April 17, 2001

Mr. Steve Byrne
Vice President, Nuclear Operations
South Carolina Electric & Gas Company
Virgil C. Summer Nuclear Station
Post Office Box 88
Jenkinsville, South Carolina 29065

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

Dear Mr. Byrne:

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

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

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

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

We will coordinate our efforts through your licensing or risk organizations as appropriate. If you have any questions, please contact me at 301-415-1438.

Sincerely,

/RA/

Karen R. Cotton, Project Manager, Section 1
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-395

Enclosure: As stated

cc w/encl: See next page

We will coordinate our efforts through your licensing or risk organizations as appropriate. If you have any questions, please contact me at 301-415-1438.

Sincerely,

/RA/

Karen R. Cotton, Project Manager, Section 1
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-395

Enclosure: As stated

cc w/encl: See next page

<u>DISTRIBUTION</u>:
PUBLIC
PDII-1 Reading
REmch RidsNrrDlpmLpdii1
EDunnington (paper copy)
OGC RidsOgcRp
ACRS RidsAcrsAcnwMailCenter
RidsRgn2MailCenter

G:\PDII-1\SUMMER\TACMA6544.WPD
ADAMS ACCESSION NUMBER:

OFFICE	PDII-1/PM	PDII-2/LA	PDII-1/SC	
NAME	KCotton:mw	EDunnington	REmch	
DATE	4/4/2001	4/4/2001	4/6/2001	/ /2001

OFFICIAL RECORD COPY

cc:

Mr. R. J. White
Nuclear Coordinator
S.C. Public Service Authority
c/o Virgil C. Summer Nuclear Station
Post Office Box 88, Mail Code 802
Jenkinsville, South Carolina 29065

Resident Inspector/Summer NPS
c/o U.S. Nuclear Regulatory Commission
576 Stairway Road
Jenkinsville, South Carolina 29065

Chairman, Fairfield County Council
Drawer 60
Winnsboro, South Carolina 29180

Mr. Henry Porter, Assistant Director
Division of Waste Management
Bureau of Land & Waste Management
Department of Health & Environmental Control
2600 Bull Street
Columbia, South Carolina 29201

Mr. Bruce C. Williams, General Manager
Nuclear Plant Operations
South Carolina Electric & Gas Company
Virgil C. Summer Nuclear Station, Mail Code 303
Post Office Box 88
Jenkinsville, South Carolina 29065

Mr. Melvin N. Browne, Manager
Nuclear Licensing & Operating Experience
South Carolina Electric & Gas Company
Virgil C. Summer Nuclear Station, Mail Code 830
Post Office Box 88
Jenkinsville, South Carolina 29065

J. B. Knotts, Jr., Esquire
Winston & Strawn Law Firm
1400 L Street, N.W.
Washington, D.C. 20005-3502

RISK-INFORMED INSPECTION NOTEBOOK FOR
V. C. SUMMER NUCLEAR STATION

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

Prepared by

Brookhaven National Laboratory
Energy Sciences and Technology Department

Contributors

M. A. Azarm
T. L. Chu
A. Fresco
J. Higgins
G. Martinez-Guridi
P. K. Samanta

NRC Technical Review Team

John Flack	**RES**
Jose Ibarra	**RES**
Doug Coe	**NRR**
Gareth Parry	**NRR**
Peter Wilson	**NRR**
See Meng Wong	**NRR**
Jim Trapp	**Region I**
Michael Parker	**Region III**
William B. Jones	**Region IV**

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.

U. S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

ABSTRACT

This notebook contains summary information to support the Significance Determination Process (SDP) in risk-informed inspections for the V. C. Summer Nuclear Station.

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

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

CONTENTS

TABLES

Page

FIGURES

Page

1. INFORMATION SUPPORTING SIGNIFICANCE DETERMINATION PROCESS (SDP)

SECY-99-007A (NRC, March 1999) describes the process for making a Phase 2 evaluation of the inspection findings. 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 V. C. Summer Nuclear Station.

1.1 INITIATING EVENT LIKELIHOOD RATINGS

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

Table 1 Categories of Initiating Events for Summer Nuclear Station

Row	Approximate Frequency	Example Event Type	Estimated Likelihood Rating		
I	> 1 per 1-10 yr	Reactor Trip (TRANS), Loss of Power Conversion System (TPCS)	**A**	**B**	**C**
II	1 per 10-10^2 yr	Loss of offsite power (LOOP), Loss of Instrument Air (LOIA)	**B**	**C**	**D**
III	1 per 10^2 - 10^3 yr	Small LOCA including RCP seal failures (SLOCA), Stuck open PORV/SRV (SORV), SGTR, MSLB (outside containment)	**C**	**D**	**E**
IV	1 per 10^3 - 10^4 yr	Medium LOCA (MLOCA), Loss of CCW (LCCW), Loss of One 125 VDC Vital Bus (LBDC), LOOP with Loss of One Division of AC (LOAC), Loss of Two 120 VAC Vital Instrumentation Panels (LTIP)	**D**	**E**	**F**
V	1 per 10^4 - 10^5 yr	Large LOCA (LLOCA)	**E**	**F**	**G**
VI	less than 1 per 10^5 yr	ATWS[1], Loss of SW system (LSSW), 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).

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 (continued)

Table 2 Initiators and System Dependency for Summer Nuclear Station

Affected System	Major Components	Support System	Initiating Event Scenarios
AC Power System	Safeguards Power System: Two buses (trains) of 7.2 KV-AC	DC, HVAC	All
	480 VAC: Six unit substations and nine MCCs	7.2 KV-AC, DC	All
	120 VAC Instrumentation and Control System: 6 panels and inverters	480 VAC	LTIP
Accumulators	Three accumulators	None	LLOCA
Component Cooling Water (CCW)	Three pumps in two loops, and three CCW booster pumps	7.2 KV-AC, DC, SW, ESFAS	LCCW
CVCS/HHSI (HPI in worksheets)	Three Charging/SI pumps[1]	7.2 KV-AC, 480 VAC, DC, CCW, ESFAS	All except LBDC
	One boric acid transfer pump		ATWS
Condensate (CO)	3 50% condensate pumps	Non-safety AC, DC, Circulating water system	TRAN, SLOCA,SORV, LSSW, LCCW, LTIP
DC Power system	Safeguards Power System: Two buses (trains) of 125 V-DC	480 VAC	LBDC
Emergency Feedwater (EFW)	Two MDPs	7.2 KV-AC, 480 VAC, DC, ESFAS	All except MLOCA, LLOCA
	One TDP	DC, MS[2], ESFAS	
Engineered Safety Features Actuation System (ESFAS)	Two-train system	120 VAC	All
Heating, Ventilation, and Air Conditioning (HVAC)[3]	ESF Switchgear Rooms and Speed Switch Rooms Cooling Systems	480 VAC, DC[4]	All

Table 2 (continued)

Affected System	Major Components	Support System	Initiating Event Scenarios
	Diesel Generator Building Ventilation System		LOOP
Instrument Air (IA)	Three motor-driven air compressors and one diesel-generator-driven air compressor	480 VAC, DC, Turbine Building Closed Cooling Water (TBCCW)	LOIA
Main Feedwater (FW)	Four 33.3% motor-driven FW booster pumps	Non-safety AC, DC, IA	TRAN, SLOCA,SORV, LSSW, LCCW, LTIP
	FW isolation valves (FWIVs)	DC	MSLB
Main Steam (MS)	Per SG: five safety valves, one PORV, one main steam air-operated isolation valve (MSIV), one MSIV bypass valves, one atmospheric air-operated steam dump valve. Eight condenser steam dump valves.	IA, DC	All except MLOCA, LLOCA
Onsite Standby Power System	Two diesel generators	DC, Diesel Generator Building Ventilation System (HVAC), SW	LOOP, LOAC
Pressurizer Pressure Relief	Three PORVs with associated block valves	480 VAC, DC, IA[5], ESFAS[6]	All except MLOCA, LLOCA, LBDC
	Three safety valves		ATWS
	Pressurizer spray	IA	SGTR
RHR/LHSI	Two RHR/LHSI pumps and two heat exchangers	480 VAC, DC, CCW, ESFAS	All except ATWS, LBDC
Reactor Coolant Pumps (RCP)	Seals	Success criteria: 1 / 2 charging pumps to seal injection or (1 / 3 CCW pumps with 1 / 3 CCW booster pumps) to thermal barrier heat exchanger	SLOCA
Service Water (SW)	Three pumps in two trains (third pump is racked-out as a spare)	7.2 KV-AC, DC, ESFAS	LSSW

Table 2 (continued)

Notes:

1. Third pump is racked-out as a spare; use of spare pump could be given a credit of 1E-1 as a recovery action. The three pumps discharge to a common discharge header that branches into three individual pipe lines leading to each reactor coolant loop cold leg (IPE, page 3-63).

2. The TDEFW pump requires steam supply from the safety-class sections of two main steam lines upstream of the main steam isolation valves. This pump does not require support from the other valves mentioned in Main Steam (MS).

3. The licensee stated they had performed engineering analyses that demonstrated that room cooling was not needed in most plant areas. The licensee stated that the 7.2 KV essential switchgear and the emergency diesels still needed room cooling.

4. The licensee's PRA model does not include cooling water for HVAC, but it includes an operator action to open doors to provide cooling.

5. IPE (page C-44) states that two of the PORVs have a tank of air as a backup supply that permits up to six valve strokes. The information provided by the licensee does not explicitly discuss whether the air accumulators have enough capacity to support feed and bleed. We assume that they do.

6. ESFAS generates signals to allow automatic operation of the pressurizer PORVs. If ESFAS relays are de-energized, the PORVs fail closed in "Auto" (IPE, page C-44).

7. Plant internal event CDF (including internal floods) = 5.6E-5/yr (from updated information provided by the licensee).

1.3 SDP WORKSHEETS

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

1. Transients (Reactor Trip) (TRANS)
2. Transients (w/o 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 (LOIA)
12. Loss of SW (LSSW)
13. Loss of CCW (LCCW)
14. Loss of One 125 VDC Vital Bus (LBDC)
15. LOOP with Loss of One Division of AC (LOAC)
16. Interfacing System LOCA (ISLOCA)

Table 3.1 SDP Worksheet for V. C. Summer Nuclear Station — Transients (Reactor Trip) (TRANS)

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Secondary Heat Removal (EFW)	1/2 MDEFW trains (1 multi-train system) or 1/1 TDEFW train (1 ASD train) through 1 / 3 SG with 1/5 associated SG safety valves or 1/1 steam generator PORV; or 1/2 condenser dump valves or 1/3 atmospheric dump valves
Feedwater System (FW)	1/3 Condensate pumps with 1/4 feedwater booster pumps (operator action = 1) (1) with 1/1 steam generator PORV or 1/2 condenser dump valves or 1/3 atmospheric dump valves
Early Inventory, High Pressure Injection (EIHP)	1/2 HPI pumps or use of spare pump (1 multi-train system) (2)
Primary Heat Removal, Feed/Bleed (FB)	2/3 pressurizer PORVs open for Feed/Bleed (operator action = 2)
High Pressure Recirculation (HPR)	1/2 HPI pumps with 1/2 RHR pumps with operator action for switchover (operator action = 3)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 TRANS - EFW - FW - HPR (4)			
2 TRANS - EFW - FW - FB (5)			
3 TRANS - EFW - FW - 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 IPE (page 3-146) uses 1.0 as the Human Error Probability for this action (OAF). We used operator action = 1 to be consistent with the HEP used by other plants of similar design.

