January 5, 2000

Mr. L. W. Myers
Senior Vice President
Beaver Valley Power Station
Post Office Box 4
Shippingport, PA 15077

SUBJECT: BEAVER VALLEY 1 AND 2 - SITE - SPECIFIC WORKSHEETS FOR USE IN THE NRC'S SIGNIFICANCE DETERMINATION PROCESS (TAC MA6544)

Dear Mr. Myers:

The purpose of this letter is to provide you with one of the key implementation tools to be used by the Nuclear Regulatory Commission (NRC) in the revised reactor oversight process, which is currently expected to be implemented at the Beaver Valley Power Station, Unit Nos. 1 and 2, in April 2000. Included in the enclosed Risk-Informed Inspection Notebook are the Significance Determination Process (SDP) worksheets that inspectors will be using to risk-characterize inspection findings. The SDP is discussed in more detail below.

On January 8, 1999, the NRC staff described to the Commission plans and recommendations to improve the reactor oversight process in SECY-99-007, "Recommendations for Reactor Oversight Process Improvements." SECY-99-007 is available on the NRC's web site at www.nrc.gov/NRC/COMMISSION/SECYS/index.html. The new process, developed with stakeholder involvement, is designed around a risk-informed framework, which is intended to focus both the NRC's and licensee's attention and resources on those issues of more risk significance.

The performance assessment portion of the new process involves the use of both licensee-submitted performance indicator data and inspection findings that have been appropriately categorized based on their risk significance. In order to properly categorize an inspection finding, the NRC has developed the SDP. This process was described to the Commission in SECY-99-007A, "Recommendations for Reactor Oversight Process Improvements (Follow-up to SECY-99-007)," dated March 22, 1999, also available at the same NRC web site noted above.

The SDP for power operations involves evaluating an inspection finding's impact on the plant's capability to limit the frequency of initiating events; ensure the availability, reliability, and capability of mitigating systems; and ensure the integrity of the fuel cladding, reactor coolant system, and containment barriers. As described in SECY-99-007A, the SDP involves the use of three tables: Table 1 is the estimated likelihood for initiating event occurrence during the degraded period, Table 2 describes how the significance is determined based on remaining mitigation system capabilities, and Table 3 provides the bases for the failure probabilities associated with the remaining mitigation equipment and strategies.

As a result of the recently concluded Pilot Plant review effort, the NRC has determined that site-specific risk data is needed in order to provide a repeatable determination of the significance of an issue. Therefore, the NRC has contracted with Brookhaven National Lab (BNL) to develop site-specific worksheets to be used in the SDP review. These enclosed worksheets were developed based on your Individual Plant Examination (IPE) submittal that was requested by Generic Letter 88-20. The NRC plans to use this site-specific information in evaluating the significance of issues identified at your facility when the revised reactor oversight process is implemented industry wide. It is recognized that the IPE utilized during this effort may not contain current information. Therefore, the NRC or its contractor will conduct a site visit before April 2000 to discuss with your staff any changes that may be appropriate. Specific dates for the site visit have not been determined, but will be communicated to you in the near future. In addition, the NRC is not requesting a written response or comments on the enclosed worksheets developed by BNL.

We will coordinate our efforts through your licensing or risk organizations as appropriate. If you have any questions, please contact me at (301) 415- 1427.

Sincerely,

/RA/

Daniel S. Collins, Project Manager, Section 1
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-334 and 50-412

Enclosures: 1. Risk Informed Inspection Notebook for Beaver Valley Unit 1
2. Risk Informed Inspection Notebook for Beaver Valley Unit 2

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RISK-INFORMED INSPECTION NOTEBOOK FOR

BEAVER VALLEY UNIT 1

PWR, WESTINGHOUSE, THREE-LOOP PLANT WITH SUB-ATMOSPHERIC CONTAINMENT

Prepared by

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Department of Advanced Technology

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Prepared for

U. S. Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
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ENCLOSURE 1

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. Technical errors in, and recommended updates to, this document should be brought to the attention of the following person:

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M/S TWFN T4 A9
11545 Rockville Pike
Rockville, MD 20852

ABSTRACT

This notebook contains summary information to support the Significance Determination Process (SDP) in risk-informed inspections for the Beaver Valley Unit 1.

SDP worksheets support the significance determination process in risk-informed inspections and are intended to be used by the NRC's inspectors in identifying the significance of their findings, i.e., in screening risk-significant findings, consistent with Phase-2 screening in SECY-99-007A. To support the SDP, additional information is given in an Initiators and System Dependency table, and as simplified event-trees, called SDP event-trees, developed in preparing the SDP worksheets.

The information contained herein is based on the licensee's IPE submittal. The information is revised based on IPE updates or other licensee or review comments providing updated information and/or additional details.

CONTENTS

FIGURES

Page

TABLES

Page

1. INFORMATION SUPPORTING SIGNIFICANCE DETERMINATION PROCESS (SDP)

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

1. Initiator and System Dependency Table
2. Significance Determination Process (SDP) Worksheets
3. SDP Event Trees

The initiator and system dependency table shows the major dependencies between front-line- and support-systems, and identifies their involvement in different types of initiators. The information in this table identifies the most risk-significant front-line- and support-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 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 finding on the core-damage scenarios, the SDP worksheets are developed and provided. They contain two parts. The first part identifies the functions, the systems, or combinations thereof that can perform mitigating functions, the number of trains in each system, and the number of trains required (success criteria) for each class of initiators. The second part of the SDP worksheet contains the core-damage accident sequences associated with each initiator class; these sequences are based on SDP event trees. In the parenthesis next to each of the sequence the corresponding event tree branch number(s) representing the sequence is included. Multiple branch numbers indicate that the different accident sequences identified by the event tree are merged into one through the boolean reduction. The classes of initiators that are considered in this notebook are 1) Transients, 2) Small Loss of Coolant Accident (LOCA), 3) Stuck-open Power Operated Relief valve (PORV), 4) Medium LOCA, 5) Large LOCA, 6) Loss of Offsite Power (LOOP), 7) Steam Generator Tube Rupture (SGTR), and 8) Anticipated Transients Without Scram (ATWS). Main Steam Line Break (MSLB) events are included separately if they are treated as such in the licensee's Individual Plant Examination (IPE) submittal.

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.

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. In cases where a plant-specific feature introduced a sequence that is not fully captured by our existing set of initiators and event trees, then a separate worksheet is included.

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

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

4. The simplified event-trees focus on classes of initiators, as defined above. In so doing, many separate event trees in the IPEs often are represented by a single tree. For example, some IPEs define four classes of LOCAs rather than the three classes considered here. The sizes of LOCAs for which high-pressure injection is not required are some times divided into two classes, the only difference between them being the need for reactor scram in the smaller break size. Some IPEs also may define several classes of transients, depending on the initiator's impact on the systems. Such differentiations generally are not considered in the SDP worksheets unless they could not be accounted for by the Initiator and System Dependency table.

5. Major operator actions during accident scenarios are assigned as high stress operator action or operator action using simple, standard criteria among a class of plants. This approach resulted in the designation of some operator actions as high-stress ones (as opposed to normal), even though the PRA may have assumed a (routine) operator action; hence, they have been assigned an error probability less than 5E-2 in the IPE. In such cases, a note is given at the end of the worksheet.

The three sections that follow include the initiators and dependency table, SDP worksheets, and the SDP event-trees for the Beaver Valley Unit 1 Plant.

1.1 INITIATORS AND SYSTEM DEPENDENCY

Table 1 provides the list of the systems included in the SDP worksheets, the major components in the systems, and the support system dependencies. The system involvements in different initiating events are noted in the last column.

Table 1 (Continued)

Table 1. Initiators and System Dependency for Beaver Valley Unit 1

Affected Systems	Major Components	Support Systems	Initiating Event Scenarios
Reactor Coolant Pumps (RCPs)	Pumps 1A, 1B, 1C	RPCCW, Offsite grid, CIA, SIA, SSPS	LOOP, Transient, RCP seal LOCA
PORVs	PORV 455C&D, 456 Block Valves 535,536,537	125V-DC, 480V AC (Block Valves), Containment IA, Backup N_2 (PORV 455C&D)	All except LLOCA, and MLOCA
Main and Dedicated Feed Water (MFW and DFP[1])	MFW Pumps P1A, P1B, DFW Pump P4[1]	TPCCW, Offsite grid, DC Battery 1-5, SSPS ERF DG (DFP P4)	Transient. SLOCA. SORV.LOOP
Condensate Pump		TPCCW, Offsite grid, Normal 125VDC Supply Battery 1-5	Transient, SLOCA, SORV, LOOP
AFWs	2 MDPs	4.16 KV EAC, EDG, 125 V-DC,SSPS	All except MLOCA and LLOCA
	1 TDP	125 V-DC,SSPS	
RHR	Pumps P1A, P1B	4.16kV EAC, EDG, 125VDC, RPCCW, SSPS	SGTR
HHSI[2]	Pumps P1A, P1B, P1C[2]	Offsite grid, 4.16kV EAC, EDG, 125VDC, SSPS, River Water Header	All except LLOCA, RCP Seal LOCA
LHSI	Pumps P1A, P1B	4.16kV EAC, EDG, 125VDC, SSPS	All including RCP Seal LOCA
	MOVs	4.16kV EAC, EDG	
Crosstie Valves (ECCS Cold Led Recirculation)	Train A and B	4.16kV EAC, EDG, SSPS	All including RCP Seal LOCA
RWST Level	LT 100 A, B, C, D	Vital Bus I, II, III, IV; SSPS	MLOCA, SGTR
Quench Spray (QS)	Pumps P1A, P1B	4.16kV EAC, EDG, 125VDC,SSPS	LLOCA

Table 1 (Continued)

Affected Systems	Major Components	Support Systems	Initiating Event Scenarios
Recirculation Spray (RS)	Pumps P1A, P1B, P1C, P1D	4.16KV EAC, EDG, 125 VDC, SSPS	All including RCP Seal LOCA
	Hx E1A, E1B, E1C, E1D	River Water Header A, B	
RPCCW	Pump 1A(normally running), Pump 1B(Auto backup), Pump 1C (manual Backup)	Offsite grid, 4.16 kV EAC, 125VDC, IA, River Water Header, Vital Bus Channel I &II, CIA, SIA (3)	RCP Seal LOCA, SGTR
TPCCW	Pump CCP-3A (normally running), Pump-3B (auto backup)	4.16 kV EAC, EDG, 125VDC	Transient, SLOCA, SORV, LOOP
	Pump WR-P-6A (normally running), Pump WR–6B (auto backup) Pump WR-P-12A (normally running), Pump WR-P-12B (auto backup)	4.16kV EAC, EDG, 125VDC	
Emergency AC (EAC)	4.16kV/480V AC Train A,B	Offsite grid, EDG	All
Emergency Diesel Generator (EDG)	EDG 1-1, 1-2	125 VDC, River Water Header, Vent. System, SSPS	LOOP
	ERF DG (Black)	Offsite grid, Vent. System	LOOP
125 V DC	Trains A, B; Batteries	4.16kV EAC, EDG, Vent. System	All

Table 1 (Continued)

Affected Systems	Major Components	Support Systems	Initiating Event Scenarios
Solid State Protection System (SSPS)	Trains A, B	Vital Bus Channel I, II, II, IV; Vent. System	All
River Water Header	Headers A,B	Offsite grid, 4.16 kV EAC, EDG, 125 VDC, SSPS, Vent. System	All
Ventilation System		Offsite grid, 4.16kV EAC, EDG, RPCCW, Chilled Water	All
Containment Instrument Air (CIA)		Offsite grid, 4.16 kV EAC, EDG, Chilled water, SIA	All except LLOCA and MLOCA
Station Instrument Air (SIA)		Offsite grid, ERF EDG (Black), TPCCW, Normal 125V DC Supply Battery 1-5	Transient, SLOCA, LOOP, RCP Seal LOCA,
Chilled Water System		Offsite grid, Normal 125V DC Supply Battery 1-5	All

Notes:

(1) the dedicated feed pump (FW-P-4) is powered off the 4160V DC ERF Substation bus 1H. The bus is normally supplied from the offsite grid. During a LOOP, the ERF (black) Diesel Generator supplies power to bus 1H.

(2) HHSI consists of two trains. HHSI pump P1C can be manually aligned to either train of electric power, but cannot be racked in unless the other charging pump is racked out from the same bus.

(3) The loss of CIA and SIA causes air-operated isolation valves for the RCP thermal barriers, motor, and bearings to fail closed. RCP seal cooling must then be provided by seal injection and the RCPs must be stopped.

The plant internal event CDF (including internal flood) is 2.1E-4/yr.

