June 6, 2001

Mr. J. S. Keenan, Vice President
Brunswick Steam Electric Plant
Carolina Power & Light Company
Post Office Box 10429
Southport, North Carolina 28461

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

Dear Mr. Keenan:

Enclosed please find the Risk-Informed Inspection Notebook that 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. This document is publicly 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 obtained during the site visits. The staff encourages further licensee comments where it is identified that the Worksheets give inaccurately low significance determinations. Any comments should be forwarded to the Document Control Desk, with a copy to the Chief, Probabilistic Safety Assessment Branch, Office of Nuclear Reactor Regulation. We will continue to assess SDP accuracy and update the document based on continuing experience.

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

Sincerely,
***/RA/***
Donnie J. Ashley, Project Manager, Section 2
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-325 and 50-324

Enclosure: Risk-Informed Inspection Notebook

cc w/encl: See next page

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Mr. William D. Johnson
Vice President and Corporate Secretary
Carolina Power & Light Company
Post Office Box 1551
Raleigh, North Carolina 27602

Mr. Donald E. Warren
Brunswick County Board of Commissioners
Post Office Box 249
Bolivia, North Carolina 28422

Resident Inspector
U.S. Nuclear Regulatory Commission
8470 River Road
Southport, North Carolina 28461

Mr. John H. O'Neill, Jr.
Shaw, Pittman, Potts & Trowbridge
2300 N Street, NW.
Washington, DC 20037-1128

Mr. Mel Fry, Director
Division of Radiation Protection
N.C. Department of Environment
and Natural Resources
3825 Barrett Dr.
Raleigh, North Carolina 27609-7721

Mr. C. J. Gannon
Plant Manager
Carolina Power & Light Company
Brunswick Steam Electric Plant
Post Office Box 10429
Southport, North Carolina 28461

Public Service Commission
State of South Carolina
Post Office Drawer 11649
Columbia, South Carolina 29211

Ms. Margaret A. Force
Assistant Attorney General
State of North Carolina
Post Office Box 629
Raleigh, North Carolina 27602

Mr. Robert P. Gruber
Executive Director
Public Staff - NCUC
Post Office Box 29520
Raleigh, North Carolina 27626-0520

Mr. J. J. Lyash
Director - Site Operations
Carolina Power & Light Company
Brunswick Steam Electric Plant
Post Office Box 10429
Southport, North Carolina 28461

Mr. Norman R. Holden, Mayor
City of Southport
201 East Moore Street
Southport, North Carolina 28461

Mr. Dan E. Summers
Emergency Management Coordinator
New Hanover County Department of
Emergency Management
Post Office Box 1525
Wilmington, North Carolina 28402

Mr. Terry C. Morton
Manager
Performance Evaluation and
Regulatory Affairs CPB 7
Carolina Power & Light Company
Post Office Box 1551
Raleigh, North Carolina 27602-1551

Mr. David C. DiCello
Manager - Regulatory Affairs
Carolina Power & Light Company
Post Office Box 10429
Southport, NC 28461

# RISK-INFORMED INSPECTION NOTEBOOK FOR

# BRUNSWICK STEAM ELECTRIC PLANT

**BWR-4, GE, WITH MARK I 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 "Reactor Oversight Process Improvement," SECY-99-007A, March 1999 discusses the activities involved in these inspections. The user of this notebook is assumed to be an inspector with an extensive understanding of plant-specific design features and operation. Therefore, the notebook is not a stand-alone document, and may not be suitable for use by non-specialists. It will be periodically updated with new or replacement pages incorporating additional information on this plant. All recommendations for improvement of this document should be forwarded to the Chief, Probabilistic Safety Assessment Branch, NRR, with a copy to the Chief, Inspection Program Branch, NRR.

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 Brunswick Steam Electric Plant.

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

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

# CONTENTS

# TABLES

# FIGURES

**Page**

# 1. INFORMATION SUPPORTING SIGNIFICANCE DETERMINATION PROCESS (SDP)

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

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

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

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

To evaluate the impact of an inspection finding on the core-damage scenarios, we developed the SDP worksheets. They contain two parts. The first part identifies the functions, the systems, and the combinations thereof that can perform mitigating functions, the number of trains in each system, and the number of trains required (success criteria) for each the initiator. It also characterizes the mitigation capability in terms of the available hardware (e.g., 1 train, 1 multi-train system) and the operator action involved. The second part of the SDP worksheet contains the core-damage accident sequences associated with each initiator; these sequences are based on SDP event trees. In the parentheses next to each of the sequences the corresponding event tree branch number(s) representing the sequence is included. Multiple branch numbers indicate that the different accident sequences identified by the event tree are merged into one through the Boolean reduction.

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

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

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

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

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

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

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

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

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

6. Loss of service water (LSW).

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

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

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

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

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

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

4. The simplified event-trees focus on classes of initiators, as defined above. In so doing, many separate event trees in the IPEs often are represented by a single tree. For example, some IPEs define four or more classes of LOCAs rather than the three classes considered here. The sizes of LOCAs for which high-pressure injection is not required are some times divided into two classes; the only difference between them being the need for reactor scram in the smaller break size. Some consolidation of transient event tree may also be done besides defining the special initiators following the criteria defined above.

5. Major actions by the operator during accident scenarios are credited using four categories of Human Error Probabilities (HEPs). They are termed operator action =1 (representing an error probability of 5E-2 to 0.5), operator action=2 (error probability of 5E-3 to 5E-2), operator action=3 (error probability of 5E-4 to 5E-3), and operator action=4 (error probability of 5E-5 to 5E-4). An human action is assigned to a category bin, based on a generic grouping of

similar actions among a class of plants. This approach resulted in designation of some actions to a higher bin, even though the IPE/PRA HEP value may have been indicative of a lower category. In such cases, it is noted at the end of the worksheet. On the other hand, if the IPE/PRA HEP value suggests a higher category than that generically assumed, the HEP is assigned to a bin consistent with the IPE/PRA value in recognition of potential plant-specific design; a note is also given in these situations. Operator's actions belonging to category 4, i.e., operator action=4, may only be noted at the bottom of worksheet because, in those cases, equipment failures may have the dominating influence in determining the significance of the findings.

The four sections that follow include the Categories of Initiating Events Table, Initiators and System Dependency Table, SDP Worksheets, and the SDP Event Trees for the Brunswick Steam Electric Plant.

## 1.1 RATINGS OF INITIATING EVENT LIKELIHOOD RATINGS

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

## Table 1 Categories of Initiating Events for Brunswick Steam Electric Plant

| 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), Inadvertent or stuck open SRVs (IORV) | B | C | D |
| III | 1 per $10^2$ - $10^3$ yr | LNSW | C | D | E |
| IV | 1 per $10^3$ - $10^4$ yr | Small LOCA (SLOCA, RCS rupture), Medium LOCA (MLOCA, RCS rupture), LEAC | D | E | F |
| V | 1 per $10^4$ - $10^5$ yr | Large LOCA (LLOCA, RCS rupture), ATWS, LDCA, LDCB | E | F | G |
| VI | less than 1 per $10^5$ yr | ISLOCA, Vessel rupture | 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 or by ARI (for BWRs). Thus, the ATWS frequency to be used by these worksheets must represent the ATWS condition that can only be mitigated by the systems shown in the worksheet (e.g., boration).