2. Third pump is racked-out as a spare; use of spare pump could be given a credit of 1E-1 as a recovery action.

Table 3.2 SDP Worksheet for V. C. Summer Nuclear Station — Transients (TPCS) (w/o PCS)

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 1/1 TDEFW train (1 ASD train) through 1 / 3 SG with 1/5 associated SG safety valves or 1/1 steam generator PORV
Early Inventory, High Pressure Injection (EIHP)	1/2 HPI pumps or use of spare pump (1 multi-train system) (1)
Primary Heat Removal, Feed/Bleed (FB)	2/3 pressurizer PORVs open for Feed/Bleed (operator action = 2)
High Pressure Recirculation (HPR)	1/2 HPI pumps with 1/2 RHR pumps with operator action for switchover (operator action = 3)

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

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

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

<u>Note</u>:

1. Third pump is racked-out as a spare; use of spare pump could be given a credit of 1E-1 as a recovery action.

Table 3.3 SDP Worksheet for V. C. Summer Nuclear Station — Small LOCA (SLOCA)

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Early Inventory, HP Injection (EIHP)	1/2 HPI pumps or use of spare pump (1 multi-train system) (1)
Secondary Heat Removal (FW/EFW)	1/2 MDEFW trains (1 multi-train system) or 1/1 TDEFW train (1 ASD train) or (1/3 Condensate pumps with 1/4 feedwater booster pumps) (operator action = 1) (2) through 1 / 3 SG with 1/5 associated SG safety valves or 1/1 steam generator PORV; or 1/2 condenser dump valves or 1/3 atmospheric dump valves
Primary Bleed (FB)	2/3 PORVs open for Feed/Bleed (operator action = 2)
RCS Cooldown / Depressurization (DEP)	Operator depressurizes RCS using 1/3 pressurizer PORVs (operator action = 1) (3)
Low Pressure Injection (LPI)	1/2 RHR pumps for Low Pressure Injection (1 multi-train system)
High Pressure Recirculation (HPR)	1/2 HPI pumps with 1/2 RHR pumps and with operator action for switchover (operator action = 3)
Low Pressure Recirculation (LPR)	1/2 RHR pumps with operator action to establish CCW cooling to RHR heat exchangers (operator action = 3)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 SLOCA - LPR (2, 9)			
2 SLOCA - DEP - HPR (4)			
3 SLOCA - FW/EFW - HPR (6)			
4 SLOCA - FW/EFW - FB (7)			
5 SLOCA - EIHP - LPI (10)			

6 SLOCA - EIHP - DEP (11)			
7 SLOCA - EIHP - FW/EFW (12)			
Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event: If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use.			

Notes:

1. Third pump is racked-out as a spare; use of spare pump could be given a credit of 1E-1 as a recovery action.

2. The IPE (page 3-146) uses 1.0 as the Human Error Probability for this action (OAF). We used operator action = 1 to be consistent with the HEP used by other plants of similar design.

3. According to an updated HRA analysis provided by the licensee (document DC00300-134, Revision 0), the action “Operator fails to depressurize primary (conditional)” (event OAPC), has a human error probability (HEP) = 1.4E-1.

Table 3.4 SDP Worksheet for V. C. Summer Nuclear Station — 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)	The closure of the block valve associated with stuck open PORV (operator action = 3)
Early Inventory, HP Injection (EIHP)	1 / 2 HPI pumps or use of spare pump (1 multi-train system) [1]
Secondary Heat Removal (FW/EFW)	1 / 2 MDEFW trains (1 multi-train system) or 1/1 TDEFW train (1 ASD train) or (1/3 Condensate pumps with 1/4 feedwater booster pumps) (operator action = 1) [2] through 1 / 3 SG with 1/5 associated SG safety valves or 1 / 1 steam generator PORV; or 1 / 2 condenser dump valves or 1/3 atmospheric dump valves
Primary Bleed (FB)	1/2 remaining PORVs open for Feed/Bleed (operator action = 2)
RCS Cooldown / Depressurization (DEP)	Operator depressurizes RCS using 1 / 2 remaining pressurizer PORVs (operator action = 1) [3]
Low Pressure Injection (LPI)	1/2 RHR pumps for Low Pressure Injection (1 multi-train system)
High Pressure Recirculation (HPR)	1/2 HPI pumps with 1/2 RHR pumps and with operator action for switchover (operator action = 3)
Low Pressure Recirculation (LPR)	1/2 RHR pumps with operator action to establish CCW cooling to RHR heat exchangers (operator action = 3)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 SORV - BLK - LPR (2, 9)			
2 SORV - BLK - DEP - HPR (4)			
3 SORV - BLK - FW/EFW - HPR (6)			
4 SORV - BLK - FW/EFW - FB (7)			

5 SORV - BLK - EIHP - LPI (10)			
6 SORV - BLK - EIHP - DEP (11)			
7 SORV - BLK - EIHP - FW/EFW (12)			

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

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

Notes:

1. Third pump is racked-out as a spare; use of spare pump could be given a credit of 1E-1 as a recovery action.

2. The IPE (page 3-146) uses 1.0 as the Human Error Probability for this action (OAF). We used operator action = 1 to be consistent with the HEP used by other plants of similar design.

3. According to an updated HRA analysis provided by the licensee (document DC00300-134, Revision 0), the action "Operator fails to depressurize primary (conditional)" (event OAPC), has a human error probability (HEP) = 1.4E-1.

Table 3.5 SDP Worksheet for V. C. Summer Nuclear Station — Medium LOCA (MLOCA)

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Early Inventory, HP Injection (EIHP)	1/2 HPI pumps or use of spare pump (1 multi-train system) (1)
RCS Cooldown/ Depressurization (DEP)	Operator depressurizes RCS with 1/3 steam generator PORVs or [1/3 MSIV bypass valves and (1/2 condenser dump valves or 1/3 atmospheric dump valves)] (operator action = 1) (2)
Low Pressure Injection (LPI)	1/2 RHR pump trains (1 multi-train system)
Low Pressure Recirculation (LPR)	1/2 RHR pump trains with operator switchover from injection to recirculation (operator action = 3)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 MLOCA - LPR (2, 4)			
2 MLOCA - EIHP - LPI (5)			
3 MLOCA - EIHP - DEP (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. Third pump is racked-out as a spare; use of spare pump could be given a credit of 1E-1 as a recovery action.

2. According to an updated HRA analysis provided by the licensee (document DC00300-134, Revision 0), the action “Operator fails to depressurize primary (conditional)” (event OAPC), has a human error probability (HEP) = 1.4E-1.

Table 3.6 SDP Worksheet for V. C. Summer Nuclear Station — Large LOCA (LLOCA)

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

<u>Safety Functions Needed</u>:	**<u>Full Creditable Mitigation Capability for Each Safety Function</u>:**
Early Inventory, HP Injection (EIHP)	2/2 remaining accumulators with (1/2 HPI pumps or use of spare pump) (1 multi-train system) [(1)]
Early Inventory, LP Injection (EILP)	1/2 RHR pump trains (1 multi-train system)
Low Pressure Recirculation (LPR)	1/2 RHR trains after operator switchover from injection to recirculation (operator action = 3)
Hot Leg Recirculation (HLR)	Operator establishes hot leg recirculation (1 multi-train system) [(2)]

<u>Circle Affected Functions</u>	**<u>Recovery of Failed Train</u>**	**<u>Remaining Mitigation Capability Rating for Each Affected Sequence</u>**	**<u>Sequence Color</u>**
1 LLOCA - HLR (2, 5)			
2 LLOCA - LPR (3, 6)			
3 LLOCA - EIHP - EILP (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. Third pump is racked-out as a spare; use of spare pump could be given a credit of 1E-1 as a recovery action.

2. Operator action = 4, limited by hardware failure.

Table 3.8 SDP Worksheet for V. C. Summer Nuclear Station — Loss of Offsite Power (LOOP)

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Emergency AC Power (EAC)	1/2 Emergency Diesel Generators (1 multi-train system)
Turbine-driven EFW pump (TDEFW)	1/1 TDP trains of EFW (1 ASD train) through 1 / 3 SG with 1/5 associated SG safety valves or 1/1 steam generator PORV, or 1/2 condenser dump valves or 1/3 atmospheric dump valves
Secondary Heat Removal (EFW)	1/2 MDEFW trains (1 multi-train system) or 1/1 TDEFW train (1 ASD train) through 1 / 3 SG with 1/5 associated SG safety valves or 1/1 steam generator PORV; or 1/3 atmospheric dump valves
Recovery of AC Power in < 2 hrs (REC2)	SBO procedures implemented (operator action = 1) [(1)]
Recovery of AC Power in < 5 hrs (REC5)	SBO procedures implemented (operator action = 2) [(1, 2)]
Early Inventory, HP Injection (EIHP)	1/2 HPI pumps or use of spare pump (1 multi-train system) [(3)]
Primary Heat Removal (FB)	Operator uses 2/3 pressurizer PORVs (operator action = 2)
RCS Cooldown/ Depressurization (DEP)	Operator depressurizes RCS using 1/3 PORVs (operator action = 1) [(4)]
Low Pressure Recirculation (LPR)	1/2 RHR pumps with operator action for switchover (operator action = 3)
High Pressure Recirculation (HPR)	1/2 HPI pumps with 1/2 RHR pumps and with operator switchover to recirculation (operator action = 3)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 LOOP - EFW - HPR (3)			
2 LOOP - EFW - FB (4)			
3 LOOP - EFW - EIHP (5)			
4 LOOP - EAC - LPR (7) (AC recovered)			

5 LOOP - EAC - DEP - HPR (9) (AC recovered)			
6 LOOP - EAC - EIHP (10, 15) (AC recovered)			
7 LOOP - EAC - REC4 (11)			
8 LOOP - EAC - TDEFW - HPR (13) (AC recovered)			
9 LOOP - EAC - TDEFW - FB (14) (AC recovered)			
10 LOOP - EAC - TDEFW - REC1 (16)			

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

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

Notes:

1. SDP generic mitigating capabilities were used for the failure to recover AC power in less than 2 and 5 hrs. The licensee assesses probabilities of failure to recover of 6.32 E-01 at 1 hour and 8.17 E-01 at 4 hours.

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

3. Third pump is racked-out as a spare; use of spare pump could be given a credit of 1E-1 as a recovery action.

4. According to an updated HRA analysis provided by the licensee (document DC00300-134, Revision 0), the action “Operator fails to depressurize primary (conditional)” (event OAPC), has a human error probability (HEP) = 1.4E-1.

Table 3.8 SDP Worksheet for V. C. Summer Nuclear Station — 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:**
Secondary Heat Removal (EFW)	1/2 MDPs of EFW (1 multi-train system) or 1/1 TDP of EFW (1 ASD train) through 1 / 3 SG with 1/5 associated SG safety valves or 1/1 steam generator PORV; or 1/2 condenser dump valves or 1/2 remaining atmospheric dump valves (of steam lines not connected to damaged SG)
Early Inventory, HP Injection (EIHP)	1/2 HPI pumps or use of spare pump (1 multi-train system) [(1)]
Pressure Equalization (EQ)	Operator isolates the ruptured SG and depressurizes RCS using 1/3 pressurizer PORV or pressurizer spray to less than setpoint of relief valves of SG (operator action = 2)
Feed-and-Bleed (FB)	Operator uses 2/3 pressurizer PORV (operator action = 2)
RCS Cooldown/ Depressurization (DEP)	Operator depressurizes RCS using 1/3 pressurizer PORV or pressurizer spray (operator action = 1) [(2)]
Low Pressure Injection (LPI)	1 / 2 RHR pumps (1 multi-train system)
High Pressure Recirculation (HPR)	1/2 RHR pump trains with 1/2 HPI pumps and with operator switchover to recirculation (operator action = 3)
Long-Term RCS Makeup Source (LTMS)	Operator refills RWST or aligns other sources to safety injection system (operator action = 1)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 SGTR - EQ - LTMS (3)			
2 SGTR - EIHP - LPI (5)			
3 SGTR - EIHP - DEP (6)			
4 SGTR - EIHP - EQ (7)			

5 SGTR - EFW - HPR - LTMS (10)			
6 SGTR - EFW - FB (11)			
7 SGTR - EFW - EQ (12)			
8 SGTR - EFW - EIHP (13)			
Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event: If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use.			