1.2 SDP WORKSHEETS

This section presents the SDP worksheets to be used in the Phase 2 evaluation of the inspection findings for the Beaver Valley Unit 1 Nuclear Plant. The SDP worksheets are presented for the following initiating event categories:

1. Transients
2. Small LOCA
3. Stuck-open PORV
4. Medium LOCA
5. Large LOCA
6. LOOP
7. Steam Generator Tube Rupture (SGTR)
8. Anticipated Transients Without Scram (ATWS)

Table 2.1 SDP Worksheet for Beaver Valley 1 —— Transients

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

Safety Functions Needed:	***Full* Creditable Mitigation Capability for Each Safety Function:**
Power Conversion System (PCS)	1 / 2 Main Feedwater (MFW) trains or dedicated feed pump (DFP) and 1/ 2 Condensate pump trains (operator action)
Secondary Heat Removal (AFW)	1 / 2 MDAFW trains (1 multi-train system) or 1 TDAFW train (1 ASD train)(1)
Early Inv., High Pressure Injection (EIHP)	1 / 3 Charging pumps (1 multi-train system).
Primary Heat Removal, Feed/Bleed (FB)	1 / 3 PORVs and block valves open for Feed/Bleed (operator action)(2)
High Pressure Recirculation (HPR)	1 / 3 charging pumps with 1/ 2 LHSI or 1/ 2 RS (2A or 2B) pumps(Operator action)
Recirculation Spray (RS)	1/ 2 Inside RS (1A or 1B) pumps or 1/ 2 Outside RS (2A or 2B) pumps (2 multi-train systems)

Circle Affected Functions	**Recovery of Failed Train**	***Remaining Mitigation Capability Rating for Each Affected Sequence***	**Sequence Color**
1 TRANS - AFW - PCS - RS (4)			
2 TRANS - AFW - PCS - HPR (5)			
3 TRANS - AFW - PCS - FB (6)			
4 TRANS - AFW - PCS - EIHP (7)			

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

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

Notes:

(1) The value assessed by the IPE (Table 3.3.2-2, page 3.3-39) for the AFW TDP failure to start is 2.1E-2. For the SDP calculation, a value of 1E-1 can be used.

(2) The human error probability (HEP) assessed in the IPE (page 3.3-117) for establishing bleed and feed cooling is 1.39E-2 (Operator failure to to initiate feed and bleed after failure to restore MFW and the dedicated feed pump).

Table 2.2 SDP Worksheet for Beaver Valley Unit 1 —— Small LOCA

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 / 3 charging pumps (1 multi-train system).
Secondary Heat Removal (AFW)	1 / 2 MDAFW trains (1 multi-train system) or 1 TDAFW train (1 ASD train)
Main Feedwater or Dedicated FWP (FW)	Operator initiated 1/ 2 main feed pump or dedicated FP (Operator action)
RCS Cooldown/ Depressurization (RCSDEP)	Operator depressurizes RCS using 1 / 3 PORVs and block valves (operator action)
Primary Bleed (FB)	1 / 3 PORVs and block valves open for Feed/Bleed (operator action)(1)
Low Pressure Recirculation (LPR)	1 / 2 LHSI trains (Operator action)
High Pressure Recirculation (HPR)	1 / 3 charging pumps with 1 / 2 LHSI pumps or 1/ 2 RS (2A or 2B) pumps (Operator action)
Recirculation Spray (RS)	1/ 2 inside RS (1A or 1B) pumps or 1/ 2 Outside RS (2A or 2B) pumps (2 multi-train systems)

Circle Affected Functions	**Recovery of Failed Train**	***Remaining Mitigation Capability Rating for Each Affected Sequence***	**Sequence Color**
1 SLOCA - RS (2, 5, 8, 11, 14)			
2 SLOCA - LPR (3, 9)			
3 SLOCA - RCSDEP - HPR (6, 12)			
4 SLOCA - AFW - FW- HPR (15)			
5 SLOCA - AFW - FW - FB (16)			
6 SLOCA - EIHP (17)			

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

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

<u>Notes</u>:

(1) The human error probability (HEP) assessed in the IPE (page 3-129) for establishing bleed and feed cooling is 1.39E-2.

Table 2.3 SDP Worksheet for Beaver Valley Unit 1 —— 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:**
Early Inventory, HP Injection (EIHP)	1 / 3 charging pumps (1 multi-train system).
Isolation of Small LOCA (BLK)	The closure of the block valve associated with stuck open PORV (recovery action)
Secondary Heat Removal (AFW)	1 / 2 MDAFW trains (1 multi-train system) or 1 TDAFW train (1 ASD train)
RCS Cooldown/ Depressurization (RCSDEP)	Operator depressurizes RCS using 1 / 3 PORVs and block valves (operator action)
Primary Bleed (FB)	1 / 3 PORVs and block valves open for Feed/Bleed (operator action[1]
Low Pressure Recirculation (LPR)	1 / 2 LHSI pumps (Operator action)
High Pressure Recirculation (HPR)	1 / 3 charging pumps with 1 / 2 LHSI pumps or 1/ 2 RSS pumps (Operator action)
Recirculation Spray (RS)	1/ 2 inside RS pumps or 1/ 2 outside RS pumps (2 multi-train systems)

Circle Affected Functions	**Recovery of Failed Train**	***Remaining Mitigation Capability Rating for Each Affected Sequence***	**Sequence Color**
1 SORV - BLK - RS (2, 5, 8, 11, 14)			
2 SORV - BLK - LPR (3, 9)			
3 SORV - BLK - RCSDEP - HPR (6, 12)			
4 SORV - BLK - AFW - FW - HPR (15)			
5 SORV - BLK - AFW - FW - FB (16)			
6 SORV - BLK - EIHP (17)			

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

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

Notes:

(1) The human error probability (HEP) assessed in the IPE (page 3-129) for establishing bleed and feed cooling is 1.39E-2

Table 2.4 SDP Worksheet for Beaver Valley Unit 1 —— Medium LOCA

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

Safety Functions Needed:	*Full* Creditable Mitigation Capability for Each Safety Function:
Early Inventory, Accumulators (EIAC)	2/ 3 accumulators (1 multi-train system)
Early Inventory, HP Injection (EIHP)	1/ 3 charging pumps (1 multi-train system).
Low Pressure Injection (LPI)[1]	1/ 2 LHSI pumps (1 multi-train system)
Low Pressure Recirculation (LPR)	1 / 2 LHSI pumps or 1/ 2 RS (2A or 2B) pumps aligned for recirculation (operator action)
RWST Makeup (RWST)[2]	Operator provides makeup for HHSI pumps (Operator action)
Recirculation Spray (RS)	1/ 2 inside RS (1A or 1B) pumps or 1/ 2 outside RS (2A or 2B) pumps in spray mode (2 multi-train system)

Circle Affected Functions	Recovery of Failed Train	*Remaining Mitigation Capability Rating for Each Affected Sequence*	Sequence Color
1 MLOCA - RS (2)			
2 MLOCA - LPR - RWST (4)			
3. MLOCA - LPI (5)			
4. MLOCA - EIHP (6)			
5. MLOCA - EIAC (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) As per the IPE, both HHSI and LHSI are required for success to cover the full range of medium LOCAs.

(2) RWST makeup actions are called for by procedure when RWST level is low and cold leg recirculation is unavailable.

Table 2.5 SDP Worksheet for Beaver Valley Unit 1 —— Large LOCA

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

Safety Functions Needed:	***Full*** **Creditable Mitigation Capability for Each Safety Function:**
Early Inventory, Accumulators (EIAC)	2/ 2 Accumulators (1 Train)
Early Inventory, LP Injection (EILP)	1/2 LHSI pump trains (1 multi-train system)
Quench Spray (QS)[(1)]	1/ 2 QS pumps drawing from RWST (1 multi-train system)
Recirculation Spray (RS)	1/ 2 inside RS pumps (1 multi-train system)
Outside recirculation spray (ORS)	1/ 2 outside RS pumps (1 multi-train system)
Low Pressure Recirculation (LPR)	1/2 LHSI pump trains; Operator switchover from injection to recirculation (operator action)

Circle Affected Functions	**Recovery of Failed Train**	***Remaining Mitigation Capability Rating for Each Affected Sequence***	**Sequence Color**
1 LLOCA - LPR (2)			
2 LLOCA - RS (3)			
3 LLOCA - QS - ORS (6)			
4 LLOCA - LHSI (7)			
5 LLOCA - EIAC (8)			

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

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

(1) A high containment pressure (8 psig) signal initiates both QS pumps. Successful operation of a QS pump is needed to fill the containment sump for required NPSH for inside RS pumps.

Table 2.6 SDP Worksheet for Beaver Valley Unit 1 —— 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 AFW pump (TDAFW)	1 / 1 TDP trains of AFW (1 ASD train)(1)
Secondary Heat Removal (AFW)	1 / 2 MDAFW trains (1 multi-train system) or 1 TDAFW train (1 diverse train)(1) or dedicated feed pump (operator action)
Recovery of AC Power in < 2 hrs (REC2)	SBO procedures implemented (operator action under high stress)(2)
Recovery of AC Power in < 5 hrs (REC5)	SBO procedures implemented (operator action)(2, 3)
Early Inventory, HP Injection (EIHP)	1 / 3 charging pumps (1 multi-train system)
Primary Heat Removal (FB)	Operator uses RCS pressurizer 1 / 3 PORVs and block valves (operator action)(4)
High Pressure Recirculation (HPR)	1 / 3 charging pumps with 1/ 2 LHSI pumps or 1/ 2 RS (2A or 2B) pumps (operator action)
Recirculation Spray (RS)	1/ 2 inside RS (1A or 1B)pumps or 1/ 2 outside RS (2A or 2B) pumps (2 multi-train system)

Circle Affected Functions	Recovery of Failed Train	*Remaining Mitigation Capability Rating for Each Affected Sequence*	Sequence Color
1 LOOP - AFW - RS (3)			
2 LOOP - AFW - HPR (4)			
3 LOOP - AFW - FB (5)			
4 LOOP - AFW - EIHP (6)			
5 LOOP - EAC - RS (8,13)			
6 LOOP - EAC - HPR (9,14)			
7 LOOP - EAC - EIHP (10,16)			
8 LOOP - EAC - REC5 (11)			
9 LOOP - EAC - TDAFW - FB (15)			
10 LOOP - EAC - TDAFW - REC2 (17)			

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

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

Notes:

(1) The failure probability of AFW TDP used in the IPE is 2.1E-2.

(3) In IPE, Recovery of AC with AFW, PORV LOCA is assigned a failure probability of 0.14, and Recovery of AC with AFW, No LOCA is assigned a failure probability of 2.1E-2.

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

(5) The human error probability (HEP) assessed in the IPE (page 3-129) for establishing bleed and feed cooling is 1.39E-2.

Table 2.7 SDP Worksheet for Beaver Valley Unit 1 —— SGTR

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

<u>Safety Functions Needed</u>:	***<u>Full</u>* <u>Creditable Mitigation Capability for Each Safety Function</u>:**
Secondary Heat Removal (SHR)	1 / 2 MDPs of AFW (1 multi-train system) or 1 / 1 TDP of AFW (1 ASD Train)
Early Inventory, HP Injection (EIHP)	1 / 3 charging pumps (1 multi-train system)
Pressure Equalization (EQ)	Operator isolates the ruptured SG and depressurizes RCS using 1 / 1 SG ARV (on each SG fed by AFW) or RCS pressurizer PORV (1 / 3) to less than setpoint of relief valves of SG (operator action under high stress)(1)
Feed-and-Bleed (FB)	Operator uses RCS pressurizer PORV and block valves (1 / 3) (operator action)(2)
Late depressurization and RWST makeup (RWST)	Operator depressurizes RCS and provides makeup to RWST for HHSI pumps (Operator action)
High Pressure Recirculation (HPR)	1 / 3 charging pumps with 1/ 2 LHSI pumps or 1/ 2 RS (2A or 2B) pumps for recirculation (operator action)
Residual Heat Removal (RHR)	Operator initiates 1/ 2 RHR pumps (Operator action)
Recirculation Spray (RS)	1/ 2 inside RS (1A or 1B) pumps or 1/ 2 outside RS (2A or 2B) pumps (2 multi-train system)

<u>Circle Affected Functions</u>	**<u>Recovery of Failed Train</u>**	***<u>Remaining Mitigation Capability Rating for Each Affected Sequence</u>***	**<u>Sequence Color</u>**
1 SGTR - EQ - RHR (3)			
2 SGTR - EQ - RWST (4)			
3 SGTR - SHR - RS (6)			
4 SGTR - SHR - HPR (7)			
5 SGTR - SHR - EQ (8)			
6 SGTR - SHR - FB (9)			
7 SGTR - EIHP - RHR (11)			
8 SGTR - EIHP - EQ (12)			
9 SGTR - EIHP - SHR (13)			

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

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

Notes:

(1) In IPE, the operator failure to depressurize RCS for RHR entry is assigned a probability of 1.6E-3, and the operator failure to isolate ruptured SG and equalize pressure is assigned a probability of 3.4E-3.

(2) The human error probability (HEP) assessed in the IPE (page 3-129) for establishing bleed and feed cooling is 1.39E-2.