## 1.2 INITIATORS AND SYSTEM DEPENDENCY

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

## Table 2 Initiators and System Dependency Table for Brunswick[1,2,3]

| Affected Systems | Major Components | Support Systems | Initiating Event Scenarios |
|---|---|---|---|
| PCS[7] | MDP, MOV, AOV | AC power, Instrument air, TBCCW, EHC, CW, DC | All except LOOP, LLOCA, MLOCA |
| ADS/SRVs[6] | RV, AOV | DC power, ACT, Instrument air or Nitrogen | All but LLOCA , LNSW |
| LPCI[8] | MDP, MOV, CKV, Strainer | AC power, DC power, ACT, HVAC | All but LNSW |
| RHR | MDP, MOV, CKV, HX, Strainer | AC power, DC power, ACT, RHR SW, SW[9] | All |
| Core Spray (CS)[8] | MDP, MOV, Strainer | AC power, DC power, ACT, HVAC | All but LNSW |
| DC power | battery, charger, breakers, Distribution panels | AC used for chargers | All[5] |
| AC power (Excluding EDG) | breakers, MCC, bus, distribution panels | DC power | All |
| AC power (EDGs) | Engine Generator, Starting air, Fuel oil transfer | DC power, ACT, SW, HVAC | LOOP, LEAC[4] |
| HPCI | TDP, MOV, CKV | DC power (Bus A), ACT | All but LLOCA, LNSW, LDCB |
| RCIC | TDP, MOV, CKV | DC power (Bus B), ACT | All but MLOCA, LLOCA, LNSW, LDCA |
| Control Rod Drive (CRD) | MDP, MOV, CKV, AOV, Filters | AC power, RBCCW, Instrument air, DC power | TRANS, TPCS, LOOP, ATWS, LDCA, LDCB |
| Instrument Air | Air comp., Filters, Receivers, Dryers, CKV | AC power, TBCCW | TPCS[11] |
| HVAC (only needed for DG Rooms) | Valves, fans, filters, dampers, thermostat | AC power | LOOP, LEAC |
| SLC | MDP, MOV, explosive valves, Tank, Heaters, CKV | AC power, DC power | ATWS |

## Table 2 (Continued)

| Affected Systems | Major Components | Support Systems | Initiating Event Scenarios |
|---|---|---|---|
| Reactor Building Component Cooling Water (RBCCW) | MDP, MOV, HX, CKV, Strainer | AC power, ACT, SW | TRANS, TPCS, LOOP, ATWS, LDCA, LDCB |
| Turbine Building Component Cooling Water (TBCCW) | MDP, MOV, HX | AC power, SW | All except LOOP, LLOCA, MLOCA (via PCS) |
| ECCS actuation (ACT) | Instrumentation, Master trip units, Slave trip units, Relays, Inverters, Power Supplies | DC power | All |
| Service Water (SW)[10] | 3 MDP, MOV, CKV, Strainer | AC power, DC power, Traveling Screens | All |
| Nuclear Service Water (NSW)[10] | 2 MDP, MOVs, CKVs | | |
| RHR SW | MDP, MOV, CKV | AC power, DC Power, SW | All |
| Containment Atm. Control / Standby Gas Treatment (Venting) | AOV and SOV Valves, Rupture disks | AC power, Instrument air & N2 Backup, DC power | All |
| Diesel fire pump | Diesel-driven pump, manual valves, CKVs, MOV (RHR), Batteries | Fuel Tank, Water Tank, X-tie MOV to RHR, AC power to RHR MOV | All |
| Motor Driven Fire Pump | MDP, MOV, CKV | AC, DC, X-tie MOV to RHR | All |
| RPT | Trip Coils, Logic, breaker | DC Power, ACT | ATWS |

**Notes:**

1. The information contained in this Table reflects the licensee comments provided as a part of site visit dated October 12, 2000.
2. Information herein was initially developed from the Brunswick Steam Electric Plant IPE Model Dated August, 1992 including Rev. 1 changes, dated September 9, 1994. The base model reflected the plant IPE Model Of Record for 1996 (MOR96). Additional information received from license via Email and site visit, reflecting the 1998 updated IPE model (MOR 98), have also been incorporated in the current SDP worksheet. A single conservative model was used for both Unit 1 and Unit 2.
3. The baseline IPE core damage frequency (CDF) from internal events was 2.75 X $10^{-5}$ events/Rx year. The current model of record (MOR 96) estimates a core damage frequency of 9.23E-6 per year.

**Table 2 (Continued)**

4. Loop with loss of one emergency AC bus (or the associated EDG) worksheet is designed to facilitate inspection finding on degradation of the EAC system.

5. There are typically redundant DC buses feeding an individual component with possibility of complex cross-connections. The loss of DC worksheets (LDCA, and LDCB) are provided to facilitate the evaluation of findings on the degradation of DC system.

6. For Brunswick, one stuck open SRV is the equivalent to Small LOCA (SLOCA).

7. Brunswick credits late recovery of PCS or portions of PCS (e.g., condensate) for all initiating events.

8. Room coolers (HVAC) are not modeled for injection phase of LPCI and CS per MOR 98 model.

9. SW injection into the RHR lines is established by the opening of RHR SW valves F073 and F075. Injection to the reactor is through recirculation loop B via F015B.

10. SW composed of five pumps, 3 for conventional and 2 for Nuclear SW. The NSW pumps feed to a common header with potential cross connection to conventional SW. The RHR-SW is fed from the NSW through two pumps per each RHR-Hx.

11. Loss of essential instrument air causes scram and a transient similar to TPCS. It also impact the operation of CRD as a part of LI. Per licensee comment and the IPE information loss of instrument air has a very low likelihood due to number of redundancies, therefore not modeled in the licensee's IPE. No initiator frequency was reported for loss of instrument air in the IPE.

## 1.3 SDP WORKSHEETS

This section presents the SDP worksheets to be used in the Phase 2 evaluation of the inspection findings for the Brunswick Steam Electric Plant. The SDP worksheets are presented for the following initiating event categories:

1. Transients (Reactor Trip) (TRANS)
2. Transients without PCS (TPCS)
3. Small LOCA (SLOCA)
4. Stuck Open Relief Valve (SORV)
5. Medium LOCA (MLOCA)
6. Large LOCA (LLOCA)
7. Station LOOP (LOOP)
8. Anticipated Transients Without Scram (ATWS)
9. Loss of Nuclear SW (LNSW)
10. Loss of DC Division A (LDCA)
11. Loss of DC Division B (LDCB)
12. Loop with Loss of one AC Division (LEAC)
13. Interfacing System LOCA/LOCA Outside Containment (ISLOCA/LOC)

## Table 3.1 SDP Worksheet for Brunswick — Transients (Reactor Trip) (TRANS)

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

| **<u>Safety Functions Needed</u>:** | **<u>Full Creditable Mitigation Capability for Each Safety Function:</u>** |
|---|---|
| **Power Conversion System (PCS)** | 1/2 condenser sections (plus 1 MSIV and 4 TBVs), 1/3 condensate pumps, 1/3 booster pumps (operator action = 3) |
| **High Press Injection (HPI)**[1] | HPCI (1 ASD train) or RCIC (1 ASD train) |
| **Depressurization (DEP)** | 3/11 SRVs manually opened (operator action = 2) [2] |
| **Low Pressure Injection (LPI)** | 1/4 RHR pumps in LPCI mode in 1/2 trains (1 multi-train system) or 1/2 CS pump trains (1 multi-train system) |
| **Containment Heat Removal (CHR)** | 1/2 RHR HXs trains in SPC mode, operator action but limited by hardware failure [6] (1 multi-train system) |
| **Containment Venting (CV)** | Containment venting from wetwell (operator action = 2) [3] |
| **Late Inventory, Makeup (LI)** | Depressurization through 3/11 SRVs and injection via 1/2 CRD or PCS recovery including 1/2 condenser sections plus 1/3 cond pumps [4] or injection with 2 of 5 SW pumps or with 1DD or 1 MD fire water pump, or 1/2 CS pump trains, limited by operator action for depressurization (operator action = 2) [5,7,8] |

| **<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 TRANS - PCS - CHR - LI (4) | | | |
| 2 TRANS - PCS - CHR - CV (5, 8) | | | |
| 2 TRANS - PCS - HPI - LPI (9) | | | |
| 3 TRANS - PCS - HPI - DEP (10) | | | |

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. Use of 1/2 CRD can only be credited if the feedwater or some sort of early injection is initially available. This is only credited as a part of LI in the SDP work sheet. Use of 2/2 CRD without Turbine bypass (failure of PCS) as an early injection is not considered in this SDP work sheet.