<u>Notes</u>:

1. Third pump is racked-out as a spare; use of spare pump could be given a credit of 1E-1 as a recovery action.

2. According to an updated HRA analysis provided by the licensee (document DC00300-134, Revision 0), the action “Operator fails to depressurize primary (conditional)” (event OAPC), has a human error probability (HEP) = 1.4E-1.

Table 3.9 SDP Worksheet for V. C. Summer Nuclear Station — Anticipated Transients Without Scram (ATWS)

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Turbine trip (TTP)	Operator trips the turbine (1) (operator action = 2)
Primary Relief (SRV)	3/3 safety valves with 3/3 PORVs open (2) (1 train)
Emergency Boration (EMBO)	Operator conducts emergency boration using 1/2 charging pumps trains with 1/1 boric acid transfer pump (operator action = 2)
Secondary Heat Removal (EFW)	2/2 MDPs of EFW with 1/1 TDP of EFW (1 train) with 1/5 SG safety valves on 3/3 SGs

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 ATWS - EFW (2)			
2 ATWS - EMBO (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.

Notes:

1. The SDP worksheets make the generic assumption that turbine trip failure results in peak RCS pressure exceeding the ASME Level C service criteria and core melt.

2. The success criteria of the IPE states 3 /3 pressurizer SVs and 1, 2, or 3 /3 pressurizer PORVs. Here, we use 3 / 3 safety valves with 3 / 3 PORVs open.

Table 3.10 SDP Worksheet for V. C. Summer Nuclear Station — Main Steam Line Break (MSLB)

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Steam Generator Isolation (SGI)	2/3 MSIVs with 2/3 FWIVs close (1 train) (1)
Early Inventory, HP Injection (EIHP)	1/2 HPI pumps or use of spare pump (1 multi-train system) (2)
Secondary Heat Removal (EFW)	1/2 MDPs of EFW (1 multi-train system) or 1/1 TDP of EFW (1 ASD train) through 1 / 3 SG with 1/5 associated SG safety valves or 1/1 steam generator PORV
Primary Heat Removal, Feed/Bleed (FB)	2/3 pressurizer PORVs open for Feed/Bleed (operator action = 2)
Operator terminates SI (OAT)	Operator terminates SI (operator action = 2)
High Pressure Recirculation (HPR)	1/2 HPI pumps with 1/2 RHR pumps with operator action for switchover (operator action = 3)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 MSLB - OAT - HPR (3)			
2 MSLB - EFW - HPR (5)			
3 MSLB - EFW - FB (6)			
4 MSLB - EIHP - EFW (8)			
5 MSLB - SGI (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.

<u>Notes</u>:

1. When safety function SGI fails, a major concern is pressurized thermal shock (PTS). We assumed it leads to core damage.

2. Third pump is racked-out as a spare; use of spare pump could be given a credit of 1E-1 as a recovery action.

Table 3.11 SDP Worksheet for V. C. Summer Nuclear Station — Loss of Instrument Air (LOIA)[1]

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Operator starts backup source of IA (OAA)	Operator starts the diesel-driven air compressor and aligns it to the IA (operator action = 2)
Secondary Heat Removal (EFW)	Operator locally controls 1/2 MDEFW trains or 1/1 TDEFW train (operator action = 1) [2] through 1 / 3 SG with 1/5 associated SG safety valves or 1/3 SG PORVs
Early Inventory, High Pressure Injection (EIHP)	1/2 HPI pumps or use of spare pump (1 multi-train system) [3]
Primary Heat Removal, Feed/Bleed (FB)	Accumulators provide air to 2/2 pressurizer PORVs for Feed/Bleed (operator action = 2) [4]
High Pressure Recirculation (HPR)	1/2 HPI pumps with 1/2 RHR pumps with operator action for switchover (operator action = 3)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 LOIA - OAA - EFW - HPR (4)			
2 LOIA - OAA - EFW - FB (5)			
3 LOIA - OAA - EFW - 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 initiating event Loss of Instrument Air (LOIA) has a frequency = 9.175E-2 / year. Instrument Air provides air to several critical components/systems; important components impacted by loss of Instrument Air are: SW alternate supply to CCW (fails open (FO)), discharge valves of EFW to steam generators (FO), steam line to EFW turbine-driven pump (FO), MSIVs (fail closed (FC)), steam dump valves to condenser (FC), steam dump valves to atmosphere (FC), SG PORVs (FC), main feedwater control valves (FC), main feedwater isolation valves (fail as is), pressurizer PORVs (FC), and pressurizer spray valves (FC). Some of these valves are provided with accumulators; in particular, 2 / 3 pressurizer PORVs are equipped with air accumulators. The licensee indicated (e-mail from the licensee dated February 22, 2001) that the air operated makeup valve from Service Water to Component Cooling Water has an accumulator to maintain the valve closed for three hours while air is restored. In addition, if air is not restored, or if the valve fails open for any other reason, the operator has sufficient indication and time to isolate it prior to any flooding impact. The Component Cooling Water surge tank has high level alarms and overflows to the floor drain tank, which also has high level alarms and is located in a curbed room.

2. The operator has to control EFW flow locally. The HEP for this action was not found in the IPE nor in the information provided by the licensee. Since this action has to be carried out locally, we assigned operator action = 1.

3. Third pump is racked-out as a spare; use of spare pump could be given a credit of 1E-1 as a recovery action.

4. The information provided by the licensee does not explicitly discuss whether the air accumulators have enough capacity to support feed and bleed. We assume that they do.

Table 3.12 SDP Worksheet for V. C. Summer Nuclear Station — Loss of SW (LSSW)[1]

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Operator recovers one train of SW (SWR2H)	Operator recovers one train of SW within two hours (operator action = 1) [2]
Early Inventory, HP Injection (EIHP)	1/1 HPI pumps (1 train)
Secondary Heat Removal (FW/EFW)	1/2 MDEFW trains (1 multi-train system) or 1/1 TDEFW train (1 ASD train) or (1/3 Condensate pumps with 1 / 4 feedwater booster pumps) (operator action = 1) [3] through 1 / 3 SG with 1/5 associated SG safety valves or 1/1 steam generator PORV; or 1/3 atmospheric dump valves
Primary Bleed (FB)	2/3 PORVs open for Feed/Bleed (operator action = 2)
RCS Cooldown / Depressurization (DEP)	Operator depressurizes RCS using 1/3 PORVs (operator action = 1) [4]
Low Pressure Injection (LPI)	1/1 RHR pumps for Low Pressure Injection (1 train)
High Pressure Recirculation (HPR)	1/1 HPI pumps with 1/1 RHR pumps and with operator action for switchover, operator action = 3 limited by hardware failure (1 train)
Low Pressure Recirculation (LPR)	1/1 RHR pumps with operator action to establish CCW cooling to RHR heat exchangers, operator action = 3 limited by hardware failure (1 train)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 LSSW - LPR (2, 6, 11)			
2 LSSW - DEP - HPR (4, 8)			
3 LSSW - FW/EFW - FB (9)			
4 LSSW - EIHP - LPI (12)			

5 LSSW - EIHP - DEP (13)			
6 LSSW - EIHP - FW/EFW (14)			
7 LSSW - SWR2H (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 frequency of total loss of SW is 4.72E-6 / year (from an e-mail from the licensee dated February 22, 2001). Service water provides cooling to CCW, which, in turn, provides cooling to the charging pumps and to the RCPs' thermal barrier heat exchangers. The licensee stated that the plant had been modified to change the cooling water source to the charging pumps from chilled water to component cooling. After a total loss of SW, an RCP seal LOCA occurs, and a train of SW has to be recovered within two hours to mitigate this LOCA.

2. The IPE models this human action as "Failure to recover one train of SW by 2 hrs" (SWR1). The human error probability assessed by the IPE is 0.46 (page 1-8).

3. The IPE (page 3-146) uses 1.0 as the Human Error Probability for this action (OAF). We used operator action = 1 to be consistent with the HEP used by other plants of similar design.

4. According to an updated HRA analysis provided by the licensee (document DC00300-134, Revision 0), the action "Operator fails to depressurize primary (conditional)" (event OAPC), has a human error probability (HEP) = 1.4E-1.

Table 3.13 SDP Worksheet for V. C. Summer Nuclear Station — Loss of CCW (LCCW)[1]

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Operator recovers one train of CCW (CCWR2H)	Operator recovers one train of CCW within two hours (operator action = 1) [2]
Early Inventory, HP Injection (EIHP)	1/1 HPI pumps (1 train)
Secondary Heat Removal (FW/EFW)	1/2 MDEFW trains (1 multi-train system) or 1/1 TDEFW train (1 ASD train) or (1/3 Condensate pumps with 1/4 feedwater booster pumps) (operator action = 1) [3] through 1 / 3 SG with 1/5 associated SG safety valves or 1/1 steam generator PORV; or 1/3 atmospheric dump valves
Primary Bleed (FB)	2/3 PORVs open for Feed/Bleed (operator action = 2)
RCS Cooldown / Depressurization (DEP)	Operator depressurizes RCS using 1/3 PORVs (operator action = 1) [4]
Low Pressure Injection (LPI)	1/1 RHR pumps for Low Pressure Injection (1 train)
High Pressure Recirculation (HPR)	1/1 HPI pumps with 1/1 RHR pumps and with operator action for switchover, operator action = 3 limited by hardware failure (1 train)
Low Pressure Recirculation (LPR)	1/1 RHR pumps with operator action to establish CCW cooling to RHR heat exchangers, operator action = 3 limited by hardware failure (1 train)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 LCCW - LPR (2, 6, 11)			
2 LCCW - DEP - HPR (4, 8)			
3 LCCW - FW/EFW - FB (9)			
4 LCCW - EIHP - LPI (12)			

5 LCCW - EIHP - DEP (13)			
6 LCCW - EIHP - FW/EFW (14)			
7 LCCW - CCWR2H (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.			

<u>Notes</u>:

1. The frequency of total loss of CCW is 1.254E-4 / year. The licensee stated that the plant had been modified to change the cooling water source to the charging pumps from chilled water to component cooling. CCW provides cooling to the charging pumps and to the RCPs' thermal barrier heat exchangers. After a total loss of CCW, an RCP seal LOCA occurs, and a train of CCW has to be recovered within two hours to mitigate this LOCA.

2. The IPE models this human action as "Recover at least one train of CC when both trains failed but supported" (CCR). The human error probability assessed by the IPE (page 3-151) is 0.11.

3. The IPE (page 3-146) uses 1.0 as the Human Error Probability for this action (OAF). We used operator action = 1 to be consistent with the HEP used by other plants of similar design.

4. According to an updated HRA analysis provided by the licensee (document DC00300-134, Revision 0), the action "Operator fails to depressurize primary (conditional)" (event OAPC), has a human error probability (HEP) = 1.4E-1.