Table 2.8 SDP Worksheet for Beaver Valley Unit 1 —— 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:**
Emergency Boration (HPI)	Operator conducts emergency boration using 1 / 3 charging pumps (operator action)
Turbine trip (TTP)	AMSAC trips the turbine (1 train)
Primary Relief (SRV)	3 / 3 SRVs with 3/3 PORVs open (1 train)
Secondary Heat Removal (AFW)	2 / 2 MDPs of AFW (1 train) or 1 / 1 TDP of AFW (1 ASD Train)

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

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

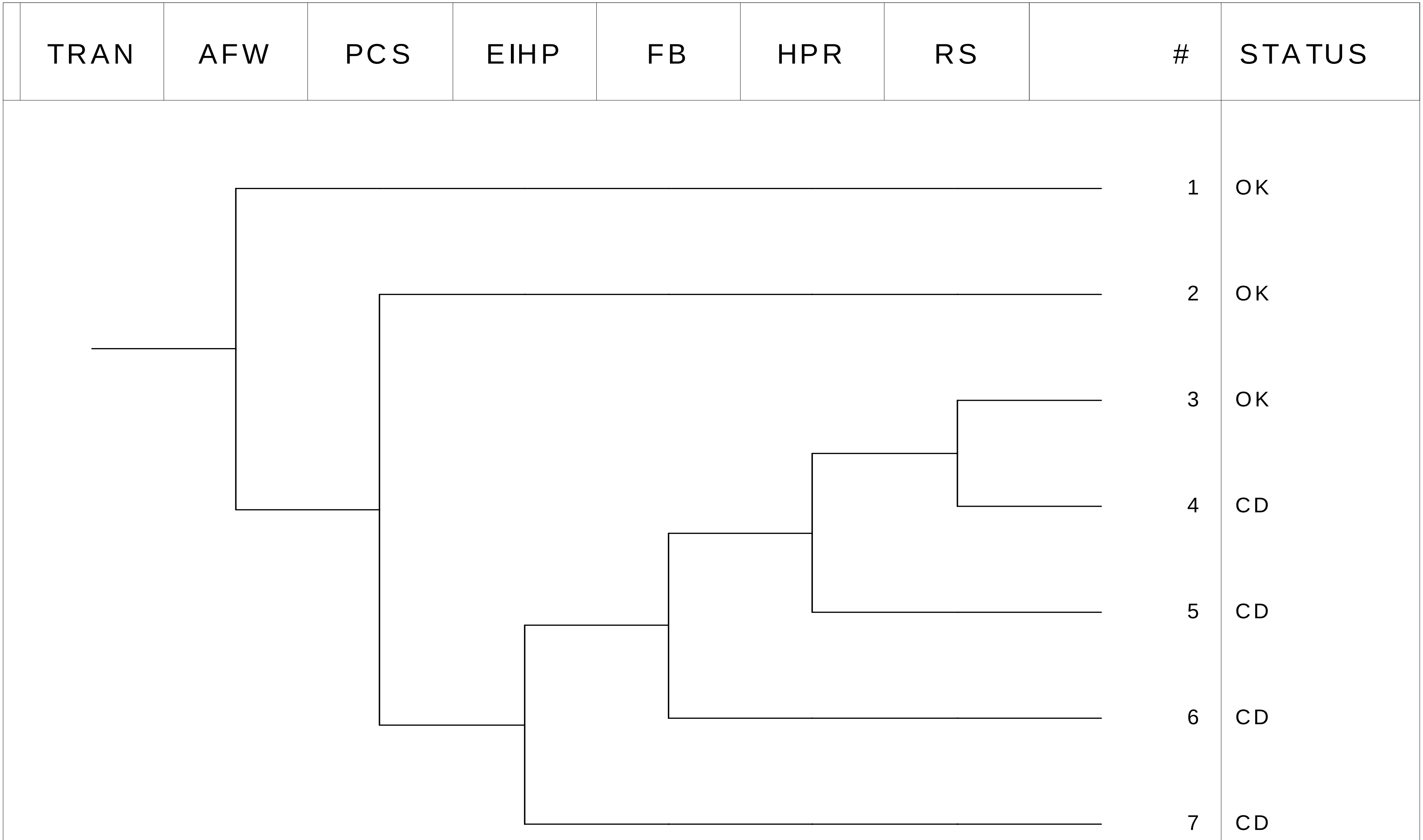
If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures 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.

1.3 SDP Event Trees

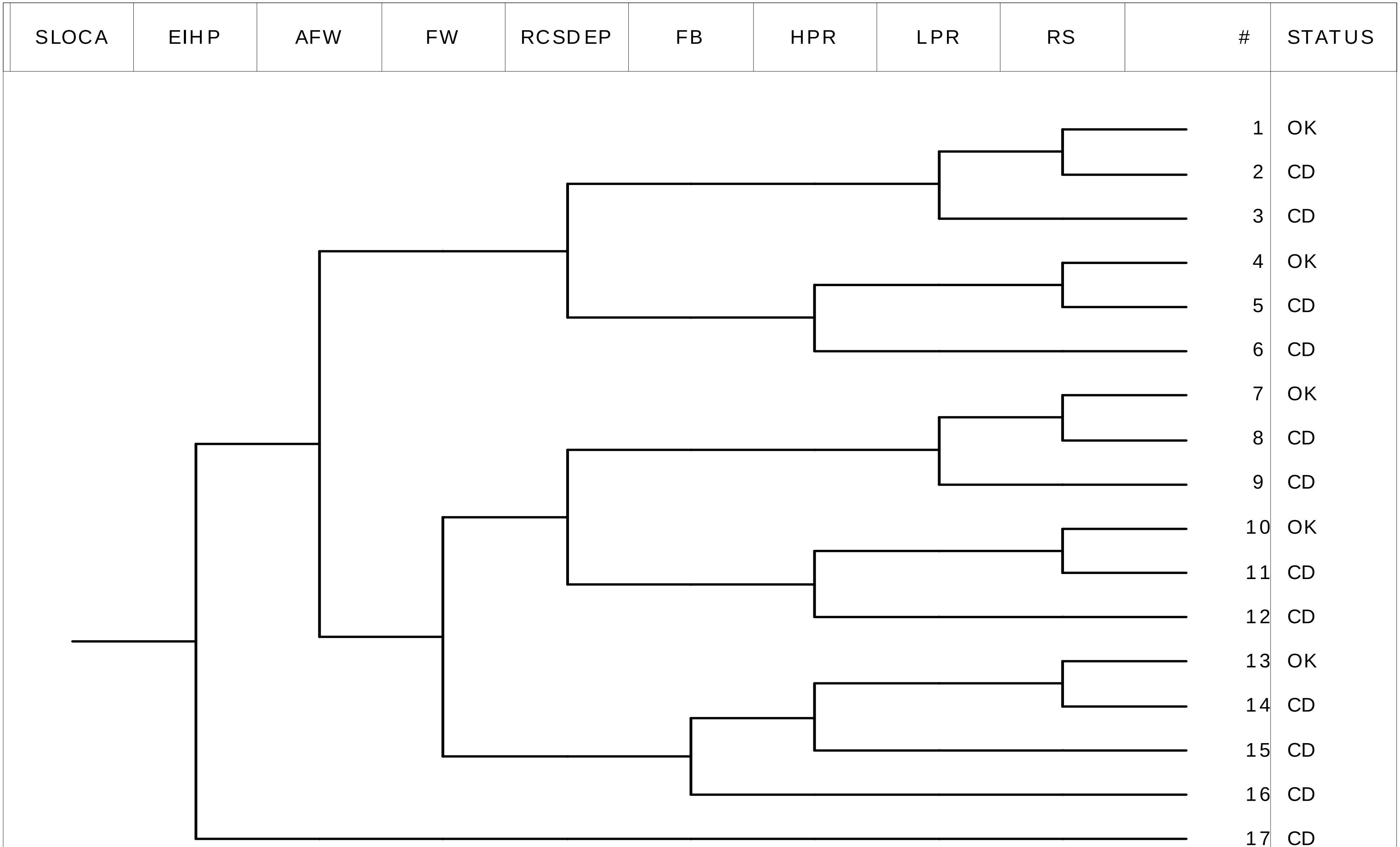
This section provides the simplified event trees called SDP event trees used to define the accident sequences identified in the SDP worksheets in the previous section. An event tree for the stuck-open PORV is not included since it is similar to the small LOCA event tree. The event tree headings are defined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

The following event trees are included:

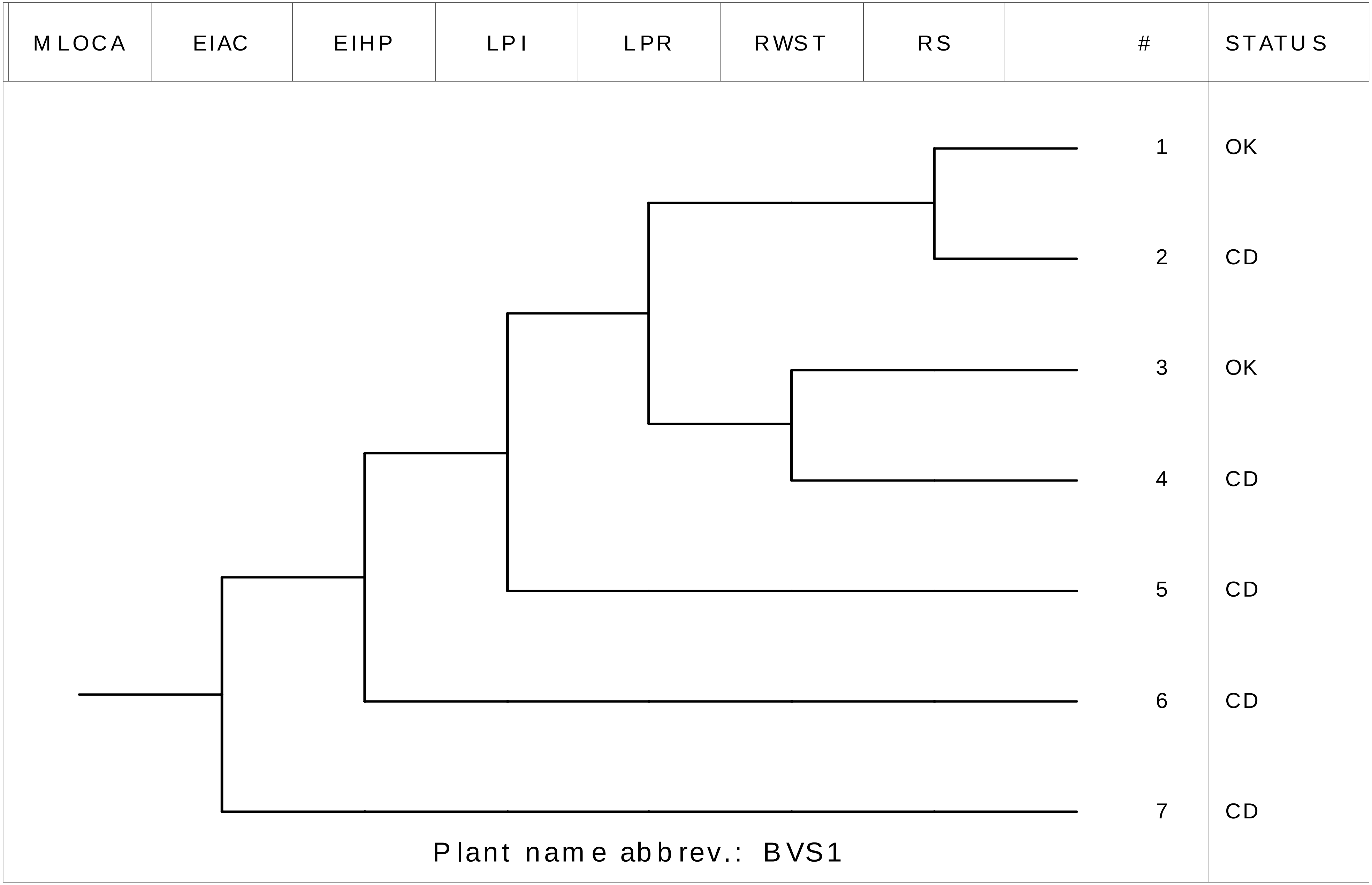
1. Transients
2. Small LOCA
3. Medium LOCA
4. Large LOCA
5. LOOP
6. Steam Generator Tube Rupture (SGTR)
7. Anticipated Transients Without Scram (ATWS)