2. The HEP value identified for depressurization using SRVs is 6.9E-3 in the IPE. An operator action credit of 2 is given to this action in the SDP sheet.

3. An operator credit of 2 is for CV function in SDP sheet. IPE uses a HEP value of 1.4E-3 for wet well venting.

4. In the Transient event tree, Brunswick models TBV and FW separately rather than together as PCS. We have maintained the standard BWR method of PCS here. Therefore late recovery of PCS is credited as a part of LI function.

5. All operator action for the portion of LI function that does not rely on suppression pool is combined to one to account for the dependencies among these actions. An operator credit of 2 is generically assigned in the SDP sheet.

6. The upgraded IPE uses a HEP value of 1.0E-4 for operator to properly initiate and align RHR for SPC mode in non-ATWS scenarios.

7. Pursuant to Licensee's comment based on MOR-98 IPE and the current plant EOP, the operation of LPI is credited after successful CV but failure of CHR. The EOP guides the operator to perform CV in a pressure control mode such that operation of LPI is not jeopardized.

8. Function LI is credited when CHR has failed. Therefore, no credit is given to RHR pumps as a part of late injection.

## Table 3.2 SDP Worksheet for Brunswick — Transients without PCS (TPCS)

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

| **Safety Functions Needed:** | **Full Creditable Mitigation Capability for Each Safety Function:** |
|---|---|
| **High Press Injection (HPI)**[1] | HPCI (1 ASD train) or RCIC (1 ASD train) |
| **Depressurization (DEP)** | 3/11 SRVs manually opened (operator action = 2) [2] |
| **Low Pressure Injection (LPI)** | 1/4 RHR pumps in LPCI mode in 1/2 trains (1 multi-train system) or 1/2 CS pump trains (1 multi-train system) |
| **Containment Heat Removal (CHR)** | 1/2 RHR HXs trains in SPC mode, operator action but limited by hardware failure (1 multi-train system) |
| **Containment Venting (CV)** | Containment venting from wetwell (operator action = 2) [3] |
| **Late Inventory, Makeup (LI)** | Depressurization through 3/11 SRVs and injection via 1/2 CRD or PCS recovery including 1/2 condenser sections plus 1/3 cond pumps [4] or injection with 2 of 5 SW pumps or with 1DD or 1 MD fire water pump , or 1/2 CS pump trains: limited by operator action for depressurization (operator action = 2) [5,6,7] |

| **Circle Affected Functions** | **Recovery of Failed Train** | **Remaining Mitigation Capability Rating for Each Affected Sequence** | **Sequence Color** |
|---|---|---|---|
| 1 TPCS - CHR - LI (3) | | | |
| 2 TPCS - CHR - CV (4, 7) | | | |
| 2 TPCS - HPI - LPI (8) | | | |
| 3 TPCS - HPI - DEP (9) | | | |

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

**Notes**:

1. Use of 1/2 CRD can only be credited if the feedwater or some sort of early injection is initially available. This is only credited as a part of LI in the SDP work sheet. Use of 2/2 CRD without Turbine bypass (failure of PCS) as an early injection is not considered in this SDP work sheet.

2. The HEP value identified for depressurization using SRVs is 6.9E-3 in the IPE. An operator action credit of 2 is given to this action in the SDP sheet.

3. An operator credit of 2 is for CV function in SDP sheet . IPE uses a HEP value of 1.4E-3 for wet well venting.

4. In the Transient event tree, Brunswick models TBV and FW separately rather than together as PCS. We have maintained the standard BWR method of PCS here. Therefore late recovery of PCS is credited as a part of LI function.

5. All operator action for the portion of LI function that does not rely on suppression pool is combined to one to account for the dependencies among these actions. An operator credit of 2 is generically assigned in the SDP sheet.

6. Pursuant to Licensee's comment based on MOR-98 IPE and the current plant EOP, the operation of LPI is credited after successful CV but failure of CHR. The EOP guides the operator to perform CV in a pressure control mode such that operation of LPI is not jeopardized.

7. Function LI is credited when CHR has failed. Therefore, no credit is given to RHR pumps as a part of late injection.

## Table 3.3 SDP Worksheet for Brunswick — 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:** | | |
| **High Press Injection (HPI)** | HPCI (1 ASD train) or RCIC (1 ASD train) | | |
| **Depressurization (DEP)** | 2/11 SRVs manually opened (operator action = 2) [1] | | |
| **Low Press Injection (LPI)** | 1/4 RHR pumps in LPCI mode in 1/2 trains (1 multi-train system) or 1/2 CS pumps (1 multi-train system) | | |
| **Containment Heat Removal (CHR)** | 1/2 RHR HXs in SPC mode, operator action but limited by hardware failure (1 multi-train system) | | |
| **Containment Venting (CV)** | Containment venting from wetwell (operator action = 2) | | |
| **Late Inventory, Makeup (LI)** | Depressurization through 3/11 SRVs and injection via PCS recovery including 1/2 condenser sections plus 1/3 cond pumps or injection with 2 out of 5 SW pumps or injection with 1 DD or 1 MD fire water pump or 1/2 CS pumps : limited by operator action to depressurize (operator action = 2) | | |

| Circle Affected Functions | Recovery or Failed Train | Remaining Mitigation Capability Rating for Each Affected Sequence | Sequence Color |
|---|---|---|---|
| 1 SLOCA - CHR - LI (3) | | | |
| 2 SLOCA -CHR - CV (4, 7) | | | |
| 3 SLOCA - HPI - LPI (8) | | | |
| 4 SLOCA - HPI - DEP (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. |

**Note**:

1. Small LOCA sizes are less than 5.0E-3 $ft^2$ for liquid break and 0.1 $ft^2$ for steam. A small LOCA is expected to increase the drywell pressure by 2 psig and initiate reactor scram. The HPCI system will actuate on drywell pressure. If HPCI failed the RCIC will actuate on low level 2. If both HPCI and RCIC fail, it is assumed that the operator will manually initiate depressurization.

## Table 3.4 SDP Worksheet for Brunswick — Stuck Open Relief Valve (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 (HPCI)** | HPCI (1 ASD train) or RCIC (1 ASD train) |
| **Depressurization (DEP)** | Operator depressurizes through 2 out of remaining 10 SRVs or ADS functions (1 multi-train system) [(1)] |
| **Low Pressure Injection (LPI)** | 1/4 RHR pumps in LPCI mode in 1/2 trains (1 multi-train system) or 1/2 CS pumps (1 multi-train system) |
| **Containment Heat Removal (CHR)** | 1/2 RHR HXs in SPC mode, operator action but limited by hardware failure (1 multi-train system) |
| **Containment Venting (CV)** | Containment venting from wetwell (operator action = 2) |
| **Late Inventory, Makeup (LI)** | Depressurization through 2 out of remaining 10 SRVs and injection via PCS recovery including 1/2 condenser sections plus 1/3 cond pumps or injection with 2 out of 5 SW pumps or injection with 1 DD or 1 MD fire water pump or 1/2 CS pumps: limited by operator action to depressurize (operator action = 2) |

| **Circle Affected Functions** | **Recovery or Failed Train** | **Remaining Mitigation Capability Rating for Each Affected Sequence** | **Sequence Color** |
|---|---|---|---|
| 1 SORV - CHR - LI (3) | | | |
| 2 SORV -CHR - CV (4, 7) | | | |
| 3 SORV - HPI - LPI (8) | | | |
| 4 SORV - HPI - DEP (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.

**Note**:

1. One SRV stuck open behaves like a SLOCA. Two stuck open SRVs or SLOCA with one stuck open SRV behaves like a MLOCA. This work sheet is developed for one SRV stuck open consistent with the SDP generic guidance. SLOCA and one stuck open SRV (or two stuck open SRVs) should be treated similar to a medium LOCA. However, one SRV stuck open should actuate automatic ADS, if HPI fails. If ADS does not auto actuate, then operators can manually perform the depressurization. This is classified here as a multi-train system. Brunswick procedure does not require inhibiting the ADS. Small LOCA event tree is used for this worksheet.