Table 3.14 SDP Worksheet for V. C. Summer Nuclear Station — Loss of One 125 VDC Vital Bus (LBDC)[1]

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Secondary Heat Removal (EFW)	Operator locally controls 1/2 MDEFW trains or 1/1 TDEFW train (operator action = 1) [2] through 1/3 SG with 1/5 associated SG safety valves or manual operation of 1/1 SG PORV[3]

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 LBDC - EFW (2)			

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

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

Notes:

1. The Loss of One 125 VDC Vital Bus has a frequency = 8.8E-4 / year. 125 VDC provides power to many critical components. In particular, two of the three pressurizer PORVs are powered from DPN1HA. Hence, the most limiting loss of a 125 VDC bus is the loss of bus 1HA. The following conditions result from the loss of bus 1HA:

   Only the train of safeguards equipment aligned to DC bus 1HB would be operable.
   The EFW turbine-driven pump will autostart on a signal from train B and the flow from the pump to the SGs must be manually locally controlled.
   Steam dump to condenser and atmospheric dump valves are not available (MSIVs are closed).
   The operator must use local manual control to open the steam generator PORVs.
   Two pressurizer PORVs are inoperable (fail closed).

Since two pressurizer PORVs are inoperable, we concluded that feed and bleed cannot be implemented. EFW appears to be the only way to remove decay heat in the short term.

2. The HEP for this action was not found in the IPE nor in the information provided by the licensee. Since this action has to be carried out locally, we assigned operator action = 1.

3. The operator must use local manual control to open the steam generator PORVs.

Table 3.15 SDP Worksheet for V. C. Summer Nuclear Station — LOOP with Loss of One Division of AC (LOAC)[1]

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
PORV recloses (SORV)	3/3 pressurizer PORVs reclose after opening during transient (1 train)
Secondary Heat Removal (EFW)	1/1 MDEFW trains (1 train) or 1 / 1 TDEFW train (1 ASD train) through 1 / 3 SG with 1/5 associated SG safety valves or 1/1 steam generator PORV; or 1/3 atmospheric dump valves
Early Inventory, HP Injection (EIHP)	1/1 HPI pumps (1 train) [2]
Primary Heat Removal, Feed/Bleed (FB)	2/3 pressurizer PORVs open for Feed/Bleed (operator action = 2)
Primary Heat Removal, Feed/Bleed (FBS)	Operator uses 1/2 remaining pressurizer PORVs (operator action = 2)
RCS Cooldown/ Depressurization (DEP)	Operator depressurizes RCS using 1/3 PORVs (operator action = 1) [3]
Low Pressure Injection (LPI)	1/1 RHR pumps for Low Pressure Injection (1 train)
High Pressure Recirculation (HPR)	1/1 HPI pumps with 1/1 RHR pumps and with operator switchover to recirculation (operator action = 3)
Low Pressure Recirculation (LPR)	1/1 RHR pumps with operator action for switchover (operator action = 3)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 LOAC - EFW - HPR (3, 15)			
2 LOAC - EFW - FB (4)			
3 LOAC - EFW - EIHP (5, 17)			
4 LOAC - SORV - LPR (7, 11)			

5 LOAC - SORV - DEP - HPR (9)			
6 LOAC - SORV - EIHP - LPI (12)			
7 LOAC - SORV - EIHP - DEP (13)			
8 LOAC - SORV - EFW - FBS (16)			

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

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

Notes:

1. For the SDP's event tree and worksheet we assumed that one train of safeguard equipment is unavailable. The IPE (page C-42) indicates that the pressurizer PORVs' block valves are powered by 480 VAC; it does not indicate the position of these valves upon loss of motive power. Here, we assumed that they fail open, so that they cannot be closed to isolate a pressurizer PORV that fails to close.

2. A pump is racked-out as a spare; use of spare pump could be given a credit of 1E-1 as a recovery action.

3. According to an updated HRA analysis provided by the licensee (document DC00300-134, Revision 0), the action "Operator fails to depressurize primary (conditional)" (event OAPC), has a human error probability (HEP) = 1.4E-1.

Table 3.16 SDP Worksheet for V. C. Summer Nuclear Station — Interfacing System LOCA (ISLOCA)(1)

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

Initiating Pathways:(2)

Low Pressure Injection System
Residual Heat Removal System
High Pressure Injection System (suction)
Chemical and Volume Control System (suction)
Component Cooling Water System (thermal barrier heat exchanger)

Mitigation Capability: Ensure Component Operability for Each Pathway:

Circle Affected Functions	Recovery of Failed Train	Remaining Mitigation Capability Rating for Each Affected Pathway	Sequence Color

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

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

Notes:

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

2. These are systems that have a high-low pressure interface such that failure of the barriers of the interface would lead to a LOCA outside the containment. These systems are identified using generic insights based on NRC studies on ISLOCA. Plant-specific adjustments may apply.

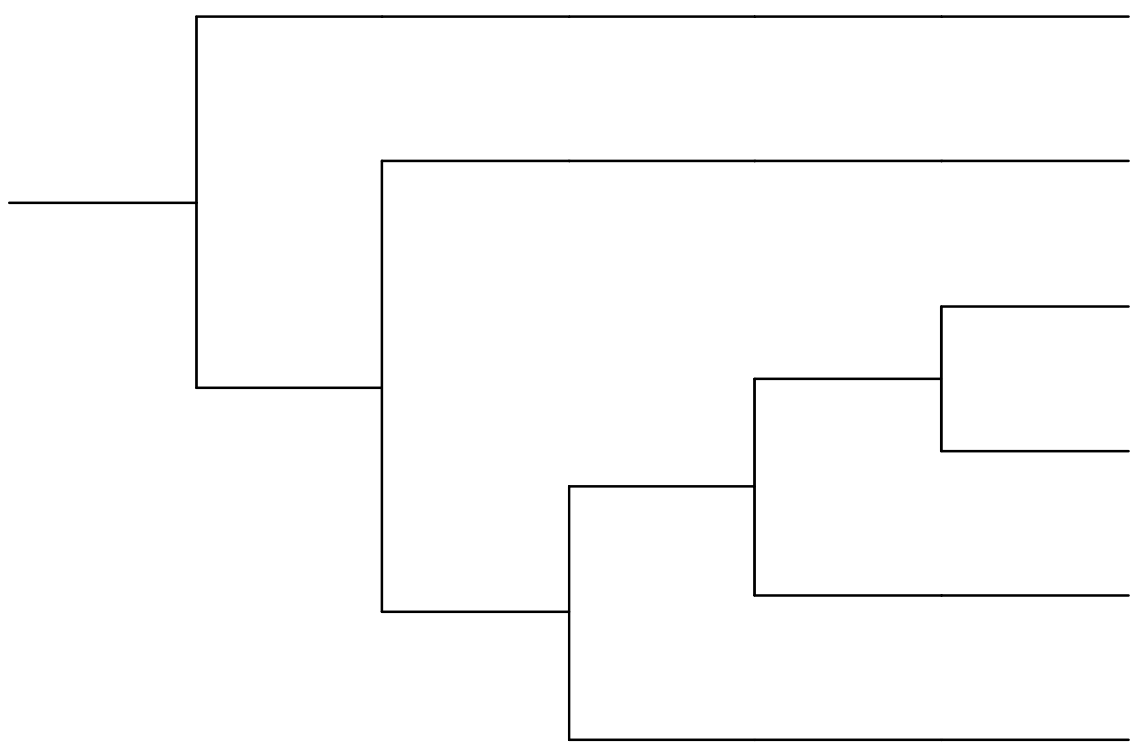
1.4 SDP Event Trees

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

The following event trees are included:

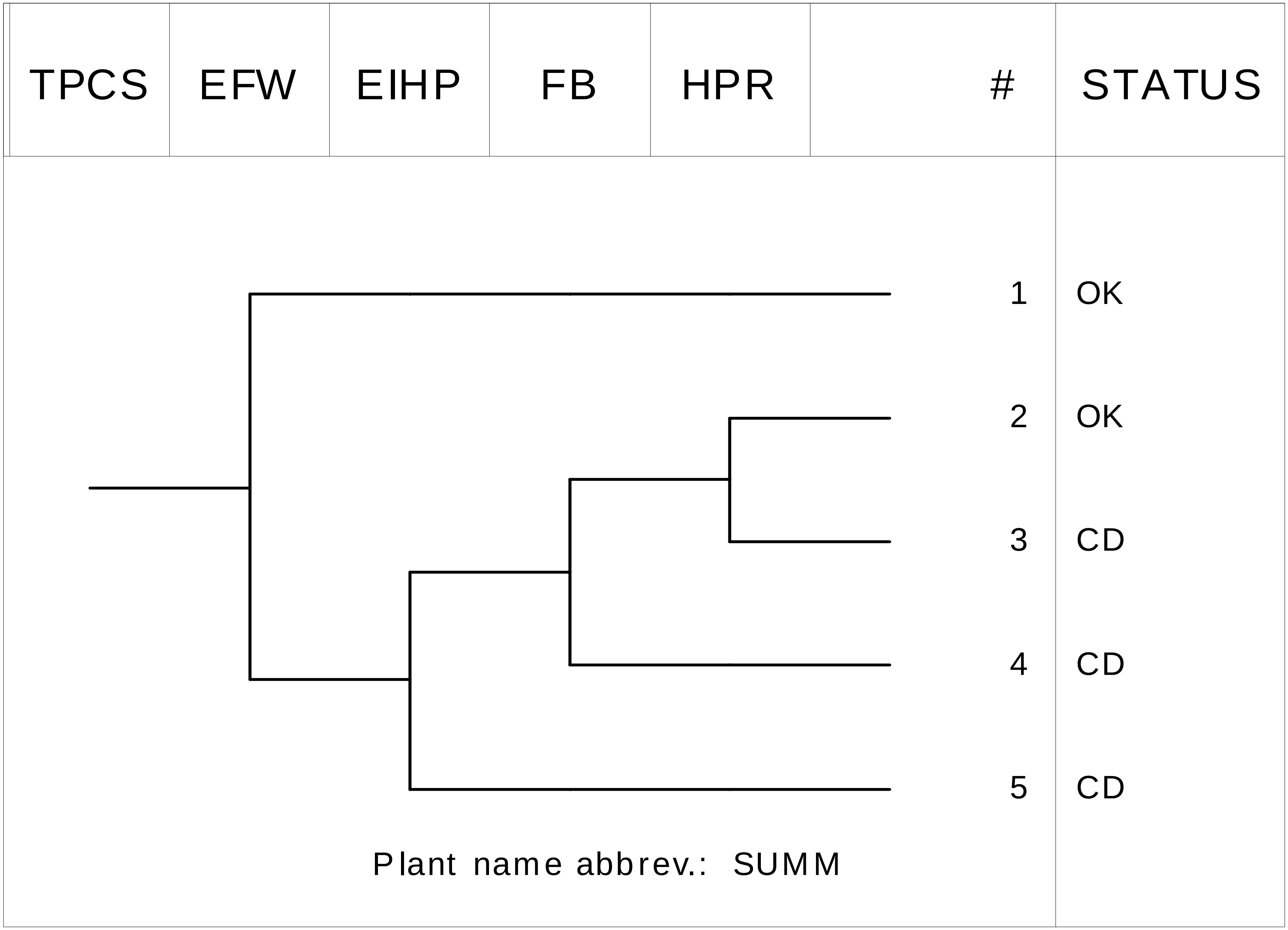
1. Transients (TRANS) (Reactor Trip)
2. Transients (w/o PCS) (TPCS)
3. Small LOCA (SLOCA)
4. Medium LOCA (MLOCA)
5. Large LOCA (LLOCA)
6. Loss of Offsite Power (LOOP)
7. Steam Generator Tube Rupture (SGTR)
8. Anticipated Transients Without Scram (ATWS)
9. Main Steam Line Break (MSLB)
10. Loss of Instrument Air (LOIA)
11. Loss of SW (LSSW)
12. Loss of CCW (LCCW)
13. Loss of One 125 VDC Vital Bus (LBDC)
14. LOOP with Loss of One Division of AC (LOAC)