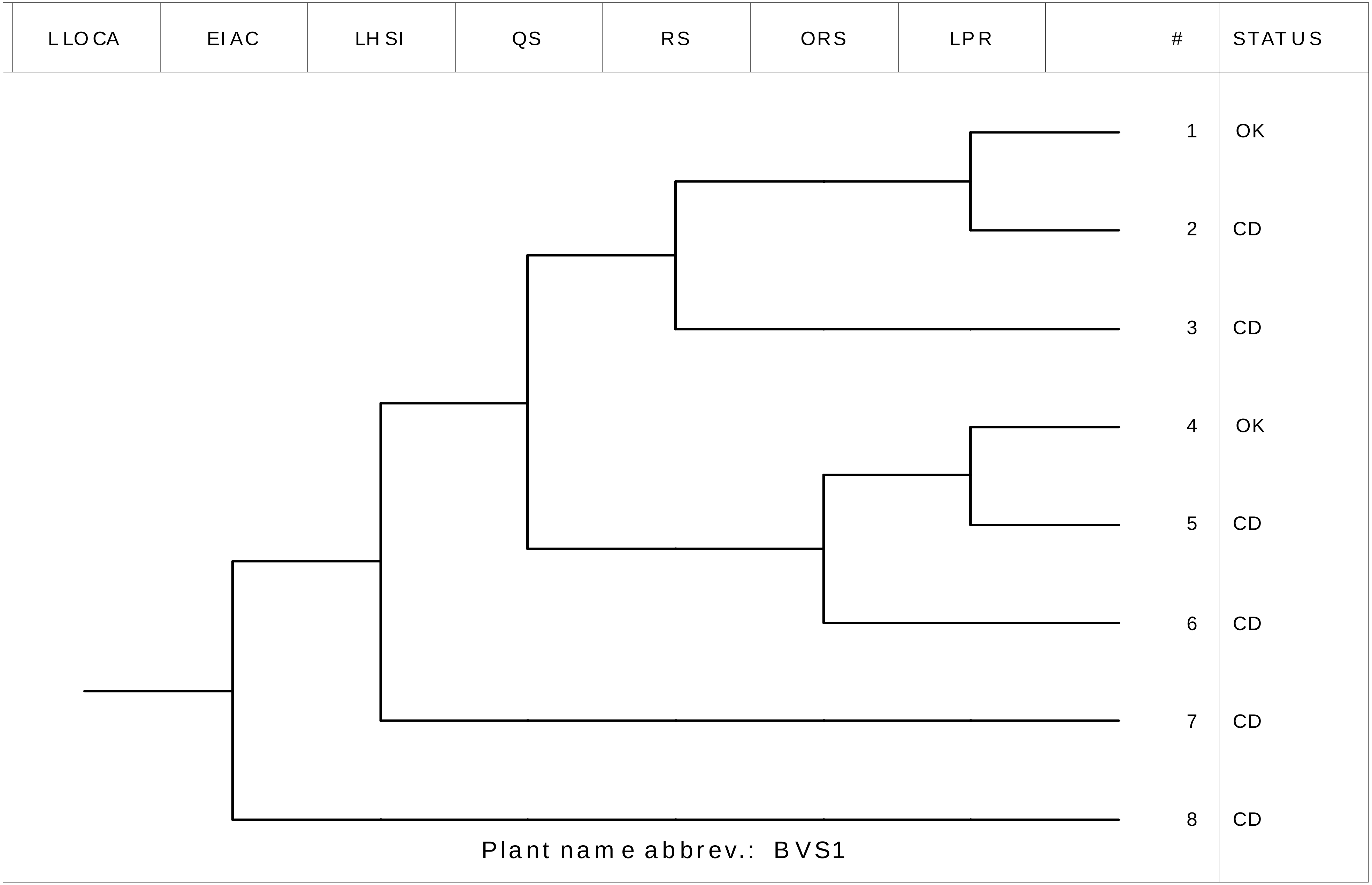


Plant name abbrev.: BVS1

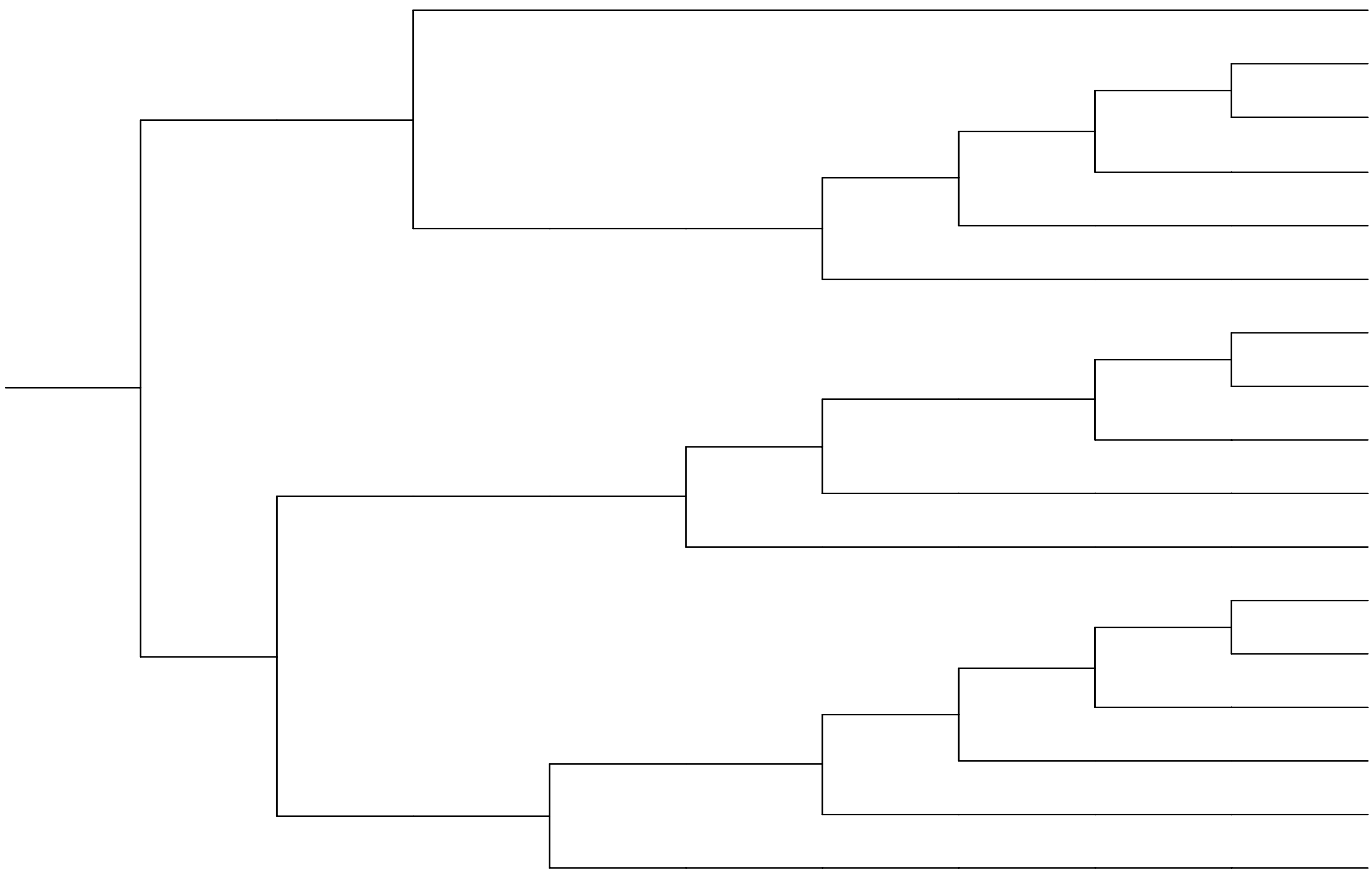


Plant name abbrev.: BVS1


MLOCA
EIAC
EIHP
LPI
LPR
RWST
RS
#
STATUS
1 OK
2 CD
3 OK
4 CD
5 CD
6 CD
7 CD
Plant name abbrev.: BVS1

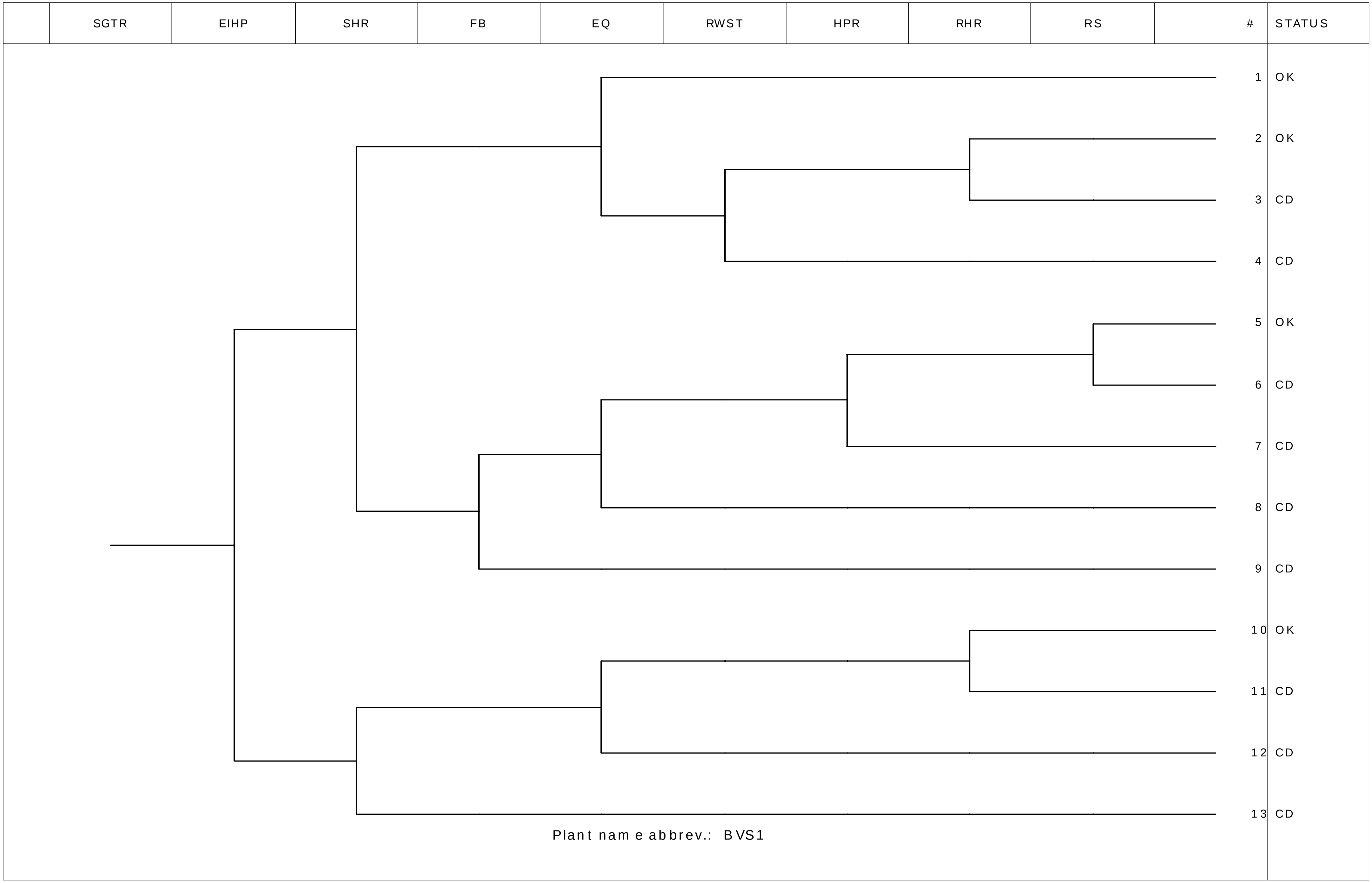

LLOCA
EIAC
LHSI
QS
RS
ORS
LPR
#
STATUS
1 OK
2 CD
3 CD
4 OK
5 CD
6 CD
7 CD
8 CD
Plant name abbrev.: BVS1

LOOP	EAC	TDAFW	AFW	REC2	REC5	EIHP	FB	HPR	RS	#	STATUS

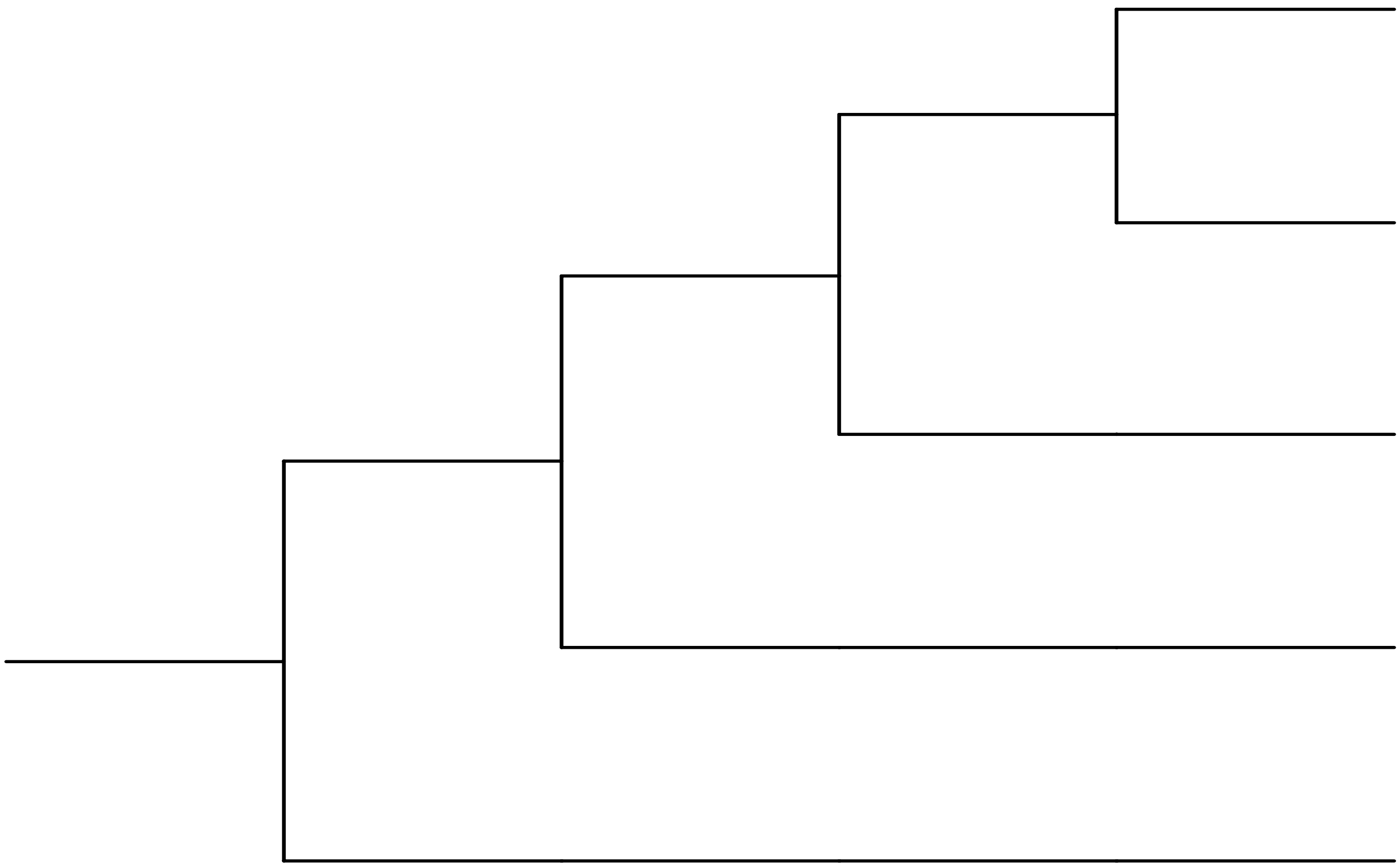


#	STATUS
1	OK
2	OK
3	CD
4	CD
5	CD
6	CD
7	OK
8	CD
9	CD
10	CD
11	CD
12	OK
13	CD
14	CD
15	CD
16	CD
17	CD

Plant name abbrev.: BVS1


SGTR
EIHP
SHR
FB
EQ
RWST
HPR
RHR
RS
#
STATUS
1 OK
2 OK
3 CD
4 CD
5 OK
6 CD
7 CD
8 CD
9 CD
10 OK
11 CD
12 CD
13 CD
Plant name abbrev.: BVS1

ATWS	TTP	AFW	SRV	HPI	#	STATUS



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

Plant name abbrev.: BVS1

2. RESOLUTION AND DISPOSITION OF COMMENTS

This section documents the comments received on the material included in this report and their resolution. This section is blank until comments are received and are addressed.