## Table 3.5 SDP Worksheet for Brunswick — 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 (HPCI)** | HPCI (1 ASD train) |
| **Early Containment Control (EC)** | Not Applicable [1] |
| **Depressurization (DEP)** | Operator depressurizes through 3/11 SRVs or ADS functions (1 multi-train system) [2] |
| **Low Pressure Injection (LPI)** | 1/4 RHR pumps in LPCI mode in 1/2 trains, operator action but limited by hardware failure (1 multi-train system) or 1/2 CS pumps (1 multi-train system) |
| **Containment Heat Removal (CHR)** | 1/2 RHR HXs in SPC mode (1 multi-train system) or Containment venting from wetwell (operator action = 2) [3] |

| **Circle Affected Functions** | **Recovery or Failed Train** | **Remaining Mitigation Capability Rating for Each Affected Sequence** | **Sequence Color** |
|---|---|---|---|
| 1 MLOCA - CHR (2, 5) | | | |
| 2 MLOCA - LPI (3,6) | | | |
| 3 MLOCA - HPCI - DEP (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. Brunswick has a unique containment design such that failure of vacuum breakers to remain closed could fail the containment but not the torus, so this top event is not applicable. EC function therefore will not be questioned in the event trees for all sizes of LOCAs.

2. A medium LOCA should actuate automatic ADS, if HPI fails. If ADS does not auto actuate, then operators can manually perform the depressurization. This is classified here as a multi-train system. Brunswick procedure does not require inhibiting the ADS. Furthermore, the licensee IPE MOR-98 uses 3/11 SRVs as a conservative success criteria.

3. For both Medium and Large LOCAs, CV is credited for CHR since the LPI could continue operation after successful CV. The plant EOP requires CV to be performed in a pressure controlled mode.

## Table 3.6 SDP Worksheet for Brunswick — Large LOCA (LLOCA)

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

| **Safety Functions Needed:** | **Full Creditable Mitigation Capability for Each Safety Function:** |
|---|---|
| **Early Inventory (LPI)** | 1/4 RHR pumps in LPCI mode in 1/2 trains (1 multi-train system) or 1/2 CS trains (1 multi-train system) |
| **Containment Heat Removal (CHR)**[1] | 1/2 RHR HXs in SPC mode, operator action but limited by hardware failure (1 multi-train system) or Containment venting from wetwell (operator action = 2) |

| **Circle Affected Functions** | **Recovery or Failed Train** | **Remaining Mitigation Capability Rating for Each Affected Sequence** | **Sequence Color** |
|---|---|---|---|
| 1 LLOCA - CHR (2) | | | |
| 2 LLOCA - LPI (3) | | | |

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

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

**Note:**

1. For both Medium and Large LOCAs, CV is credited for CHR since the LPI could continue operation after successful CV. The plant EOP requires CV to be performed in a pressure controlled mode.

## Table 3.7 SDP Worksheet for Brunswick — Station LOOP (LOOP) [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: |
|---|---|
| **Dedicated Emergency Power (EAC1)** | 1/2 EDGs dedicated to the unit (1 multi-train system) |
| **Sister Unit Emergency Power (EAC2)** | 2/2 EDG in the sister unit (1 train system)[2] |
| **Closure of SRVs (SRVR)** | All open SRVs in response to LOOP close (1 train system) |
| **Recovery of LOOP in 30 mins (RLOOP30M)** | Recovery from station LOOP in 30 minutes (not credited) [2] |
| **CSW to NSW header Cross Tie (X_TIE)** | Operator aligns CSWP to NSW header (operator action = 1) [3,5] |
| **Recovery of LOOP in 2 hrs (RLOOP2H)** | Recovery from station LOOP in 2 hours (operator action = 1) [4] |
| **High Pressure Injection (HPI)** | HPCI (1 ASD train) or RCIC (1 ASD train) |
| **Depressurization (DEP)** | 3/11 SRVs manually opened (operator action = 2) |
| **Low Pressure Injection (LPI)** | 1/4 RHR pumps in LPCI mode in 1/2 trains (1 multi-train system) or 1/2 CS pump trains (1 multi-train system) |
| **Containment Heat Removal (CHR)** | 1/2 RHR HXs trains in SPC mode, operator action but limited by hardware failure (1 multi-train system) |
| **Low Pressure Injection, SBO in one Unit (LPIL)** | 1/1 RHR pumps in LPCI mode in 1/2 RHR trains (1 train system) |
| **Containment Heat Removal, SBO in one unit (CHRL)** | 1/1 RHR HXs in SPC mode, operator action but limited by hardware failure (1 train system) |
| **Containment Venting (CV)** | Containment venting from wetwell (operator action = 2) |
| **Late Inventory, Makeup (LI)** | Depressurization through 3/11 SRVs and injection via 2 out of 5 SW pumps or 1 MD or 1 DD Fire water pump (operator action = 2). |
| **Late Inventory Makeup, SBO in one unit (LIL)** | Depressurization through 3/11 SRVs and injection via 1 DD or 1 MD Fire water pump (operator action = 1) |

| Circle Affected Functions | Recovery or Failed Train | Remaining Mitigation Capability Rating for Each Affected Sequence | Sequence Color |
|---|---|---|---|
| 1 LOOP - CHR - LI (1,2, 5,17) | | | |
| 2 LOOP - CHR - CV (1,2,6,18) | | | |

| | | | |
|---|---|---|---|
| 3 LOOP - HPI - LPI (1, 2) | | | |
| 4 LOOP - HPI - DEP (1, 2) | | | |
| 5 LOOP - EAC1 - RLOOP2 - CHRL - LIL (10) | | | |
| 6 LOOP - EAC1 - RLOOP2 - CHRL - CV (11) | | | |
| 7 LOOP - EAC1 - RLOOP2 - X_TIE (12) | | | |
| 8 LOOP - RLOOP30M -EAC1 - HPI (7,19,13) | | | |
| 9 LOOP - RLOOP30M - EAC1 -RLOOP2 - EAC2 (14) | | | |
| 10 LOOP - RLOOP 30 M - EAC1 - SRVR - RLOOP2 (20) | | | |

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

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

**Notes:**

1. Single unit LOOP has a frequency of 9.8E-3 per year and site Loop has a frequency of 1.5E-2 per year based on the upgraded IPE. This work sheet is modeling a site LOOP event . Due to complexity of the Brunswick electrical system, some simplifying assumptions, albeit on the conservative side, have been made in developing this worksheet. This was necessary to keep the work sheet simple and suitable for Phase-2 analyses. Detailed consideration as usual should be accounted for in the phase-3 evaluation.

2. Recovery of LOOP in 30 min is considered a demanding operator action. Brunswick IPE assigns a failure probability of 0.474. The recovery of offsite power in less than 30 minutes is not credited in this SDP sheet. Success of EAC2 followed by failure of EAC1 assumes that one train of Emergency bus can be cross-tied to the sister unit. Therefore, reduced mitigation capability corresponding to availability of one Emergency bus is only credited for this case. As a result, an “L” is added to the end of the function name to indicate this reduced mitigation capability (e.g. CHR vs. CHRL).

3. A HEP value of 7.4E-3 is estimated for operator failure to open a path from conventional SW to vital header based on the upgraded IPE. A HEP value with credit of 1 is given to this action indicating the strenuous condition caused by LOOP and loss ESF AC bus E1 and E2.

4. Dual unit (site) LOOP is considered for this SDP worksheet. Therefore, successful recovery of LOOP (RLOOP2) in two hours means either recovery of at least 1 EDG per unit, or recovery of offsite power. Recovery of LOOP in 2 hrs is considered as an operator action. The probability assigned to this operator action accounts for cross tie between the units electrical bus, as well as offsite activities that results in restoration of offsite power. This action and its timing also depends on availability of HPI and DC load shedding. The SDP work sheet assigns a generic HEP credit of 1 to this operator action.