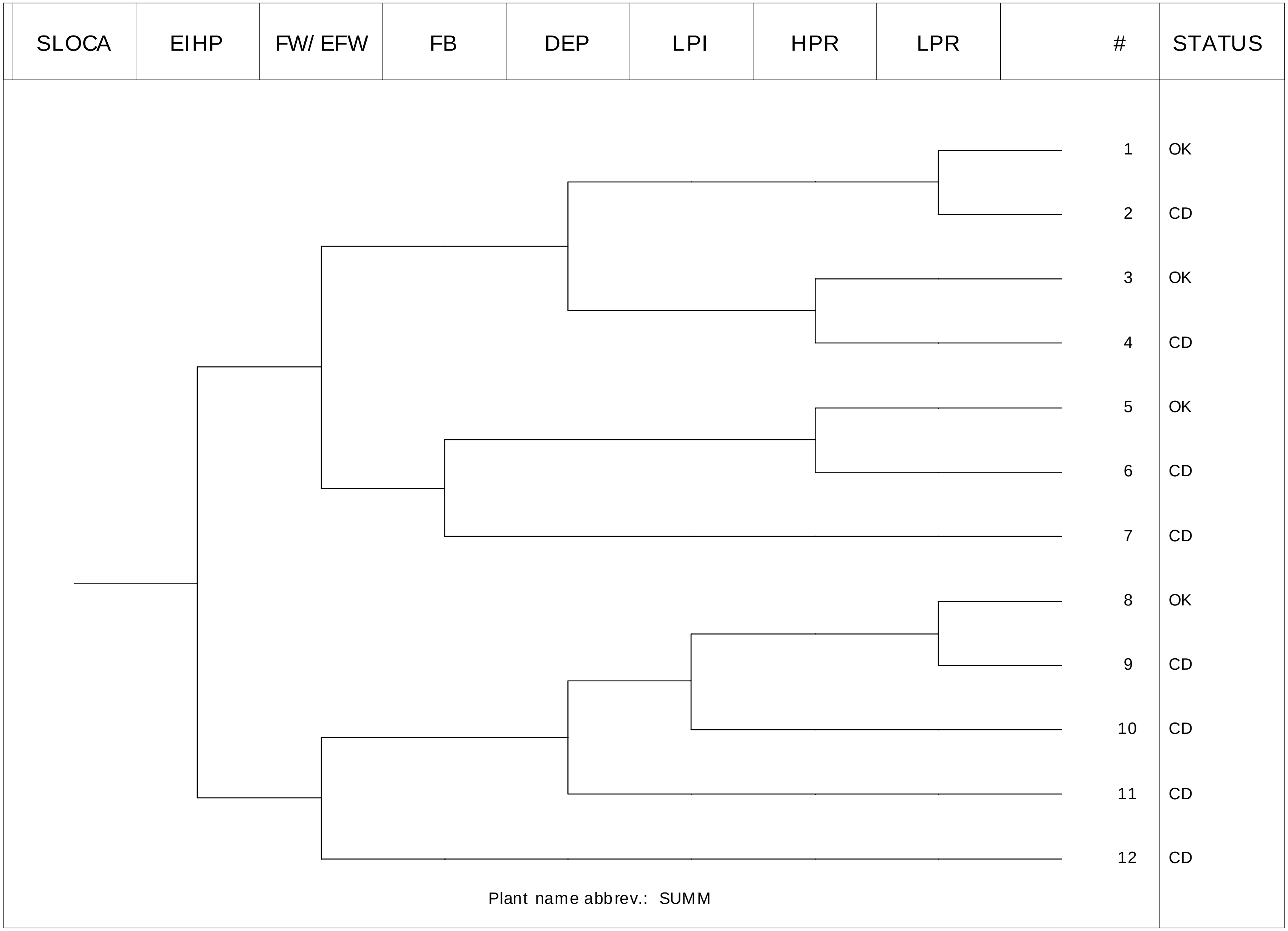
TRAN	EFW	FW	EIHP	FB	HPR	#	STATUS



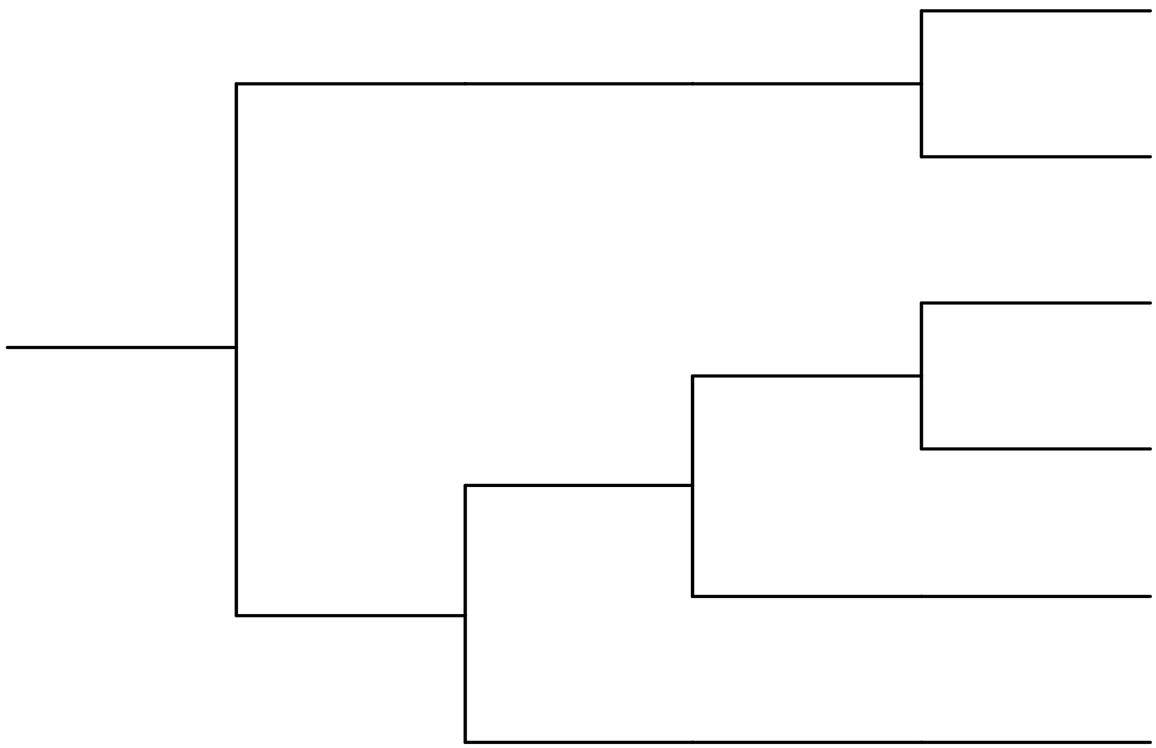
#	STATUS
1	OK
2	OK
3	OK
4	CD
5	CD
6	CD

Plant name abbrev.: SUMM


TPCS
EFW
EIHP
FB
HPR
#
STATUS
1 OK
2 OK
3 CD
4 CD
5 CD
Plant name abbrev.: SUMM

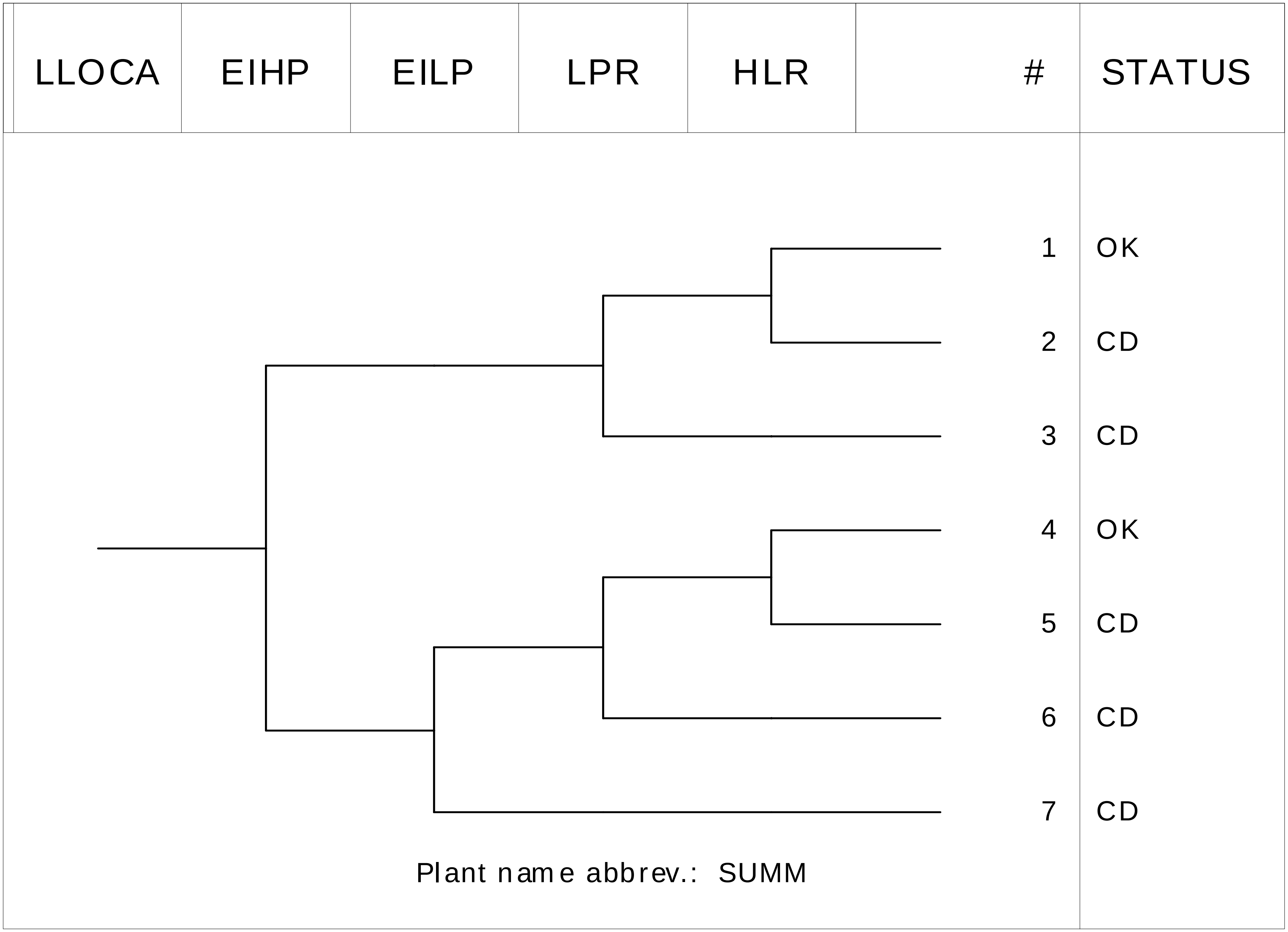

SLOCA
EIHP
FW/ EFW
FB
DEP
LPI
HPR
LPR
#
STATUS
1 OK
2 CD
3 OK
4 CD
5 OK
6 CD
7 CD
8 OK
9 CD
10 CD
11 CD
12 CD
Plant name abbrev.: SUMM