REFERENCES

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

2. Dusquesne Light Company, "Beaver Valley Power Station, Unit 1 Probabilistic Risk Assessment Individual Plant Examination Report," October 1, 1992.

RISK-INFORMED INSPECTION NOTEBOOK FOR

BEAVER VALLEY UNIT 2

PWR, WESTINGHOUSE, THREE-LOOP PLANT WITH SUB-ATMOSPHERIC CONTAINMENT

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Prepared for

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Office of Nuclear Regulatory Research
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ENCLOSURE 2

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. Technical errors in, and recommended updates to, this document should be brought to the attention of the following person:

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ABSTRACT

This notebook contains summary information to support the Significance Determination Process (SDP) in risk-informed inspections for the Beaver Valley Power Station Unit 2.

SDP worksheets support the significance determination process in risk-informed inspections and are intended to be used by the NRC's inspectors in identifying the significance of their findings, i.e., in screening risk-significant findings, consistent with Phase-2 screening in SECY-99-007A. To support the SDP, additional information is given in an Initiators and System Dependency table, and as simplified event-trees, called SDP event-trees, developed in preparing the SDP worksheets.

The information contained herein is based on the licensee's IPE submittal. The information is revised based on IPE updates or other licensee or review comments providing updated information and/or additional details.

CONTENTS

FIGURES

Page

TABLES

Page

1. INFORMATION SUPPORTING SIGNIFICANCE DETERMINATION PROCESS (SDP)

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

1. Initiator and System Dependency Table
2. Significance Determination Process (SDP) Worksheets
3. SDP Event Trees

The initiator and system dependency table shows the major dependencies between front-line- and support-systems, and identifies their involvement in different types of initiators. The information in this table identifies the most risk-significant front-line- and support-systems; it is not an exhaustive nor comprehensive compilation of the dependency matrix as known in Probabilistic Risk Assessments (PRAs). 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 finding on the core-damage scenarios, the SDP worksheets are developed and provided. They contain two parts. The first part identifies the functions, the systems, or combinations thereof that can perform mitigating functions, the number of trains in each system, and the number of trains required (success criteria) for each class of initiators. The second part of the SDP worksheet contains the core-damage accident sequences associated with each initiator class; these sequences are based on SDP event trees. In the parenthesis next to each of the sequence the corresponding event tree branch number(s) representing the sequence is included. Multiple branch numbers indicate that the different accident sequences identified by the event tree are merged into one through the boolean reduction. The classes of initiators that are considered in this notebook are 1) Transients, 2) Small Loss of Coolant Accident (LOCA), 3) Medium LOCA, 4) Large LOCA, 5) Loss of Offsite Power (LOOP), and 6) Anticipated Transients Without Scram (ATWS). Main Steam Line Break (MSLB) events are included separately if they are treated as such in the licensee's Individual Plant Examination (IPE) submittal.

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.

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. In cases where a plant-specific feature introduced a sequence that is not fully captured by our existing set of initiators and event trees, then a separate worksheet is included.

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

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

4. The simplified event-trees focus on classes of initiators, as defined above. In so doing, many separate event trees in the IPEs often are represented by a single tree. For example, some IPEs define four classes of LOCAs rather than the three classes considered here. The sizes of LOCAs for which high-pressure injection is not required are some times divided into two classes, the only difference between them being the need for reactor scram in the smaller break size. Some IPEs also may define several classes of transients, depending on the initiator's impact on the systems. Such differentiations generally are not considered in the SDP worksheets unless they could not be accounted for by the Initiator and System Dependency table.

5. Major operator actions during accident scenarios are assigned as high stress operator action or operator action using simple, standard criteria among a class of plants. This approach resulted in the designation of some operator actions as high-stress ones (as opposed to normal), even though the PRA may have assumed a (routine) operator action; hence, they have been assigned an error probability less than 5E-2 in the IPE. In such cases, a note is given at the end of the worksheet.

The three sections that follow include the initiators and dependency table, SDP worksheets, and the SDP event-trees for the Beaver Valley Unit 2 Plant.

1.1 INITIATORS AND SYSTEM DEPENDENCY

Table 1 provides the list of the systems included in the SDP worksheets, the major components in the systems, and the support system dependencies. The system involvements in different initiating events are noted in the last column.

Table 1 (Continued)

Table 1. Initiators and System Dependency for Beaver Valley Unit 2

Affected Systems	Major Components	Support Systems	Initiating Event Scenarios
Reactor Coolant Pumps (RCPs)	Pumps 21A, 21B, 21C	PCCW, Offsite grid, IA/CIA	LOOP, Transient, RCP seal LOCA
PORVs	PORV 455C&D, 456 Block Valves 535,536,537	125 V-DC, 480 V-AC (Block Valves), SSPS, Vital Bus Channel I, II, III, & IV	All except LLOCA, and MLOCA
Main and Startup Feed Pump (MFW and SUP(1))	MFW Pumps P21A, P21B, SU Pump P24(1)	Offsite grid, DC Battery 1-5, SSPS, Secondary CCW, Normal 125 VDC Supply, Batteries 2-5,2-6, ERF DG (SUP-P24)	Transient. SLOCA. SORV.LOOP
Condensate Pump		Offsite grid, Normal 125 V-DC Supply Battery 1-5, Secondary CCW	Transient, SLOCA, SORV, LOOP
MSIVs		125 V-DC, IA/CIA, SSPS	
AFWs	2 MDPs	4.16 KV EAC, EDG, 125 V-DC, SW Header B (backup water supply)	All except MLOCA and LLOCA
	1 TDP	125 V-DC,SSPS, SW Header B (backup water supply)	
RHR	Pumps P21A, P21B	4.16 kV EAC, EDG, 125VDC, PCCW, SSPS	SGTR
HHSI(2)	Pumps P21A, P21B, P21C(2)	Offsite grid, 4.16 kV EAC, EDG, 125 V-DC, SSPS, SW	All except LLOCA, RCP Seal LOCA
LHSI	Pumps P21A, P21B	4.16 kV EAC, EDG, 125 V-DC, SSPS	All including RCP Seal LOCA
	MOVs	4.16 kV EAC, EDG	
Crosstie Valves (ECCS Cold Leg Recirculation)	Train A and B	4.16 kV EAC, EDG, SSPS	All including RCP Seal LOCA

Table 1 (Continued)

Affected Systems	Major Components	Support Systems	Initiating Event Scenarios
RWST Level	LT 104 A, B, C, D	Vital Bus I, II, III, IV; SSPS	MLOCA, SGTR
Quench Spray (QS)	Pumps P21A, P21B	4.16 kV EAC, EDG, 125 V-DC,SSPS	LLOCA
Recirculation Spray (RS)	Pumps P21A, P21B, P21C, P21D	4.16 KV EAC, EDG, 125 V-DC, SSPS	All including RCP Seal LOCA
	Hx E1A, E1B, E1C, E1D	SW	
PCCW	Pump 1A (normally running), Pump 1B(Auto backup), Pump 1C (manual Backup)	Offsite grid, 4.16 kV EAC, 125 V-DC, SW, Vital Bus Channel I &II, IA/CIA (3)	RCP Seal LOCA, SGTR
Emergency AC (EAC)	4.16 kV / 480 V-AC Train A,B	Offsite grid, EDG	All
Emergency Diesel Generator (EDG)	EDG 2-1, 2-2	125 V-DC, SW, Vent. System, SSPS	LOOP
	ERF DG (Black)	Offsite grid, Normal DC Supply Batteries 2-5 and 2-6, Vent. System	LOOP
125 V DC	Trains A, B; Batteries	4.16 kV EAC, EDG, Vent. System	All
Solid State Protection System (SSPS)	Trains A, B	Vital Bus Channel I, II; Vent. System	All
Service Water (SW)	Headers A,B	Offsite grid, 4.16 kV EAC, EDG, 125 V-DC, SSPS, Vital Bus I&II, Vent. System	All
Ventilation System		4.16 kV EAC, EDG, PCCW, Vital Bus I &II	All
Instrument Air / Containment Instrument Air (IA/CIA)		Offsite grid, Vital Bus I&II, SSPS, PCCW, SCCW	All except LLOCA and MLOCA

Table 1 (Continued)

Affected Systems	Major Components	Support Systems	Initiating Event Scenarios
Secondary CCW (SCCW)	Pump 2CCS-P21A normally running, Pump 2CCS-P21B for auto backup	Offsite grid, Vital Bus I &II, SSPS, SW, Normal DC Supply Batteries 2-5 and 2-6	Transient, SLOCA, SORV, LOOP, RCP Seal LOCA,
Chilled Water System		Offsite grid, SW, Normal DC Battery Supplies 2-5 and 2-6	All

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

(1) the Startup feed pump (SUP-P4) is powered off the Unit 1 4160V Bus 1G. The bus 1G power is backed up by the ERF (black) Diesel Generator, but the control logic prevents startup feed pump from operating unless supplied from offsite power.

(2) HHSI consists of two trains. HHSI pump P1C can be manually aligned to either train of electric power and the associated train of SW, but is not normally aligned to either train. It receives start signal from the train aligned to it.

(3) The loss of CIA and SIA causes air-operated isolation valves for the RCP thermal barriers, motor, and bearings to fail closed. RCP seal cooling must then be provided by seal injection from normal charging and the RCPs must be tripped.

The plant internal event CDF (including internal flood) is 1.9E-4/yr.

1.2 SDP WORKSHEETS

This section presents the SDP worksheets to be used in the Phase 2 evaluation of the inspection findings for the Beaver Valley Unit 2 Nuclear Plant. The SDP worksheets are presented for the following initiating event categories:

1. Transients
2. Small LOCA
3. Stuck-open PORV
4. Medium LOCA
5. Large LOCA
6. LOOP
7. Steam Generator Tube Rupture (SGTR)
8. Anticipated Transients Without Scram (ATWS)

Table 2.1 SDP Worksheet for Beaver Valley 2 —— Transients

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

Safety Functions Needed:	***Full* Creditable Mitigation Capability for Each Safety Function:**
Power Conversion System (PCS)	1 / 2 Main Feedwater (MFW) trains or Startup pump (SUP) and 1/ 2 Condensate pump trains (operator action)
Secondary Heat Removal (AFW)	1 / 2 MDAFW trains (1 multi-train system) or 1 TDAFW train (1 ASD train)(1)
Early Inv., High Pressure Injection (EIHP)	1 / 3 Charging pumps (1 multi-train system).
Primary Heat Removal, Feed/Bleed (FB)	1 / 3 PORVs and block valves open for Feed/Bleed (operator action)(2)
High Pressure Recirculation (HPR)	1 / 3 charging pumps with 1/ 2 LHSI or 1/ 2 RS (2A or 2B) pumps(Operator action)
Recirculation Spray (RS)	1/ 2 Inside RS (1A or 1B) pumps or 1/ 2 Outside RS (2A or 2B) pumps (2 multi-train systems)

Circle Affected Functions	**Recovery of Failed Train**	***Remaining Mitigation Capability Rating for Each Affected Sequence***	**Sequence Color**
1 TRANS - AFW - PCS - RS (4)			
2 TRANS - AFW - PCS - HPR (5)			
3 TRANS - AFW - PCS - FB (6)			
4 TRANS - AFW - PCS - EIHP (7)			

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

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

Notes:

(1) The value assessed by the IPE (Table 3.3.2-2, page 3.3-31) for the AFW TDP failure to start is 2.3E-2. For the SDP calculation, a value of 1E-1 can be used.

(2) The human error probability (HEP) assessed in the IPE (page 3.3-76) for establishing bleed and feed cooling is 3.7E-2 (Operator failure to to initiate feed and bleed after failure to restore MFW and the startup feed pump).