5. LOOP with failure of EAC1 (loss of bus E1 and E2) is assumed to directly fail CRD pumps A&B, RHR and RHRSW for pumps C&D, both CS pumps, CSW-A&B, NSW-A&B, and MD fire pump D. If the operator does not cross tie AC between the units, loss of NSW- A&B will fail the long term operation of CHR/LPI unless the CSW is aligned to NSW header.

## Table 3.8 SDP Worksheet for Brunswick — Anticipated Transients Without Scram (ATWS)

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

| **Safety Functions Needed:** | **Full Creditable Mitigation Capability for Each Safety Function:** |
|---|---|
| **Overpressure Protection (OVERP)** | 6/11 SRVs (1 multi-train system) [8] |
| **Recirculation Pump Trip (RPT)** | Manual or automatic trip of recirculation pumps (1 multi-train system) |
| **Reactivity Control (SLC)** | Initiate 2/2 SLC pumps, operator action but limited by hardware failure (1 train) [1] |
| **Inhibit ADS (INH)** | Operator inhibits ADS (operator action =2) [2] |
| **High Pressure Injection (HPI)** | Operator injects and controls RV level with HPCI; or RCIC, or FW and 1/2 CRD pumps [3] (operator action = 2) [4] |
| **Depressurization (DEP)** | 3/11 SRVs manually opened (operator action = 2) |
| **Low Pressure Injection (LPI)** | Operator injects and controls RV level with 1/2 RHR train in LPCI mode or 1/2 LPCS train (operator action = 2) [5]; or 1/3 condensate train (operator action = 1) |
| **Containment Overpressure Protection (CHR)** | 1/2 RHR HXs in SPC mode (operator action = 1) [6], or 3 out of 4 circulating Water pumps and 2 out of 2 condenser Sections (operator action = 1) [7] |
| **Containment Venting (CV)** | Containment venting from wetwell (operator action = 2) |
| **Late Inventory, Makeup (LI)** | Depressurization through 3/11 SRVs and injection via 2 out of 5 SW pumps or 1 MD or 1 DD Fire water pump (operator action = 2). |

| **Circle Affected Functions** | **Recovery or Failed Train** | **Remaining Mitigation Capability Rating for Each Affected Sequence** | **Sequence Color** |
|---|---|---|---|
| 1 ATWS - OVERP (14) | | | |
| 2 ATWS - RPT (13) | | | |
| 3 ATWS - INH[9] (12) | | | |
| 4 ATWS - SLC (11) | | | |

| | | | |
|---|---|---|---|
| 5 ATWS - HPI - DEP (10) | | | |
| 6 ATWS - HPI - LPI (9) | | | |
| 7 ATWS - CHR - LI (3, 7) | | | |
| 8 ATWS - CHR -CV (4,8) | | | |

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

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

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

(1) In Brunswick upgraded IPE the HEP value for action to initiate SLC is given as 1.5E-3 which classifies it as an operator action with a credit of 3, however, the system reliability is limited by hardware failure.

(2) Operator inhibiting ADS is considered as a dependent operator action to other proceduralized actions required during ATWS. A generic HEP credit of 2 is assigned to this action for use in this SDP worksheet.

(3) For HPI, Brunswick requires either HPCI or RCIC, or FW plus CRD. Licensee has indicated that the operation of 1/2 CRD would be sufficient.

(4) The HEP credit of 2 for injecting with HPI and controlling RV level at the top of the active fuel (TAF) is generically assigned. The upgraded IPE uses a HEP value of 7.0E-3 for Boron washout for this type of scenario.

(5) Level control to avoid Boron Washout when using low pressure injection is a demanding operator action. A credit of 2 is generically assigned to this action for this work sheet. The IPE upgrade has an estimate of 9.1E-3.

(6) In Brunswick the HEP for aligning the RHR trains for SPC mode during ATWS is 0.05.

(7) The containment heat removal function could be performed either by bleeding steam to the condenser, or use of RHR in SPC mode.

(8) In this SDP worksheet, ATWS with failure of SRV to re-close is not considered consistent with the SDP guideline.

(9) ATWS with failure to inhibit is considered as a core damage sequence in this worksheet consistent with all other similar BWRs.

## Table 3.9 SDP Worksheet for Brunswick — Loss of Nuclear SW (LNSW) (1)

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

| **Safety Functions Needed:** | **Full Creditable Mitigation Capability for Each Safety Function:** |
|---|---|
| **Early Inventory (LPI)** | 1/4 RHR pumps in LPCI mode in 1/2 trains (1 multi-train system) or 1/2 CS trains (1 multi-train system) |
| **Recover NSW Early (RECE)** | Realign the Conventional SW to NSW before the dry well temperature reaches $300^0$F (operator action = 1) |
| **Containment Heat Removal (CHR)** | 1/1 RHR HXs trains in SPC mode, operator action but limited by hardware failure (1 train system) |
| **Containment Venting (CV)** | Containment venting from wetwell (operator action = 2) |
| **Late Inventory, Makeup (LI)** | Condensate injection including 1/2 condenser sections plus 1/3 cond pumps (operator action = 2) |

| **Circle Affected Functions** | **Recovery or Failed Train** | **Remaining Mitigation Capability Rating for Each Affected Sequence** | **Sequence Color** |
|---|---|---|---|
| 1 LNSW - RECE - CHR- CV (4) | | | |
| 2 LNSW - RECE - LPI - LI (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.

**Note:**

(1) Failure of both of nuclear service water pumps will lead to loss of the cooling water supply to NSW header (frequency 3.3 E-3 per year). If the conventional SW is not realigned to NSW before the drywell reaches 300 degree F, the operator is assumed to depressurize the reactor. The loss of NSW impacts RHR and CSS room cooler, RHR heat exchanger, RHR pump seal cooler, drywell cooler, CRD pumps, and RBCCW. However, RHR and CSS room coolers are not needed for injection (MOR-98). RHR pump seal cooler is only needed for shutdown cooling. Furthermore, at least one loop of SPC is available since it is normally aligned to conventional service water (MOR-98). Therefore, the CHR mitigation capability should be reduced to one train, and CRD should not be credited for LI function.

## Table 3.10 SDP Worksheet for Brunswick — Loss of DC Division A; Bus 1A1&1A2 (LDCA) (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:** |
|---|---|
| **High Press Injection (HPI)** | RCIC (1 ASD train) |
| **Depressurization (DEP)** | 3/11 SRVs manually opened (operator action = 2) |
| **Low Pressure Injection (LPI)** | 1/2 RHR pumps in LPCI mode in 1/1train (1 train system) or 1/1 CS pump train (1 train system) |
| **Containment Heat Removal (CHR)** | 1/1 RHR HXs train in SPC mode (1 train system) |
| **Containment Venting (CV)** | Containment venting from wetwell (operator action = 2) |
| **Late Inventory, Makeup (LI)** | Depressurize through 3/11 SRVs and inject via 1/1 CRD or PCS recovery including 1/2 condenser sections plus 1/3 cond pumps or injection with 2 out of 3 SW pumps or with 1DD or 1 MD fire water pump, or 1/2 RHR pumps in LPCI mode in 1/1train or 1/1 CS pump train; limited by operator action to depressurize (operator action = 2) |

| **Circle Affected Functions** | **Recovery of Failed Train** | **Remaining Mitigation Capability Rating for Each Affected Sequence** | **Sequence Color** |
|---|---|---|---|
| 1 LDCA - CHR - LI (4) | | | |
| 2 LDCA - CHR - CV (5, 8) | | | |
| 2 LDCA - HPI - LPI (9) | | | |
| 3 LDCA - HPI - DEP (10) | | | |

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) Loss of DC Division A causes the closure of inboard MSIVs resulting in reactor scram. This initiator is considered as a loss of power to both 1A1 and 1A2, and consequential loss of AC bus E1. It also impacts the operation of HPCI, RHR pump A&C and RHRSW-A&C, CS pump A, CSW Pump B, and NSW pump A. The frequency of loss of a DC bus (1A1 or 1A2) or a DC panel is considered as initiator in IPE with an estimated frequency of 2.9E-3 per year. The frequency for this initiator in SDP worksheet (Loss of DC bus 1A1 and 1A2) is estimated about 2.9E-5 per year. The TPCS event tree is used for this SDP sheet.