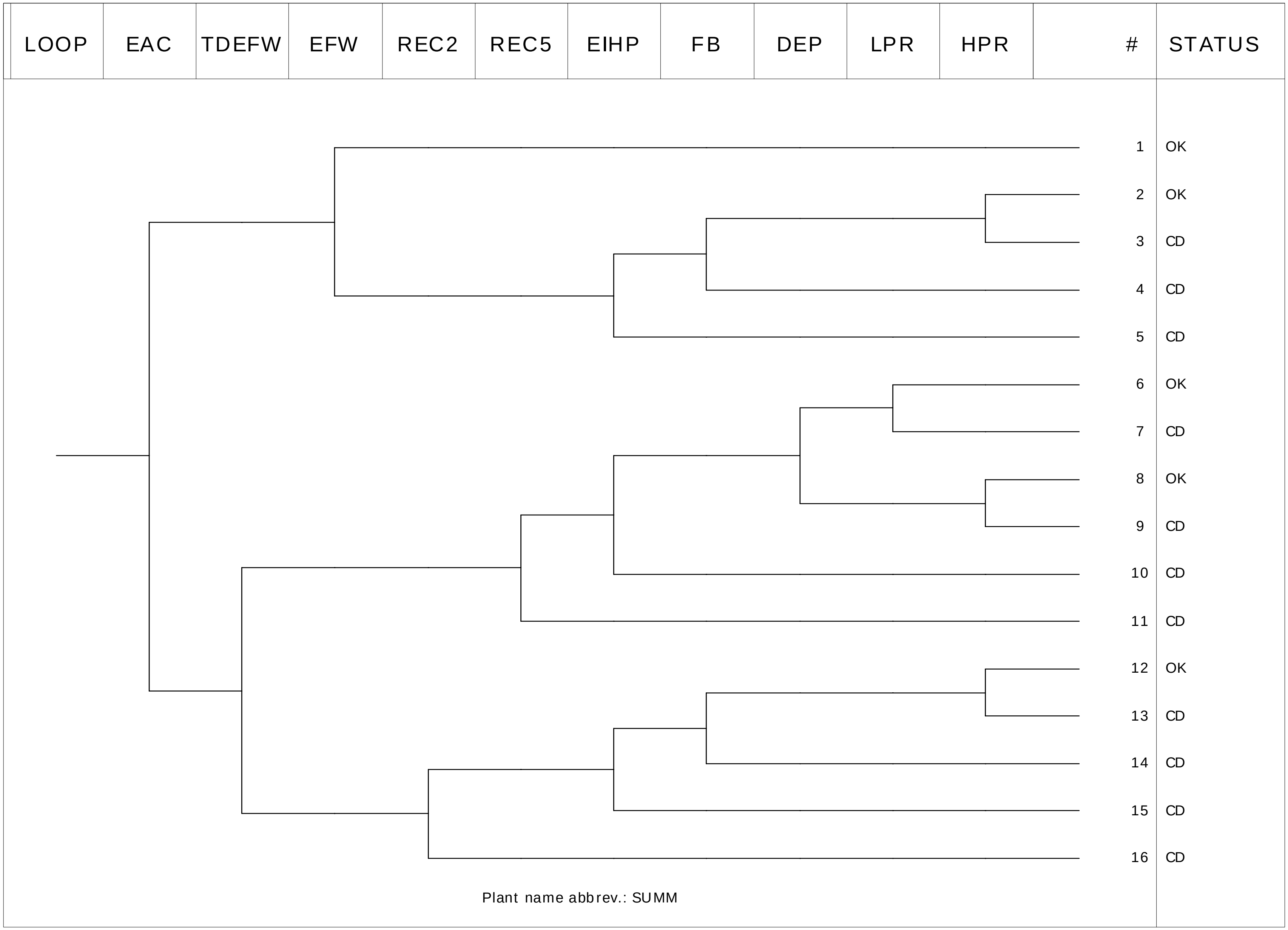
MLOCA	EIHP	DEP	LPI	LPR	#	STATUS

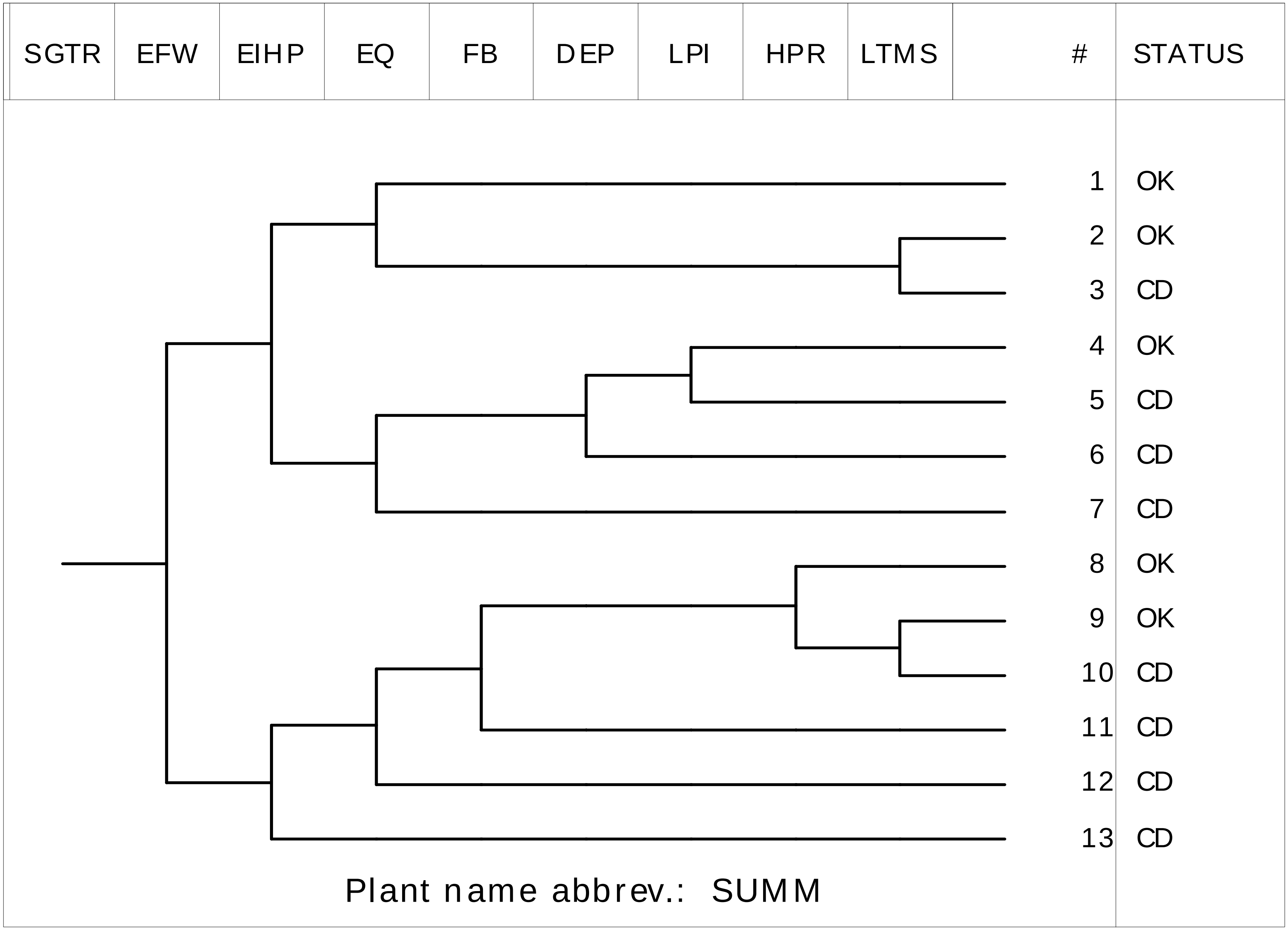


#	STATUS
1	OK
2	CD
3	OK
4	CD
5	CD
6	CD

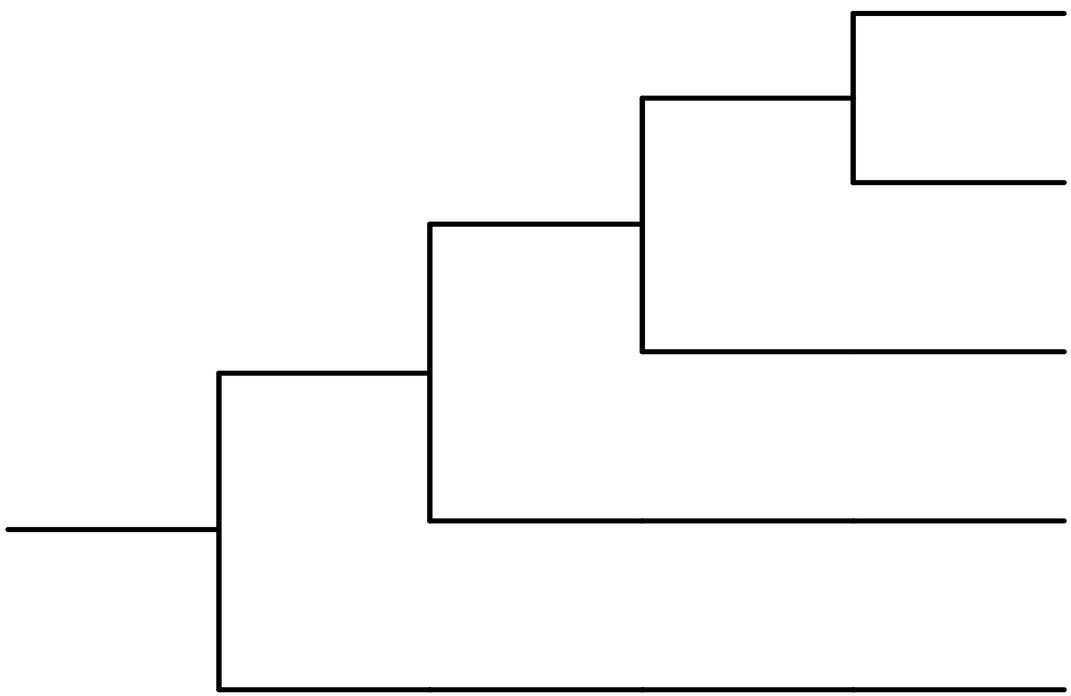
Plant name abbrev.: SUMM


LLOCA
EIHP
EILP
LPR
HLR
#
STATUS
1 OK
2 CD
3 CD
4 OK
5 CD
6 CD
7 CD
Plant name abbrev.: SUMM


LOOP
EAC
TDEFW
EFW
REC2
REC5
EIHP
FB
DEP
LPR
HPR
#
STATUS
1 OK
2 OK
3 CD
4 CD
5 CD
6 OK
7 CD
8 OK
9 CD
10 CD
11 CD
12 OK
13 CD
14 CD
15 CD
16 CD
Plant name abbrev.: SUMM