Table 2.2 SDP Worksheet for Beaver Valley Unit 2 —— Small LOCA

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 / 3 charging pumps (1 multi-train system).
Secondary Heat Removal (AFW)	1 / 2 MDAFW trains (1 multi-train system) or 1 TDAFW train (1 ASD train)
Main Feedwater or Dedicated FWP (FW)	Opeartor initiates 1/ 2 main feed pump or Startup pump (Operator action)
RCS Cooldown/ Depressurization (RCSDEP)	Operator depressurizes RCS using 1 / 3 PORVs and block valves (operator action)
Primary Bleed (FB)	1 / 3 PORVs and block valves open for Feed/Bleed (operator action)(1)
Low Pressure Recirculation (LPR)	1 / 2 LHSI trains (Operator action)
High Pressure Recirculation (HPR)	1 / 3 charging pumps with 1 / 2 LHSI pumps or 1/ 2 RS (2A or 2B) pumps (Operator action)
Recirculation Spray (RS)	1/ 2 inside RS (1A or 1B) pumps or 1/ 2 Outside RS (2A or 2B) pumps (2 multi-train systems)

Circle Affected Functions	**Recovery of Failed Train**	***Remaining Mitigation Capability Rating for Each Affected Sequence***	**Sequence Color**
1 SLOCA - RS (2, 5, 8, 11, 14)			
2 SLOCA - LPR (3, 9)			
3 SLOCA - RCSDEP - HPR (6, 12)			
4 SLOCA - AFW - FW- HPR (15)			
5 SLOCA - AFW - FW - FB (16)			
6 SLOCA - EIHP (17)			

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

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

Notes:

(1) The human error probability (HEP) assessed in the IPE (page 3.3 -76) for establishing bleed and feed cooling is 3.9E-2.

Table 2.3 SDP Worksheet for Beaver Valley Unit 2 —— 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:**
Early Inventory, HP Injection (EIHP)	1 / 3 charging pumps (1 multi-train system).
Isolation of Small LOCA (BLK)	The closure of the block valve associated with stuck open PORV (recovery action)
Secondary Heat Removal (AFW)	1 / 2 MDAFW trains (1 multi-train system) or 1 TDAFW train (1 ASD train)
RCS Cooldown/ Depressurization (RCSDEP)	Operator depressurizes RCS using 1 / 3 PORVs and block valves (operator action)
Primary Bleed (FB)	1 / 3 PORVs and block valves open for Feed/Bleed (operator action[1]
Low Pressure Recirculation (LPR)	1 / 2 LHSI pumps (Operator action)
High Pressure Recirculation (HPR)	1 / 3 charging pumps with 1 / 2 LHSI pumps or 1/ 2 RSS pumps (Operator action)
Recirculation Spray (RS)	1/ 2 inside RS pumps or 1/ 2 outside RS pumps (2 multi-train systems)

Circle Affected Functions	**Recovery of Failed Train**	***Remaining Mitigation Capability Rating for Each Affected Sequence***	**Sequence Color**
1 SORV - BLK - RS (2, 5, 8, 11, 14)			
2 SORV - BLK - LPR (3, 9)			
3 SORV - BLK - RCSDEP - HPR (6, 12)			
4 SORV - BLK - AFW - FW - HPR (15)			
5 SORV - BLK - AFW - FW - FB (16)			
6 SORV - BLK - EIHP (17)			

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

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

Notes:

(1) The human error probability (HEP) assessed in the IPE (page 3.3 -76) for establishing bleed and feed cooling is 3.7E-2

Table 2.4 SDP Worksheet for Beaver Valley Unit 2 —— Medium LOCA

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

Safety Functions Needed:	***Full* Creditable Mitigation Capability for Each Safety Function**:
Early Inventory, Accumulators (EIAC)	2/ 3 accumulators (1 multi-train system)
Early Inventory, HP Injection (EIHP)	1/ 3 charging pumps (1 multi-train system).
Low Pressure Injection (LPI)[(1)]	1/ 2 LHSI pumps (1 multi-train system)
Low Pressure Recirculation (LPR)	1 / 2 LHSI pumps or 1/ 2 RS (2A or 2B) pumps aligned for recirculation (operator action)
RWST Makeup (RWST)[(2)]	Operator provides makeup for HHSI pumps (Operator action)
Recirculation Spray (RS)	1/ 2 inside RS (1A or 1B) pumps or 1/ 2 outside RS (2A or 2B) pumps in spray mode (2 multi-train system)

Circle Affected Functions	**Recovery of Failed Train**	***Remaining Mitigation Capability Rating for Each Affected Sequence***	**Sequence Color**
1 MLOCA - RS (2)			
2 MLOCA - LPR - RWST (4)			
3. MLOCA - LPI (5)			
4. MLOCA - EIHP (6)			
5. MLOCA - EIAC (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) As per the IPE, both HHSI and LHSI are required for success to cover the full range of medium LOCAs.

(2) RWST makeup actions are called for by procedure when RWST level is low and cold leg recirculation is unavailable.

Table 2.5 SDP Worksheet for Beaver Valley Unit 2 —— Large LOCA

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**:
Earlt Inventory, Accumulators (EIAC)	2/ 2 Accumulators (1 Train)
Early Inventory, LP Injection (EILP)	1/2 LHSI pump trains (1 multi-train system)
Quench Spray (QS)(1)	1/ 2 QS pumps drawing from RWST (1 multi-train system)
Recirculation Spray (RS)	1/ 2 inside RS pumps (1 multi-train system)
Outside recirculation spray (ORS)	1/ 2 outside RS pumps (1 multi-train system)
Low Pressure Recirculation (LPR)	1/2 LHSI pump trains; Operator switchover from injection to recirculation (operator action)

Circle Affected Functions	**Recovery of Failed Train**	***Remaining Mitigation Capability Rating for Each Affected Sequence***	**Sequence Color**
1 LLOCA - LPR (2)			
2 LLOCA - RS (3)			
3 LLOCA - QS - ORS (6)			
4 LLOCA - LHSI (7)			
5 LLOCA - EIAC (8)			

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

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

(1) A high containment pressure (8 psig) signal initiates both QS pumps. Successful operation of a QS pump is needed to fill the containment sump for required NPSH for inside RS pumps.

Table 2.6 SDP Worksheet for Beaver Valley Unit 2 —— 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 AFW pump (TDAFW)	1 / 1 TDP trains of AFW (1 ASD train)(1)
Secondary Heat Removal (AFW)	1 / 2 MDAFW trains (1 multi-train system) or 1 TDAFW train (1 diverse train)(1)
Recovery of AC Power in < 2 hrs (REC2)	SBO procedures implemented (operator action under high stress)(2)
Recovery of AC Power in < 5 hrs (REC5)	SBO procedures implemented (operator action)(2, 3)
Early Inventory, HP Injection (EIHP)	1 / 3 charging pumps (1 multi-train system)
Primary Heat Removal (FB)	Operator uses RCS pressurizer 1 / 3 PORVs and block valves (operator action)(4)
High Pressure Recirculation (HPR)	1 / 3 charging pumps with 1/ 2 LHSI pumps or 1/ 2 RS (2A or 2B) pumps (operator action)
Recirculation Spray (RS)	1/ 2 inside RS (1A or 1B)pumps or 1/ 2 outside RS (2A or 2B) pumps (2 multi-train system)

Circle Affected Functions	**Recovery of Failed Train**	***Remaining Mitigation Capability Rating for Each Affected Sequence***	**Sequence Color**
1 LOOP - AFW - RS (3)			
2 LOOP - AFW - HPR (4)			
3 LOOP - AFW - FB (5)			
4 LOOP - AFW - EIHP (6)			
5 LOOP - EAC - RS (8,13)			
6 LOOP - EAC - HPR (9,14)			
7 LOOP - EAC - EIHP (10,16)			
8 LOOP - EAC - REC5 (11)			
9 LOOP - EAC - TDAFW - FB (15)			
10 LOOP - EAC - TDAFW - REC2 (17)			

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

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

Notes:

(1) The failure probability of AFW TDP used in the IPE is 2.3E-2.

(2) In IPE, Recovery of AC with AFW, PORV LOCA is assigned a failure probability of 0.12, and Recovery of AC with AFW, No LOCA is assigned a failure probability of 5.0E-3.

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

(4) The human error probability (HEP) assessed in the IPE (page 3-129) for establishing bleed and feed cooling is 3.7E-2.

Table 2.7 SDP Worksheet for Beaver Valley Unit 2 —— 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 (SHR)	1 / 2 MDPs of AFW (1 multi-train system) or 1 / 1 TDP of AFW (1 ASD Train)
Early Inventory, HP Injection (EIHP)	1 / 3 charging pumps (1 multi-train system)
Pressure Equalization (EQ)	Operator isolates the ruptured SG and depressurizes RCS using 1 / 1 SG ARV (on each SG fed by AFW) or RCS pressurizer PORV (1 / 3) to less than setpoint of relief valves of SG (operator action under high stress)(1)
Feed-and-Bleed (FB)	Operator uses RCS pressurizer PORV and block valves (1 / 3) (operator action)(2)
Late depressurization and RWST makeup (RWST)	Operator depressurizes RCS and provides makeup to RWST for HHSI pumps (Operator action)
High Pressure Recirculation (HPR)	1 / 3 charging pumps with 1/ 2 LHSI pumps or 1/ 2 RS (2A or 2B) pumps for recirculation (operator action)
Residual Heat Removal (RHR)	Operator initiates 1/ 2 RHR pumps (Operator action)
Recirculation Spray (RS)	1/ 2 inside RS (1A or 1B) pumps or 1/ 2 outside RS (2A or 2B) pumps (2 multi-train system)

Circle Affected Functions	**Recovery of Failed Train**	***Remaining Mitigation Capability Rating for Each Affected Sequence***	**Sequence Color**
1 SGTR - EQ - RHR (3)			
2 SGTR - EQ - RWST (4)			
3 SGTR - SHR - RS (6)			
4 SGTR - SHR - HPR (7)			
5 SGTR - SHR - EQ (8)			
6 SGTR - SHR - FB (9)			
7 SGTR - EIHP - RHR (11)			
8 SGTR - EIHP - EQ (12)			
9 SGTR - EIHP - SHR (13)			

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

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

Notes:

(1) In IPE, the operator failure to depressurize RCS for RHR entry is assigned a probability of 1.2E-3, and the operator failure to isolate ruptured SG and equalize pressure is assigned a probability of 5.4E-3.

(2) The human error probability (HEP) assessed in the IPE (page 3-129) for establishing bleed and feed cooling is 3.7E-2 .

Table 2.8 SDP Worksheet for Beaver Valley Unit 2 —— 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:**
Emergency Boration (HPI)	Operator conducts emergency boration using 1 / 3 charging pumps (operator action)
Turbine trip (TTP)	AMSAC trips the turbine (1 train)
Primary Relief (SRV)	3 / 3 SRVs with 3/3 PORVs open (1 train)
Secondary Heat Removal (AFW)	2 / 2 MDPs of AFW (1 train) or 1 / 1 TDP of AFW (1 ASD Train)

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

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

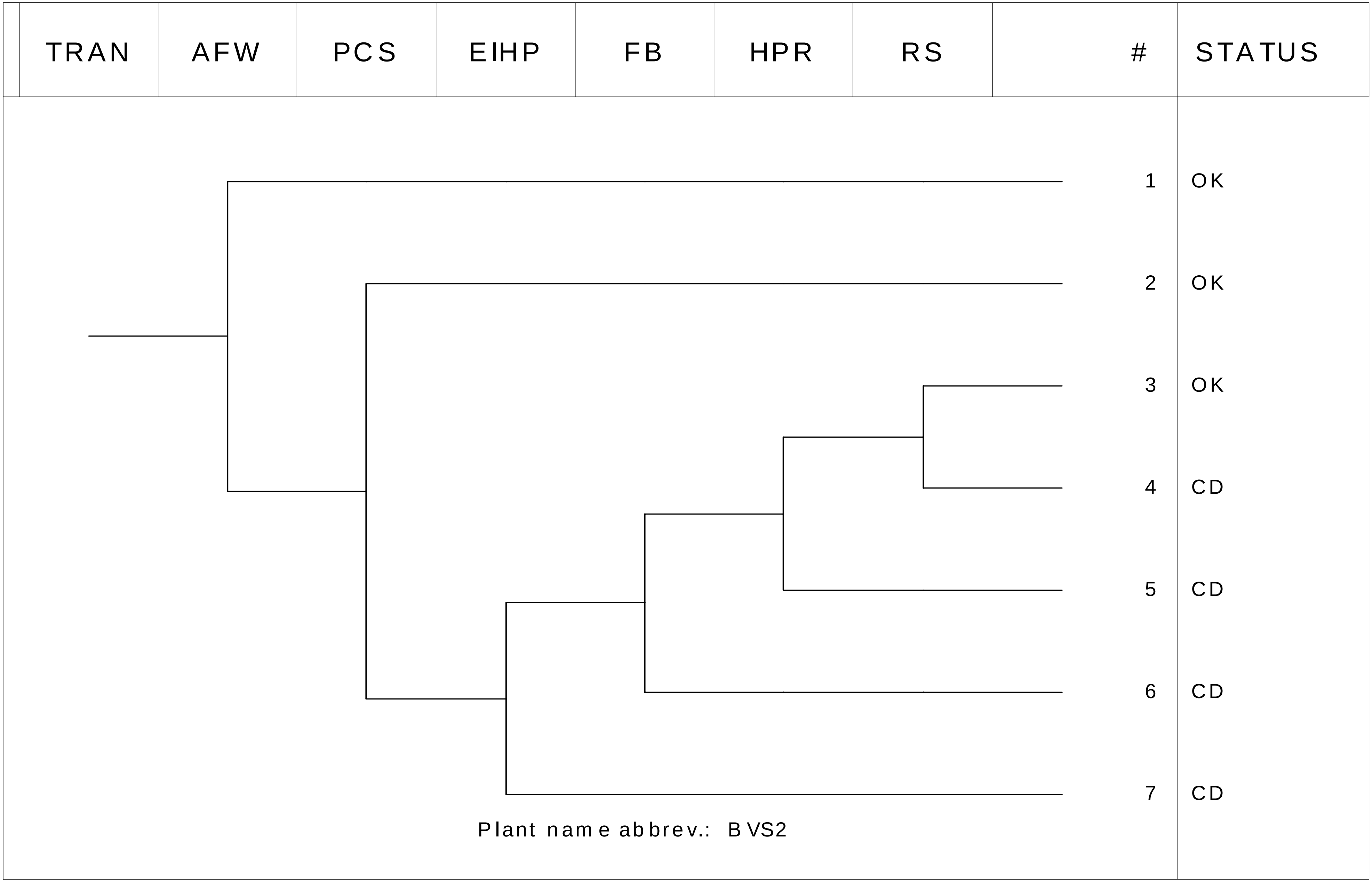
If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures 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.