## Table 3.11 SDP Worksheet for Brunswick — Loss of DC Division B; Bus 1B1&1B2 (LDCB)

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

| **Safety Functions Needed:** | **Full Creditable Mitigation Capability for Each Safety Function:** |
|---|---|
| **High Press Injection (HPI)** | HPCI (1 ASD train) |
| **Depressurization (DEP)** | 3/11 SRVs manually opened (operator action = 2) |
| **Low Pressure Injection (LPI)** | 1/2 RHR pumps in LPCI mode in 1/1 train (1 train system) or 1/1 CS pump train (1 train system) |
| **Containment Heat Removal (CHR)** | 1/1 RHR HXs trains in SPC mode (1 train system) |
| **Containment Venting (CV)** | Containment venting from wetwell (operator action = 2) |
| **Late Inventory, Makeup (LI)** | Depressurization with 3/11 SRVs and injection via 1/1 CRD or PCS recovery including 1/2 condenser sections plus 1/3 cond pumps or injection with 2 out of 3 SW pumps or with 1/1 DD fire water pump or 1/1 MD fire water pump, 1/2 RHR pumps in LPCI mode in 1/1 train or 1/1 CS pump train; limited by operator action to depressurize (operator action = 2) |

| **Circle Affected Functions** | **Recovery of Failed Train** | **Remaining Mitigation Capability Rating for Each Affected Sequence** | **Sequence Color** |
|---|---|---|---|
| 1 LDCB - CHR - LI (4) | | | |
| 2 LDCB - CHR - CV (5,8) | | | |
| 2 LDCB - HPI - LPI (9) | | | |
| 3 LDCB - HPI - DEP (10) | | | |

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

**Note**:

(1) Loss of DC Division B causes the closure of outboard MSIVs resulting in reactor scram. This initiator is considered as a loss of power to both 1B1 and 1B2, and consequential loss of AC bus E2. It also impacts the operation of RCIC, CRD pump B, RHR pump D, CS pump B, CSW pump C, NSW pump B, and RHRSW-B&D. It also impact many of auto actuation signals, therefore requiring manual actions. The frequency of loss of a DC bus (1B1 or 1B2) or a DC panel is considered as initiator in IPE with an estimated frequency of 2.9E-3 per year. The frequency for this initiator in SDP worksheet (Loss of DC bus 1B1 and 1B2) is estimated about 2.9E-5 per year. The TPCS event tree is used for this SDP sheet.

## Table 3.12 SDP Worksheet for Brunswick — Loop with loss of one Division AC; Bus E1 or E2 (LEAC)

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

| **<u>Safety Functions Needed</u>:** | **<u>Full Creditable Mitigation Capability for Each Safety Function:</u>** |
|---|---|
| **High Press Injection (HPI)** | HPCI (1 ASD train) or RCIC (1 ASD train) |
| **Depressurization (DEP)** | 3/11 SRVs manually opened (operator action = 2) |
| **Low Pressure Injection (LPI)** | 1/3 RHR pumps in LPCI mode in 1/2 trains (1 multi-train system) or 1/1 CS pump train (1 train system) |
| **Containment Heat Removal (CHR)** | 1/1 RHR HXs trains in SPC mode (1 train) |
| **Containment Venting (CV)** | Containment venting from wetwell (operator action = 2) |
| **Late Inventory, Makeup (LI)** | Depressurization with 3/11 SRVs and injection via 1/1 CRD or PCS recovery including 1/2 condenser sections plus 1/3 cond pumps or injection with 2 out of 3 SW pumps or with 1/1 DD fire water pump (operator action = 2) or [LPI:] 1/3 RHR pumps in LPCI mode in 1/2 trains (1 multi-train system) or 1/1 CS pump train (1 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 LEAC - CHR - LI (4) | | | |
| 2 LEAC - CHR - CV (5, 8) | | | |
| 2 LEAC - HPI - LPI (9) | | | |
| 3 LEAC - HPI - DEP (10) | | | |

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. Loop with loss of one division AC will impact one SLC train, one CRD train, one RHR pump, one CS pump train, one CSW , and one NSW pump in addition to loss of power conversion system. Loss of AC division E2 will also impact the MD fire pump, however, the pump can be powered from E4. This work sheet assumes loss of MD fire pump for either AC division E1 or E2. The initiator frequency for this work sheet is assumed to be the frequency of dual Loop multiplied by 0.01 to account for loss of one AC division (1.5E-4 per year). The TPCS event tree is used for this worksheet.

## Table 3.13 SDP Worksheet for Brunswick — Interfacing System LOCA/LOCA Outside Containment (ISLOCA/LOC)

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

| Initiation Pathways: | Mitigation Capability: Ensure Component Operability for Each Pathway |
|---|---|
| **ISLOCA PATHWAYS:** | |
| **RHR Suction From Recirc. Loop A** | Low pressure piping, with wo Normally Closed (NC) MOVs (Inside and outside Drywell) |
| **RHR SDC return to Loop A&B** | Low pressure piping, each with one check valve and one NC MOV. |
| **CSS injection Loop A&B** | Low pressure piping, each with one check valve and one NC MOV |
| **RWCU Suction from Loops A&B** | Each with two NO MOVs that can be isolated |
| **SLC injection line** | Two check valves |
| **RCIC injection line** | One check valve and one NC MOV |
| **HPCI injection line** | One check valve and one NC MOV |
| **RCIC/HPCI turbine inlet** | Each with two NC MOVS |
| **Feedwater inlet Lines (A&B)** | Two lines each with one check valve and one MOV that can be isolated |
| **Main Steam Lines** | Four lines, each with 2 MSIVs per line |