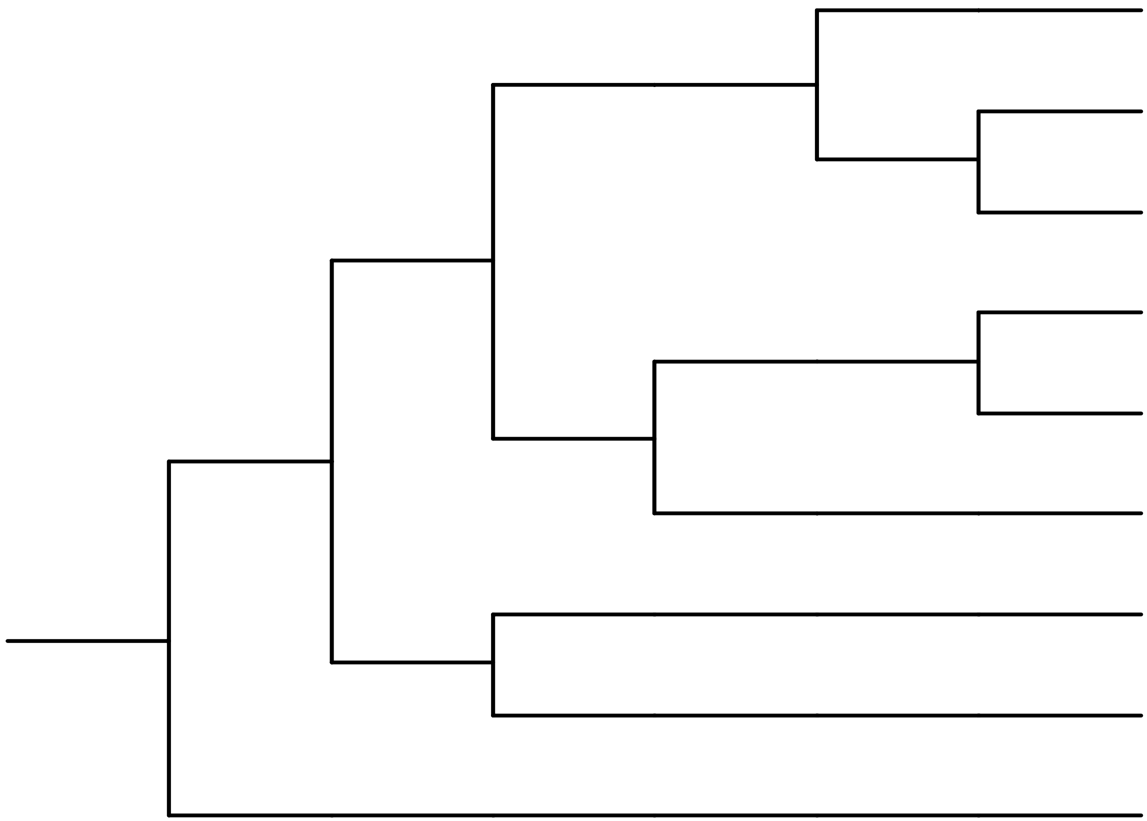

SGTR
EFW
EIHP
EQ
FB
DEP
LPI
HPR
LTMS
#
STATUS
1 OK
2 OK
3 CD
4 OK
5 CD
6 CD
7 CD
8 OK
9 OK
10 CD
11 CD
12 CD
13 CD
Plant name abbrev.: SUMM

ATWS	TTP	SRV	EMBO	EFW	#	STATUS
					1	OK
					2	CD
					3	CD
					4	CD
					5	CD



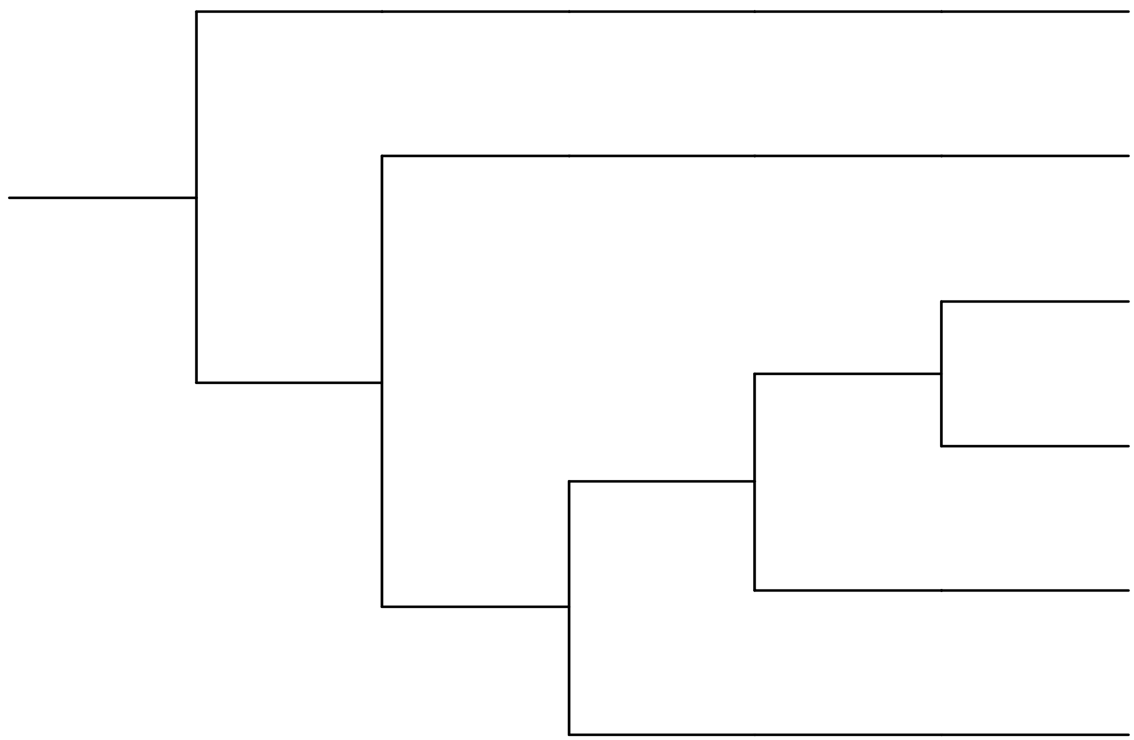
Plant name abbrev.: SUMM

MSLB	SGI	EIHP	EFW	FB	OAT	HPR	#	STATUS
							1	OK
							2	OK
							3	CD
							4	OK
							5	CD
							6	CD
							7	OK
							8	CD
							9	CD