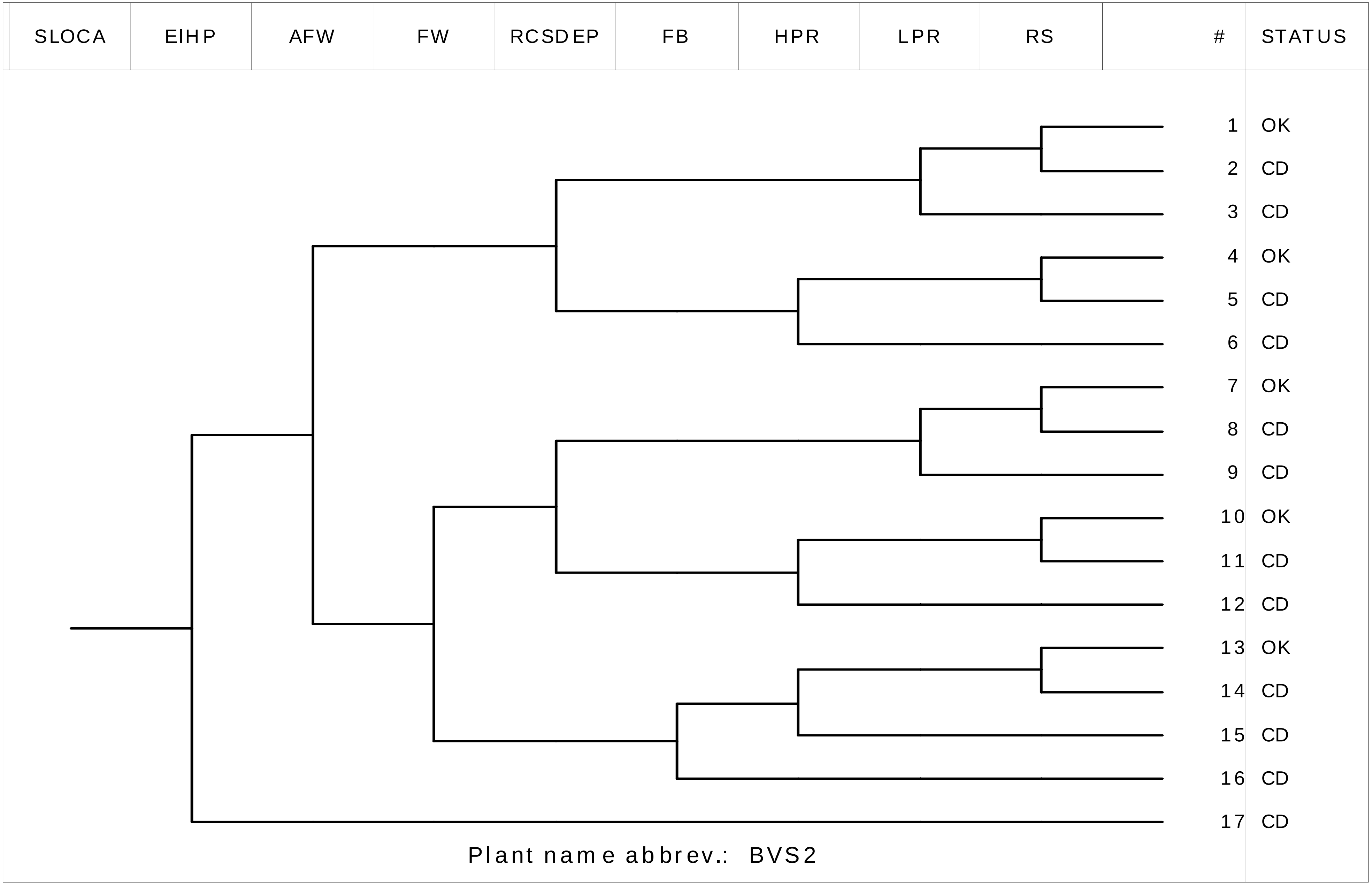
1.3 SDP Event Trees

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

The following event trees are included:

1. Transients
2. Small LOCA
3. Medium LOCA
4. Large LOCA
5. LOOP
6. Steam Generator Tube Rupture (SGTR)
7. Anticipated Transients Without Scram (ATWS)


TRAN
AFW
PCS
EIHP
FB
HPR
RS
#
STATUS
1 OK
2 OK
3 OK
4 CD
5 CD
6 CD
7 CD
Plant name abbrev.: BVS2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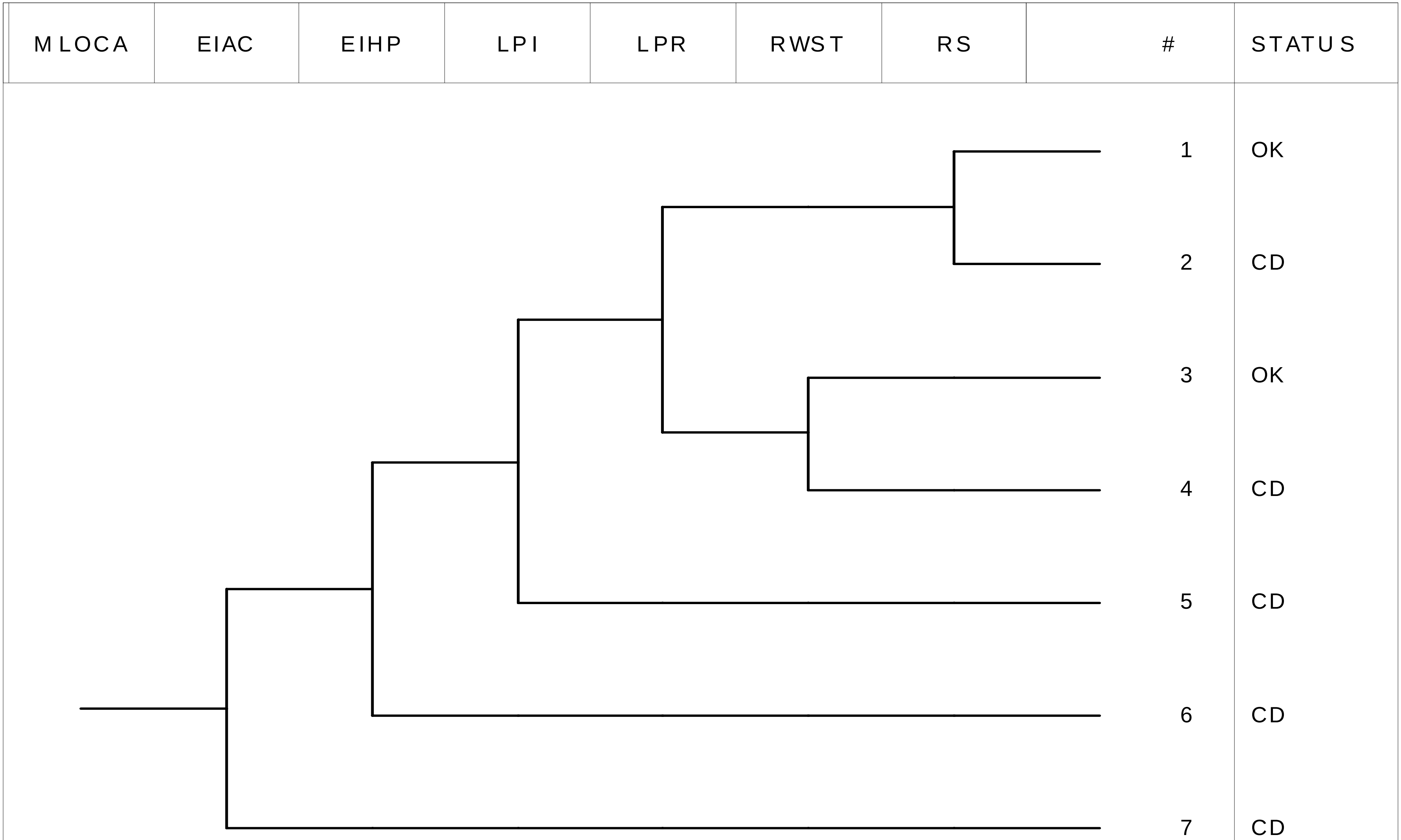
EIHP
AFW
FW
RCSDEP
FB
HPR
LPR
RS
#
STATUS
1 OK
2 CD
3 CD
4 OK
5 CD
6 CD
7 OK
8 CD
9 CD
10 OK
11 CD
12 CD
13 OK
14 CD
15 CD
16 CD
17 CD
Plant name abbrev.: BVS2