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

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

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

**<u>Note</u>:**

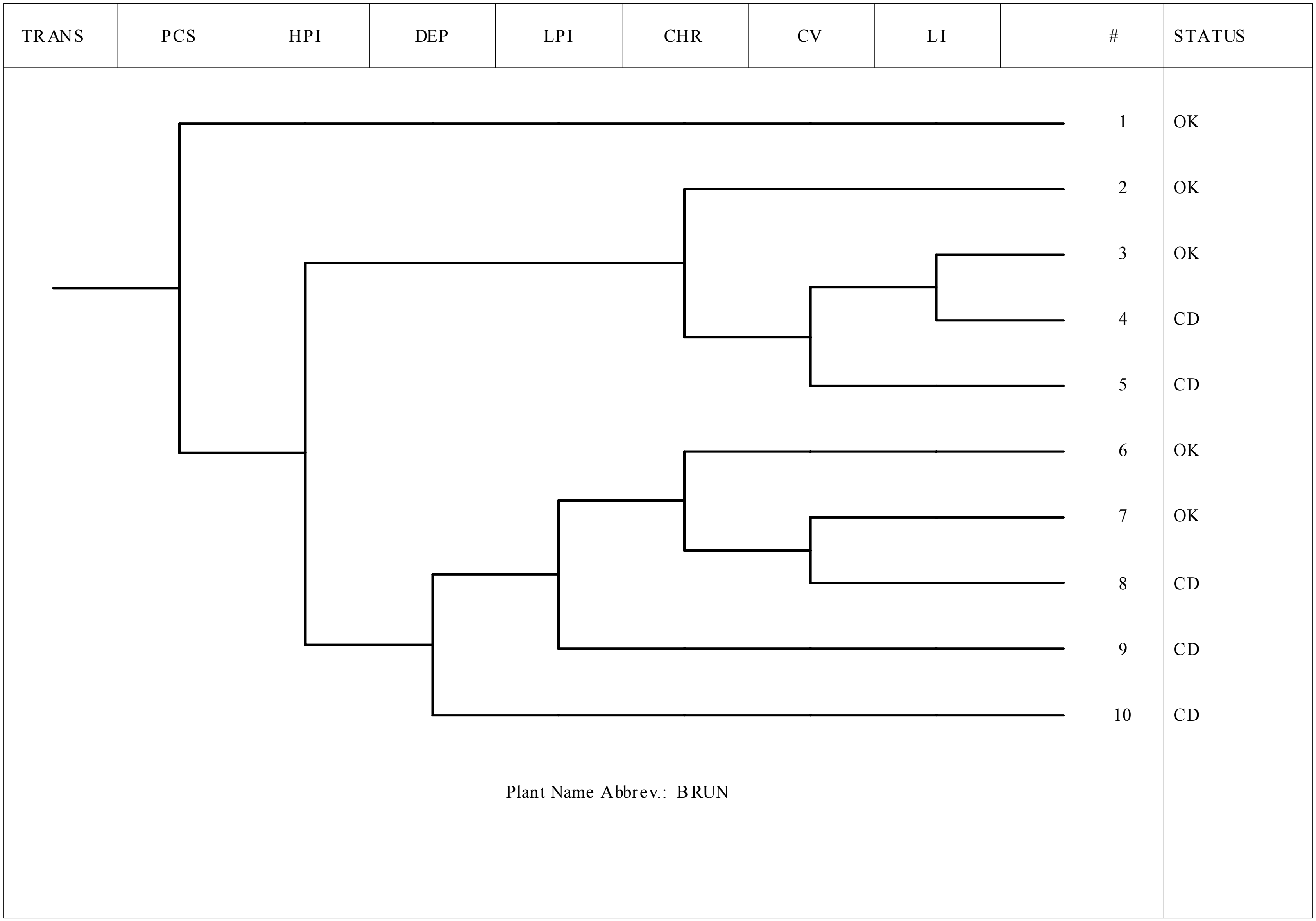
1. This worksheet contains pathways for both ISLOCA and LOC. Licensees typically analyze these events separately. These sequences constitute less than 1% of internal events CDF in the Brunswick IPE. They are provided in Table 3.1.3 of Volume 1 of the IPE. The principle contributors were the CS and RHR lines.

## 1.4 SDP Event Trees

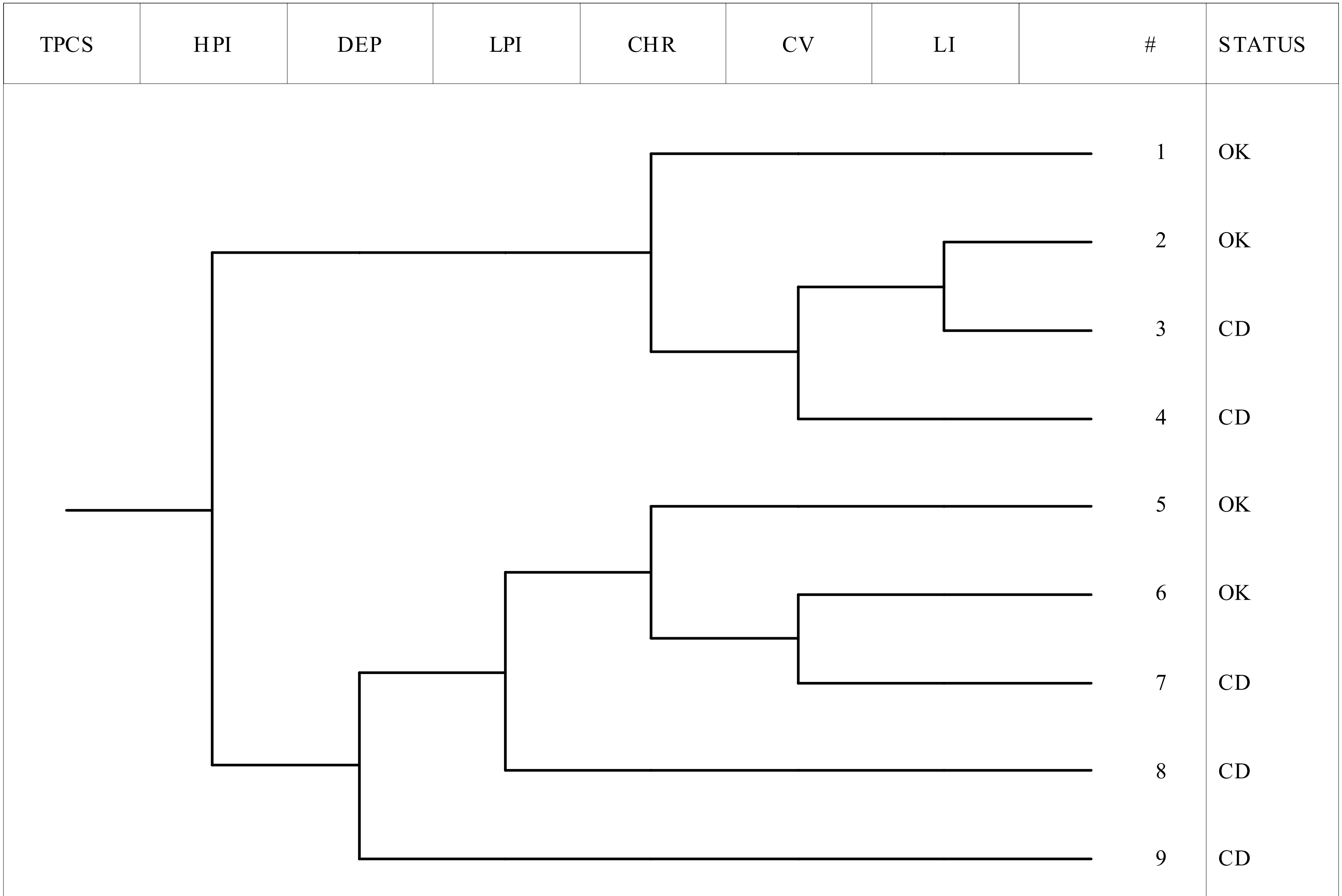
This section provides the simplified event trees, called SDP event trees, used to define the accident sequences identified in the SDP worksheets in the previous section. The event tree headings are defined in the corresponding SDP worksheets.

The following event trees are included:

