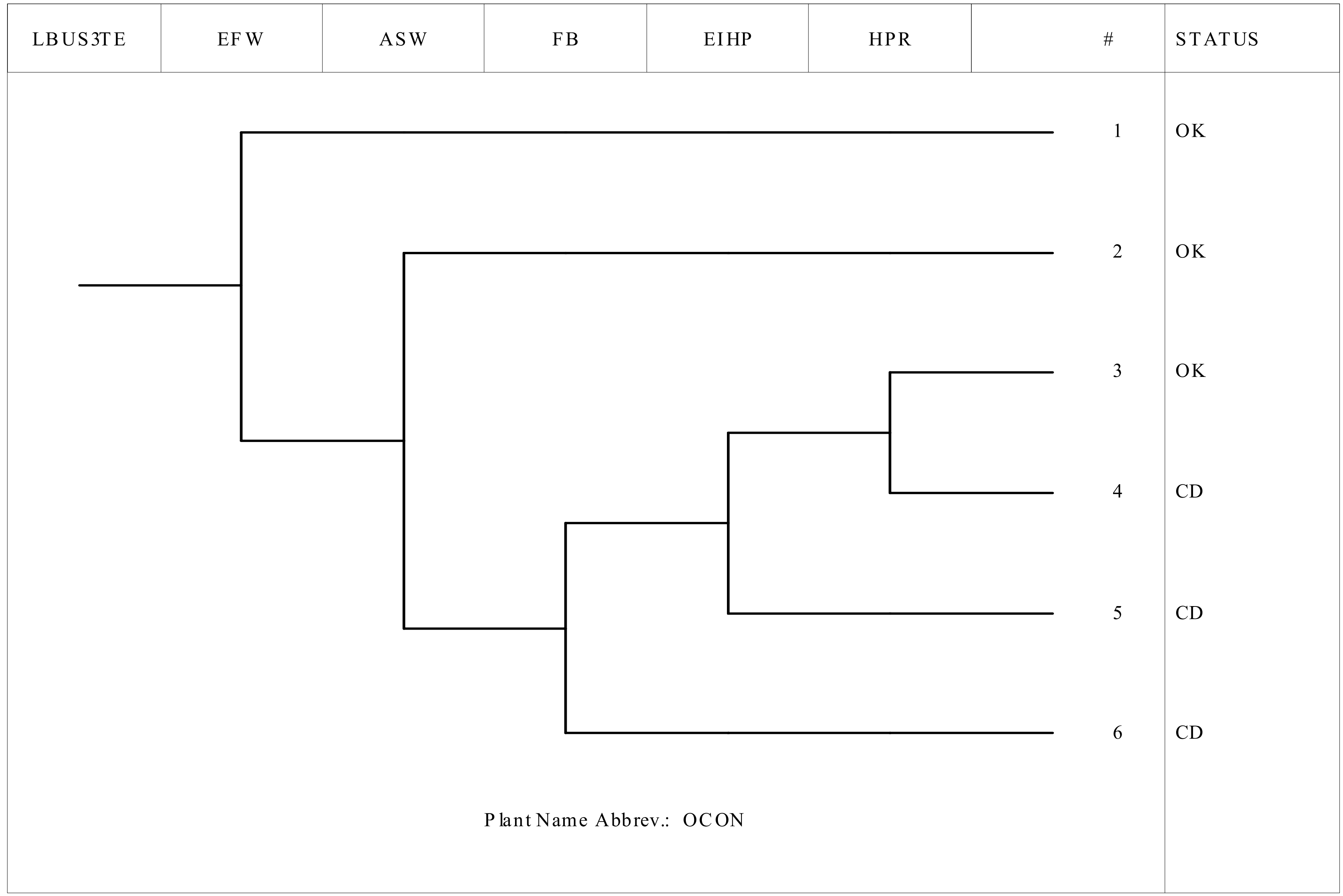
LBUS3TE
EFW
ASW
FB
EIHP
HPR
#
STATUS
1 OK
2 OK
3 OK
4 CD
5 CD
6 CD
Plant Name Abbrev.: OCON

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

The utility reviewed an early version of the notebook, and provided its own version of the note book. The utility's version does not cover initiating events MSLB, LIA, LLPSW, LBUS3TC, LBUS3TD, and LBUS3TE.

Transients - The utility's version modeled the potential of a seal LOCA which is excluded from all SDP notebooks. See resolution of generic comments.

LOOP - The utility's version only includes one offsite power recovery event. This note book models two recovery times, in an attempt to cover the importance of the TDEFW pump in a station blackout. Due to lack of timing information in the IPE, two recovery times were assumed, 1 hour and 5 hour. The former represents time to core damage when TDEFW pump is not available, while the latter represents the case with TDEFW pump available as long as the batteries are not depleted.

SGTR, MLOCA, and LLOCA - There is little difference between the two versions.

SLOCA - The utility's version does not require decay heat removal, while this note book requires heat removal through a SG or by feed-and-bleed.

ATWS - The utility's version questions moderator temperature coefficient while this notebook assumes it is favorable such that the ATWS can be mitigated.

REFERENCES

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

2. Duke Power Company, "Oconee Nuclear Station, Unit 3 — Individual Plant Examination Report," November 1990.