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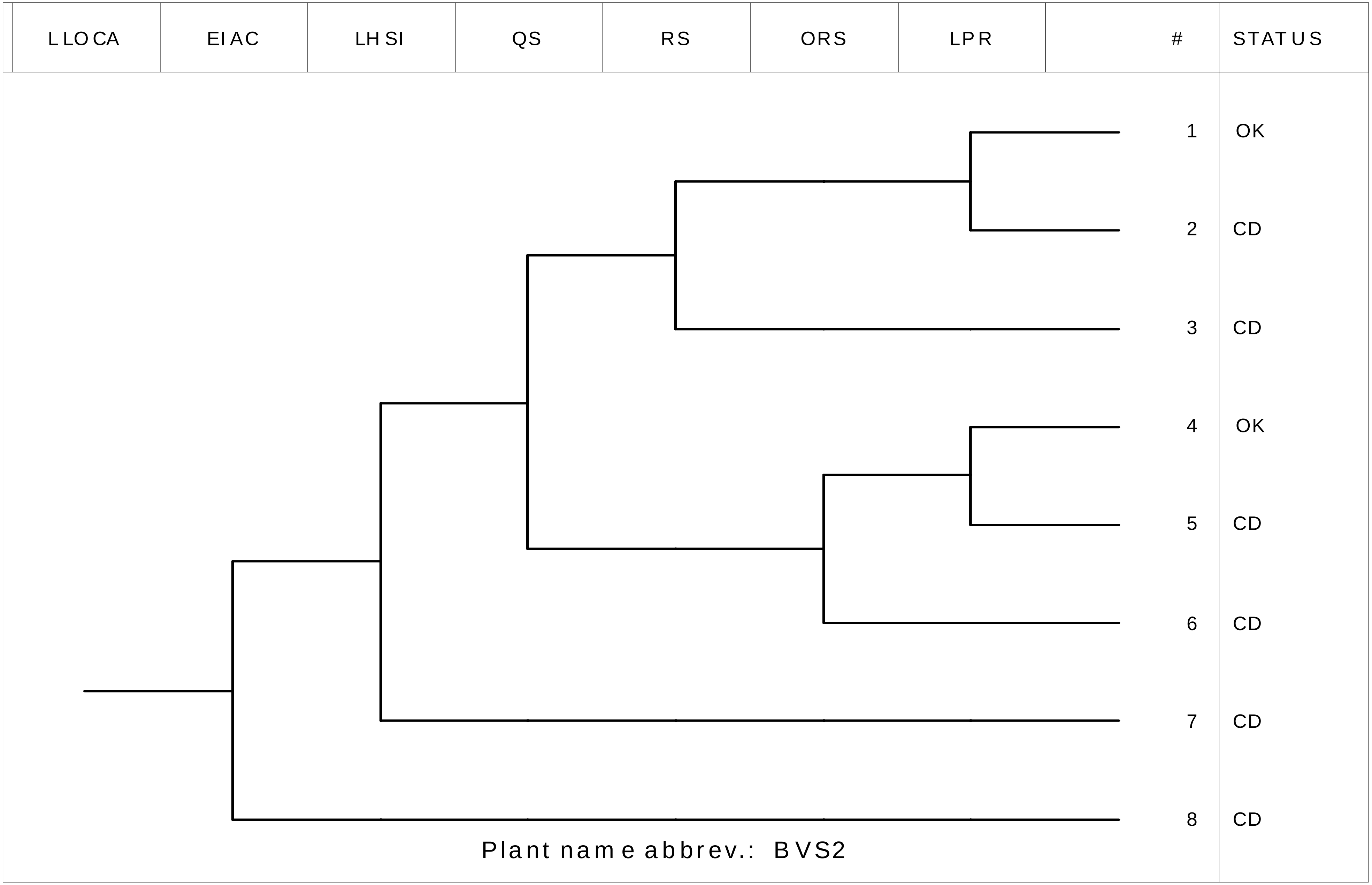
LLOCA
EIAC
LHSI
QS
RS
ORS
LPR
#
STATUS
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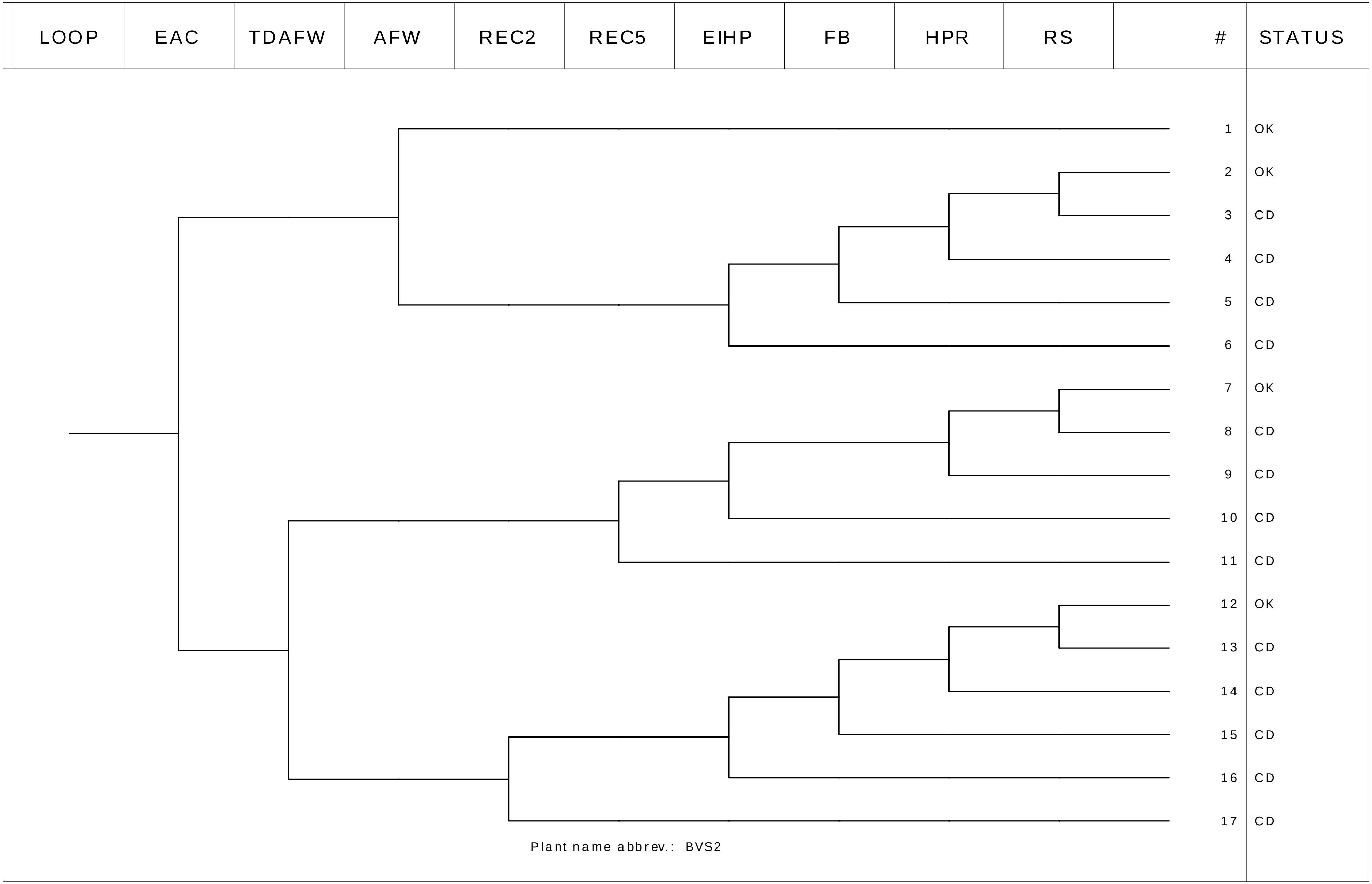
2 CD
3 CD
4 OK
5 CD
6 CD
7 CD
8 CD
Plant name abbrev.: BVS2


LOOP
EAC
TDAFW
AFW
REC2
REC5
EIHP
FB
HPR
RS
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4 CD
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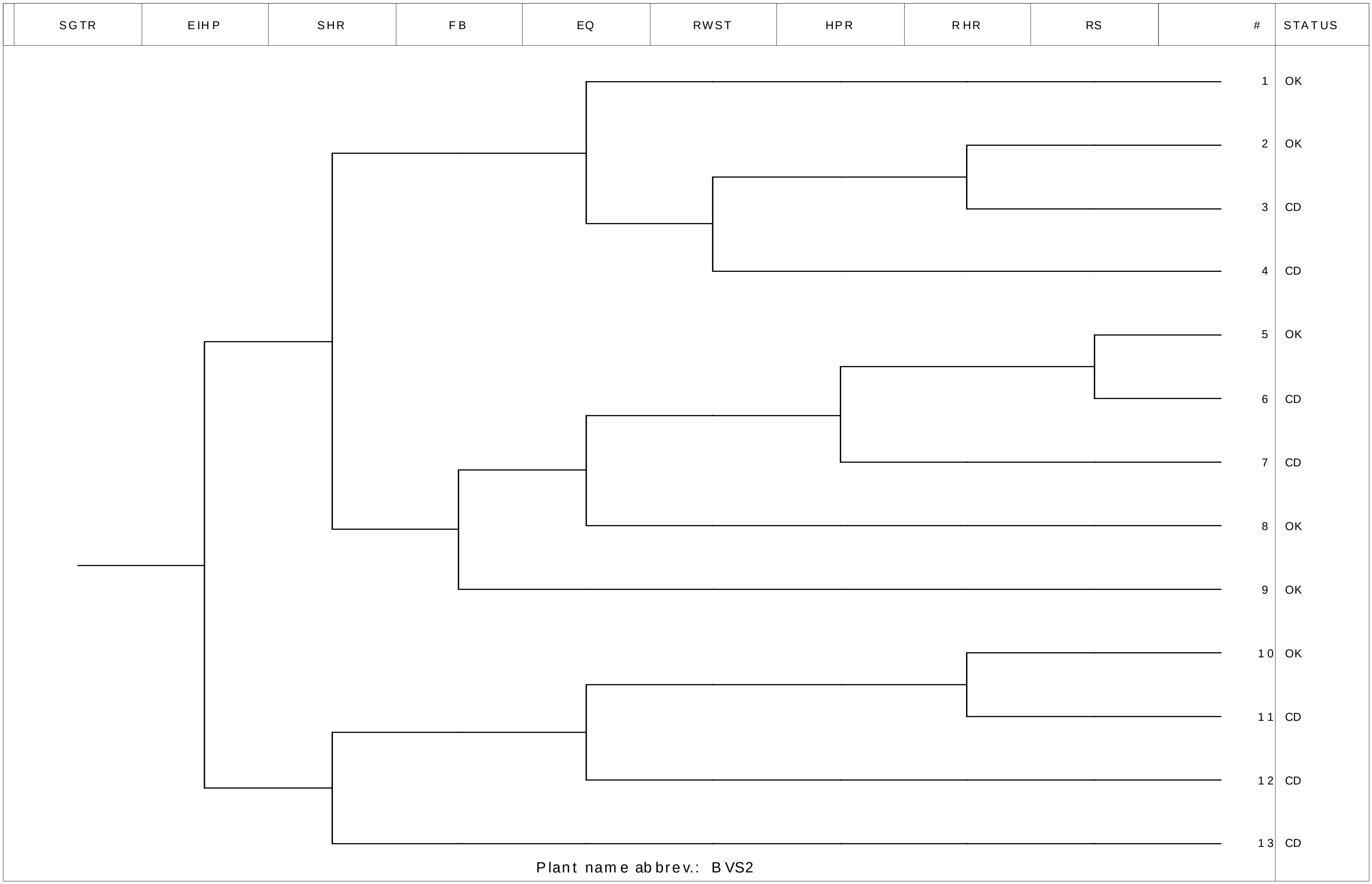
17 CD
Plant name abbrev.: BVS2


SGTR
EIHP
SHR
FB
EQ
RWST
HPR
RHR
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STATUS
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10 OK
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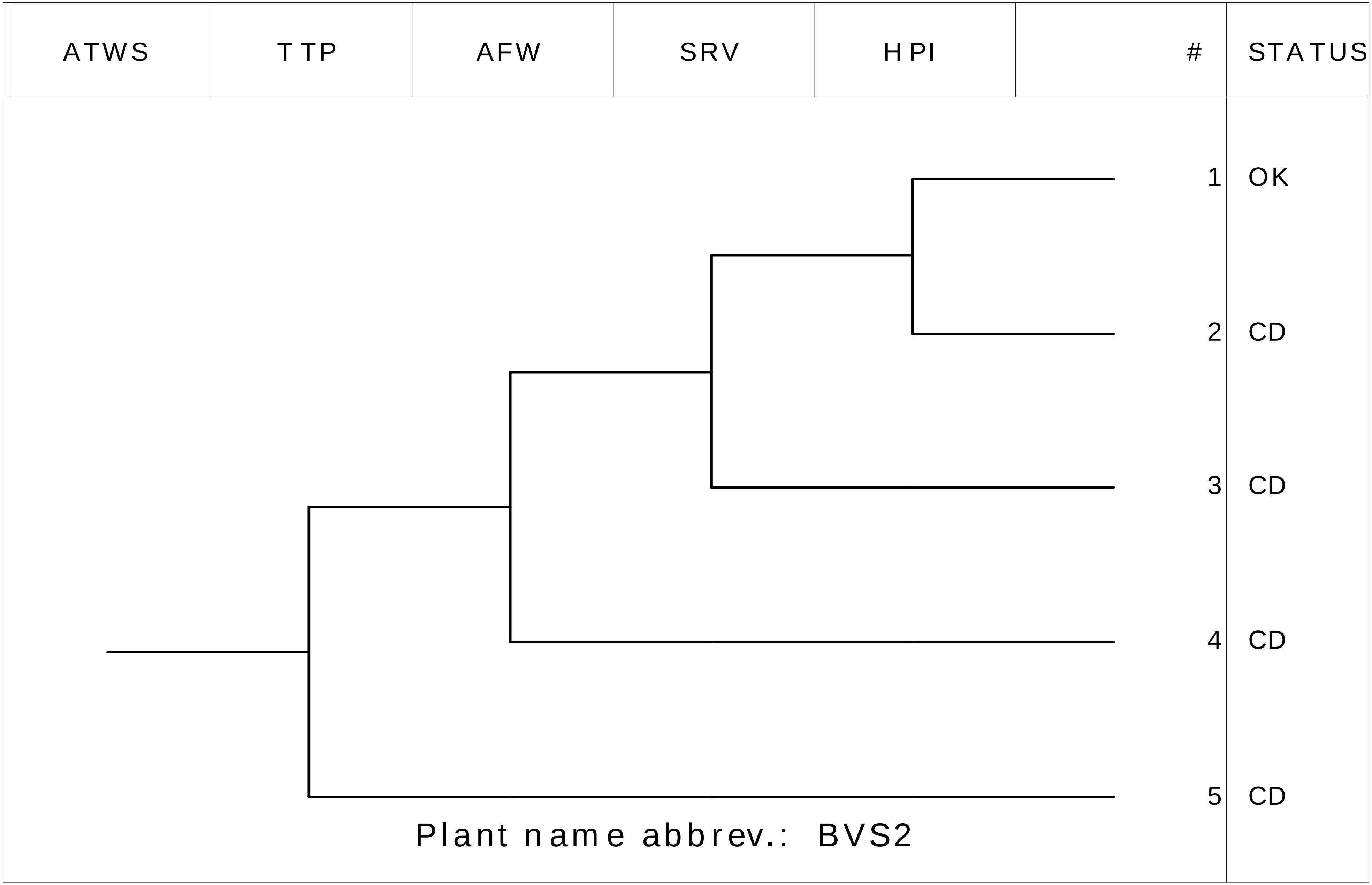
13 CD
Plant name abbrev.: BVS2


ATWS
TTP
AFW
SRV
HPI
#
STATUS
1 OK
2 CD
3 CD
4 CD
5 CD
Plant name abbrev.: BVS2

2. RESOLUTION AND DISPOSITION OF COMMENTS

This section documents the comments received on the material included in this report and their resolution. This section is blank until comments are received and are addressed.

REFERENCES

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

2. Dusquesne Light Company, "Beaver valley Power Station Unit 2 Probabilistic Risk Assessment Individual Plant Examination Report," March 17, 1992.

3. Dusquesne Light Company, "Beaver Valley Power Station Unit 2 Response to NRC RAI," October 26, 1992.