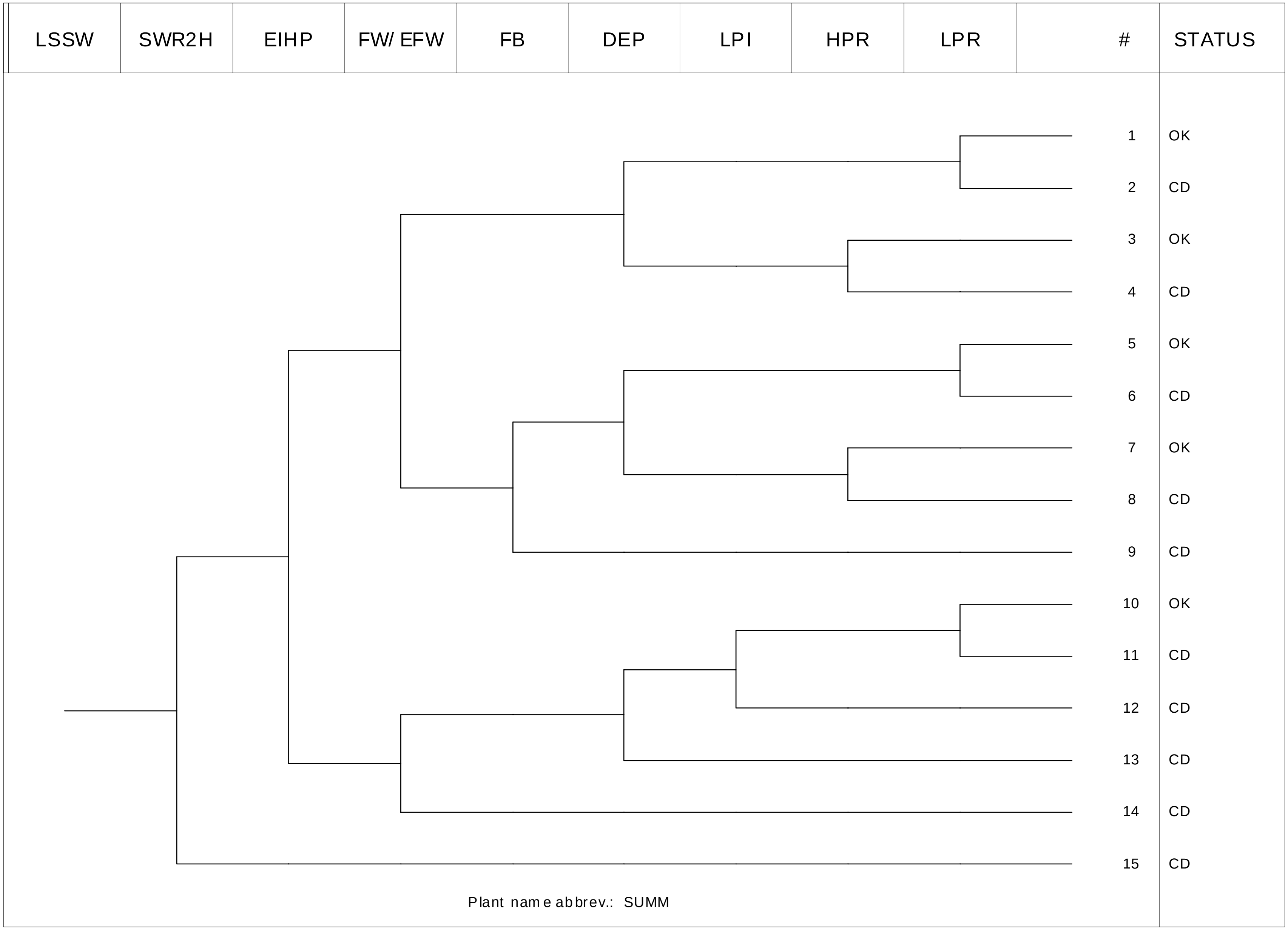


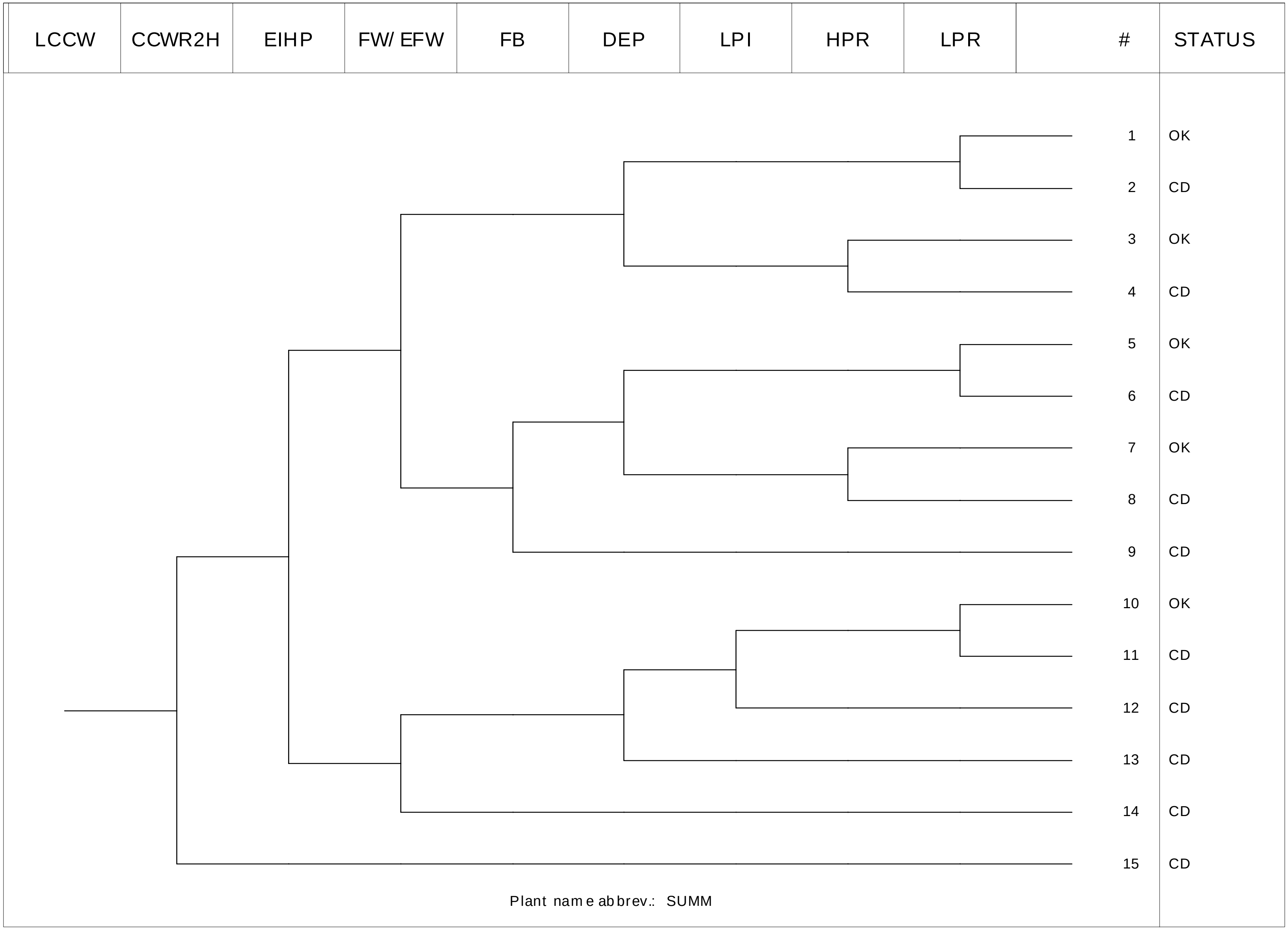
Plant name abbrev.: SUMM

LOIA	OAA	EFW	EIHP	FB	HPR	#	STATUS
						1	OK
						2	OK
						3	OK
						4	CD
						5	CD
						6	CD

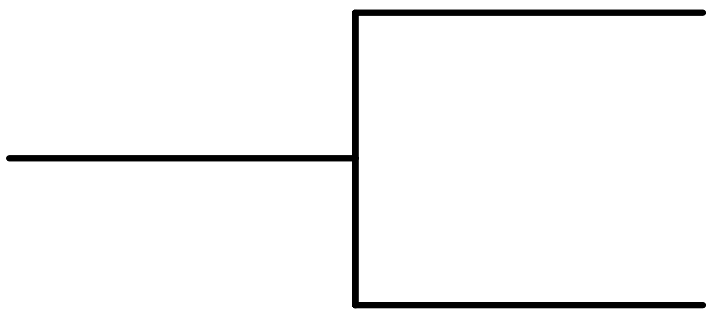


Plant name abbrev.: SUMM

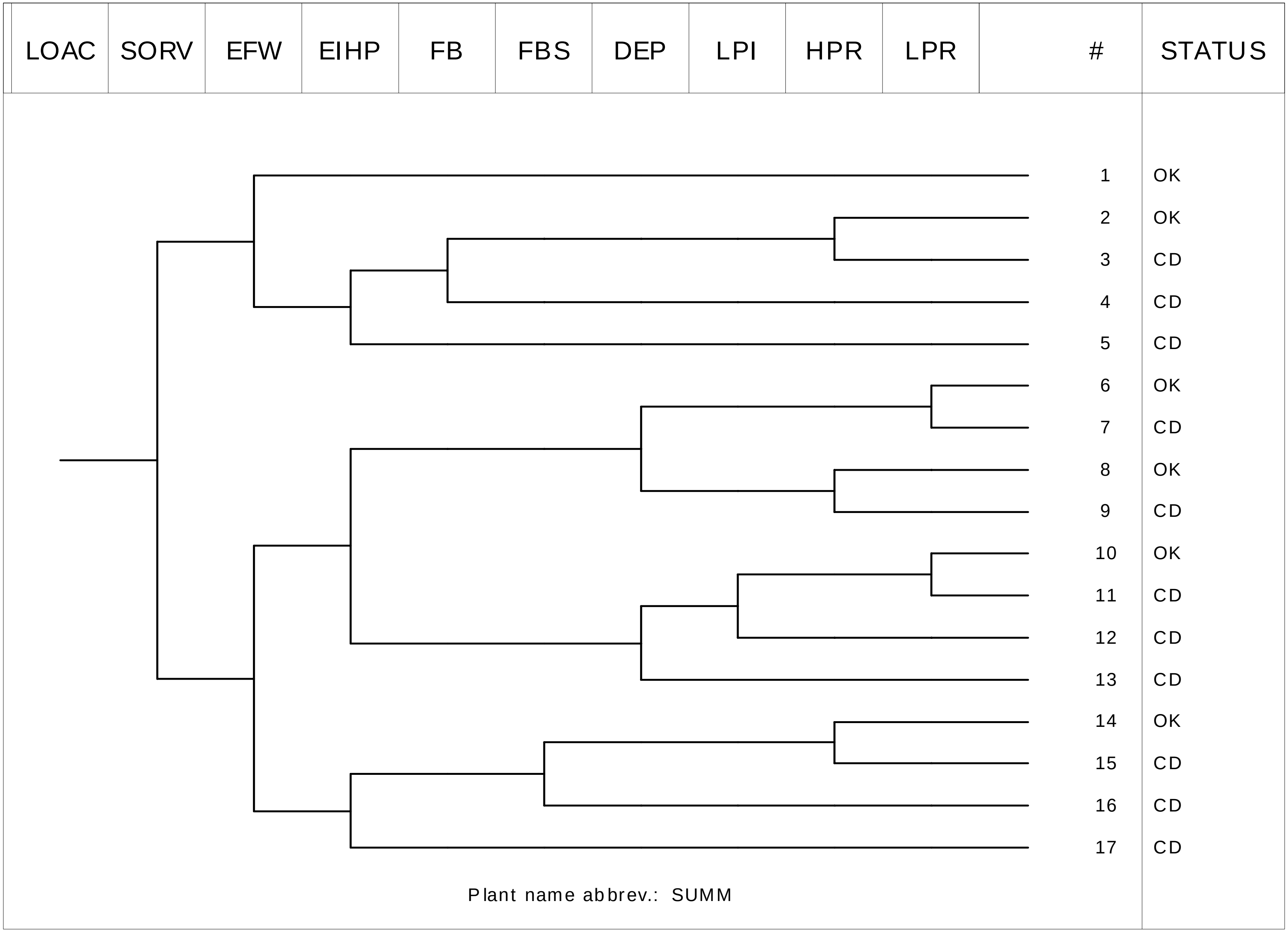

LSSW
SWR2H
EIHP
FW/ EFW
FB
DEP
LPI
HPR
LPR
#
STATUS
1 OK
2 CD
3 OK
4 CD
5 OK
6 CD
7 OK
8 CD
9 CD
10 OK
11 CD
12 CD
13 CD
14 CD
15 CD
Plant name abbrev.: SUMM


LCCW
CCWR2H
EIHP
FW/ EFW
FB
DEP
LPI
HPR
LPR
#
STATUS
1 OK
2 CD
3 OK
4 CD
5 OK
6 CD
7 OK
8 CD
9 CD
10 OK
11 CD
12 CD
13 CD
14 CD
15 CD
Plant name abbrev.: SUMM

LBDC	EFW		#	STATUS
			1	OK
			2	CD



Plant name abbrev.: SUMM


LOAC
SORV
EFW
EIHP
FB
FBS
DEP
LPI
HPR
LPR
#
STATUS
1 OK
2 OK
3 CD
4 CD
5 CD
6 OK
7 CD
8 OK
9 CD
10 OK
11 CD
12 CD
13 CD
14 OK
15 CD
16 CD
17 CD
Plant name abbrev.: SUMM

2. RESOLUTION AND DISPOSITION OF COMMENTS

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

2.1 GENERIC GUIDELINES AND ASSUMPTIONS (PWRs)

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

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

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

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

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

3. Inclusion of special initiators:

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

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

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

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

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

6. Crediting of non-safety related equipment:

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

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

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

8. Crediting system trains with high unavailability:

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

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

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

10. Crediting accumulators:

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

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

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

11. Crediting operator actions:

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

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

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

13. Dependency among multiple operator actions:

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

14. Crediting the standby high-pressure pump:

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

15. Emergency AC Power:

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

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

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

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

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

16. Treatment of HPR and LPR:

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

17. SGTR event tree:

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

18. ATWS scenarios:

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

19. Recovery of losses of offsite power:

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

20. RCP seal LOCA in a SBO:

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

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

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

22. Tripping the RCP on loss of CCW:

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

23. Hot leg/Cold leg switchover:

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

2.2 RESOLUTION OF PLANT-SPECIFIC COMMENTS

NRC met with Summer personnel. The Licensee provided useful comments on the draft worksheets. The special initiators, plant response, and the initiator impacts were discussed. Other items included as a part of NRC review process were also discussed. The licensee's comments were reviewed and incorporated into this document to the extent possible within the framework, scope, and limitations of the SDP worksheets. The licensee's comments and feedback have significantly contributed to the improvement of this document.

(1) The information on the licensee's current initiating events was incorporated into Table 1, Categories of Initiating Events.

(2) Licensee's comments on the Initiator and System Dependency Table reflecting the up to date plant-specific system interactions, clarification notes, and plant-specific acronyms were incorporated. The initiating event column of Table 2 now includes all initiating events that are considered by the SDP worksheets.

(3) Licensee's comments on the SDP worksheets, including the current understanding of success criteria, were incorporated in the SDP sheets.

(4) The information provided by the licensee on the special initiators were incorporated in developing the SDP sheets for the special initiators and the associated event trees.

(5) Since the IPE, the licensee modified the plant to change the cooling water source to the charging pumps from chilled water to component cooling. The VU system is no longer modeled in their PRA. Another change the licensee made to their PRA was to eliminate the dependency for room cooling for most mitigative systems. These changes have been incorporated in this document.

(6) The licensee provided a copy of its own ISLOCA event tree, but it did not provide a copy of the corresponding description. Since no description of the specific pathways of ISLOCA was received from the licensee, a generic worksheet was generated for ISLOCA, containing generic pathways for a PWR.

(7) The licensee stated that operators are directed in their EOPs to initiate LPR if HPR is not available. The licensee's IPE does not credit LPR in most sequences. Per the licensee's request, we included LPR in the SDP's event trees and worksheets as we considered appropriate.

(8) The licensee's IPE does not model the main feedwater and condensate systems. The licensee stated that they plan to model these systems in the future. Like LPR, the licensees' EOPs direct the operators to restore feedwater flow if EFW is lost. Per the licensee's request, we included these systems in the SDP's event trees and worksheets as we considered appropriate.

(9) The IPE (page 3-3) considered the potential of a loss of Heating, Ventilation, and Air Conditioning (HVAC) as an initiating event, but it did not include this loss in the set of analyzed special initiators.

REFERENCES

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

2. South Carolina Electric & Gas Company, "V. C. Summer Nuclear Station – Individual Plant Examination Report," June, 1993.

3. NRC memorandum from P. Wilson to J. Ibarra, “Significance Determination Process Review for V. C. Summer”, April 5, 2000.