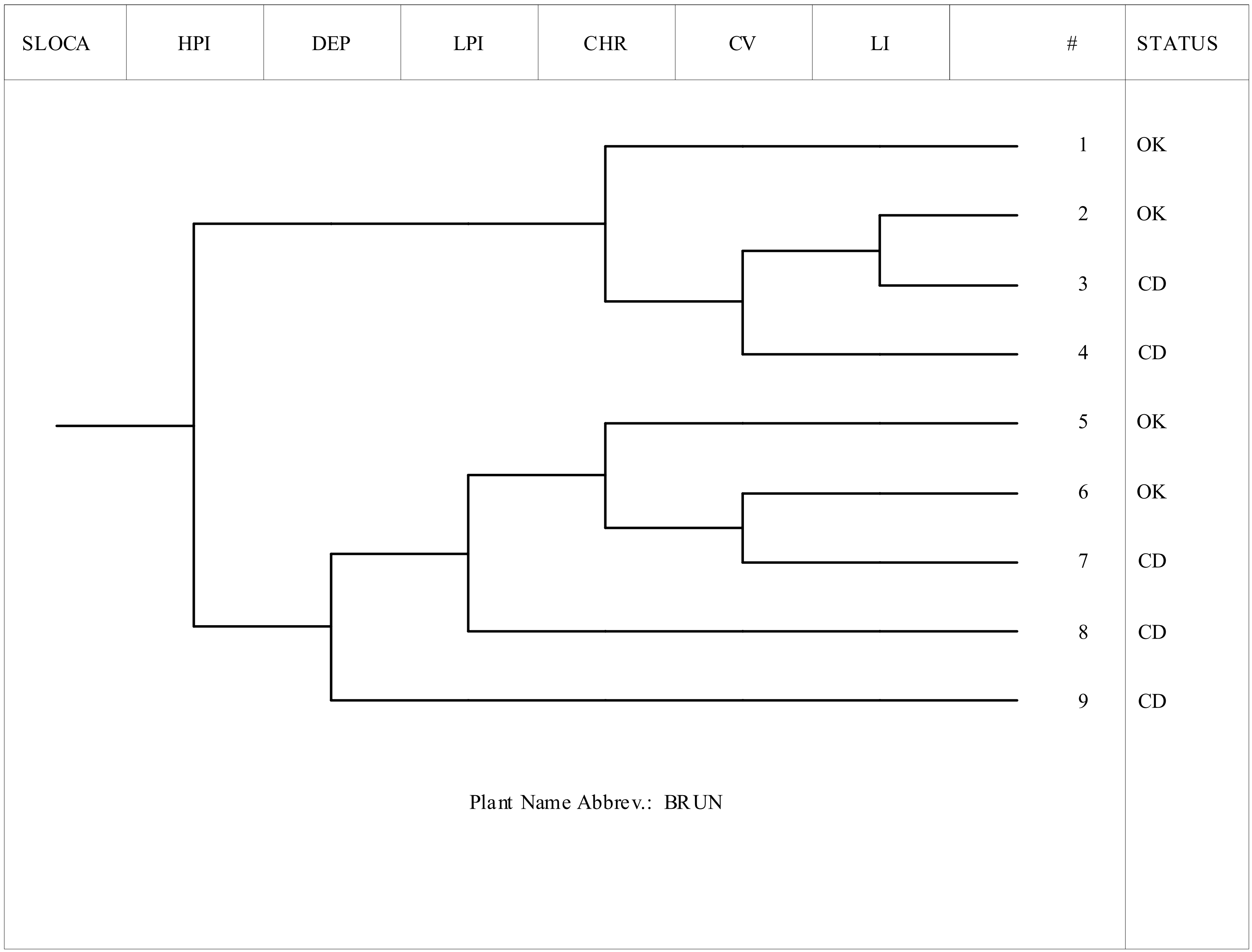
1. Transients (Reactor Trip) (TRANS)
2. Transients without PCS (TPCS)
3. Small LOCA (SLOCA)
4. Medium LOCA (MLOCA)
5. Large LOCA (LLOCA)
6. Station LOOP (LOOP)
7. Anticipated Transients Without Scram (ATWS)
8. Loss of Nuclear SW (LNSW)



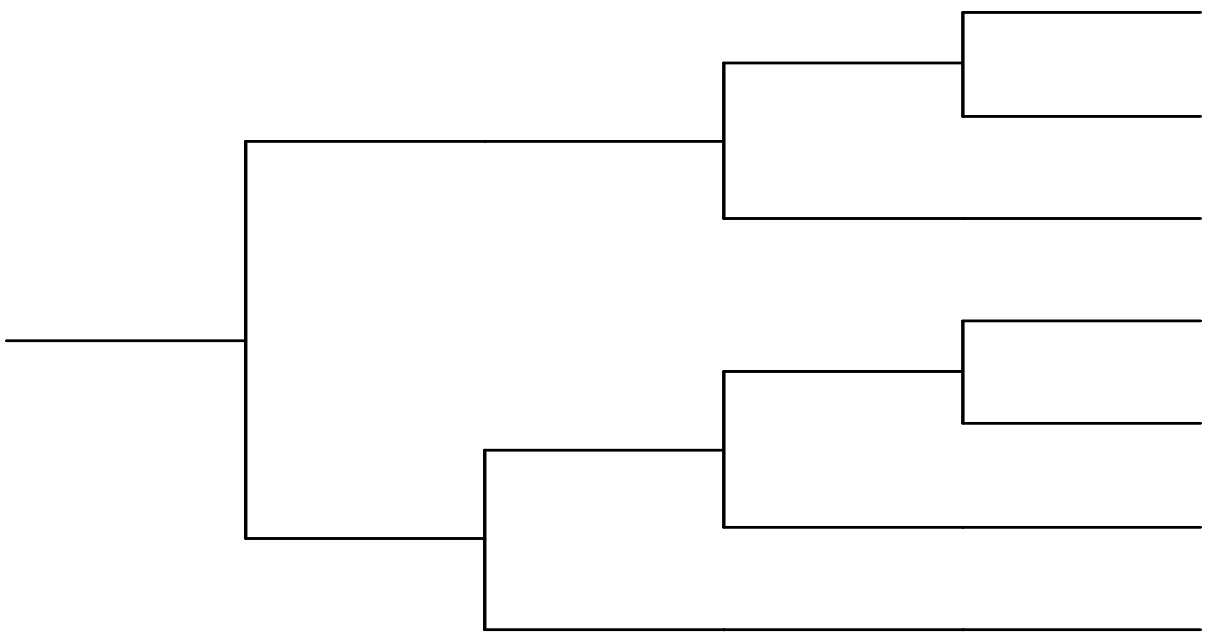

Plant Name Abbrev.: BRUN




Plant Name Abbrev.: BRUN


SLOCA
HPI
DEP
LPI
CHR
CV
LI
#
STATUS
1 OK
2 OK
3 CD
4 CD
5 OK
6 OK
7 CD
8 CD
9 CD
Plant Name Abbrev.: BRUN

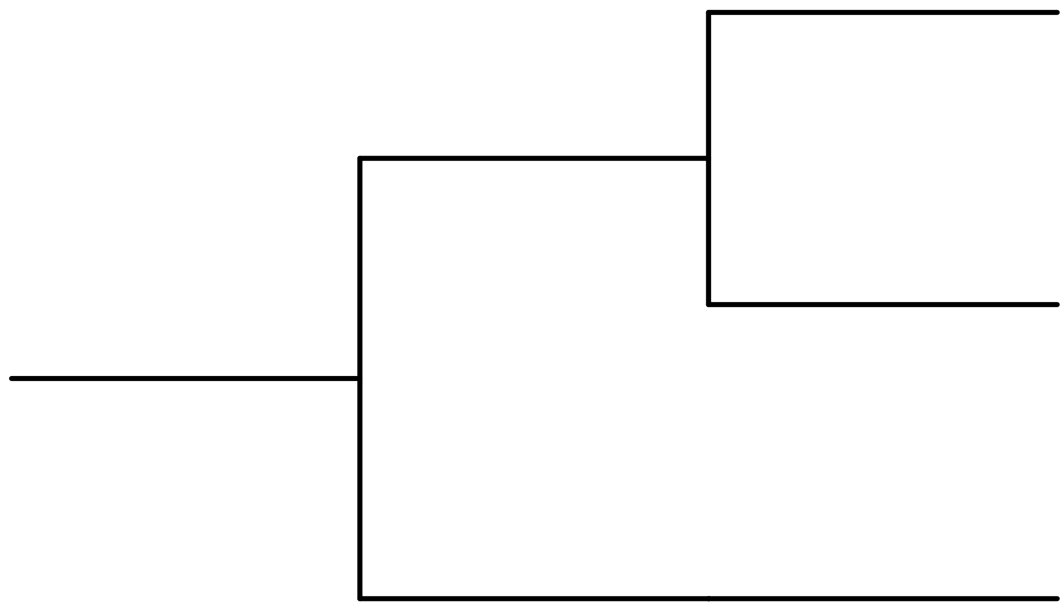
| MLOCA | HPCI | DEP | LPI | CHR | # | STATUS |
|---|---|---|---|---|---|---|



| # | STATUS |
|---|---|
| 1 | OK |
| 2 | CD |
| 3 | CD |
| 4 | OK |
| 5 | CD |
| 6 | CD |
| 7 | CD |

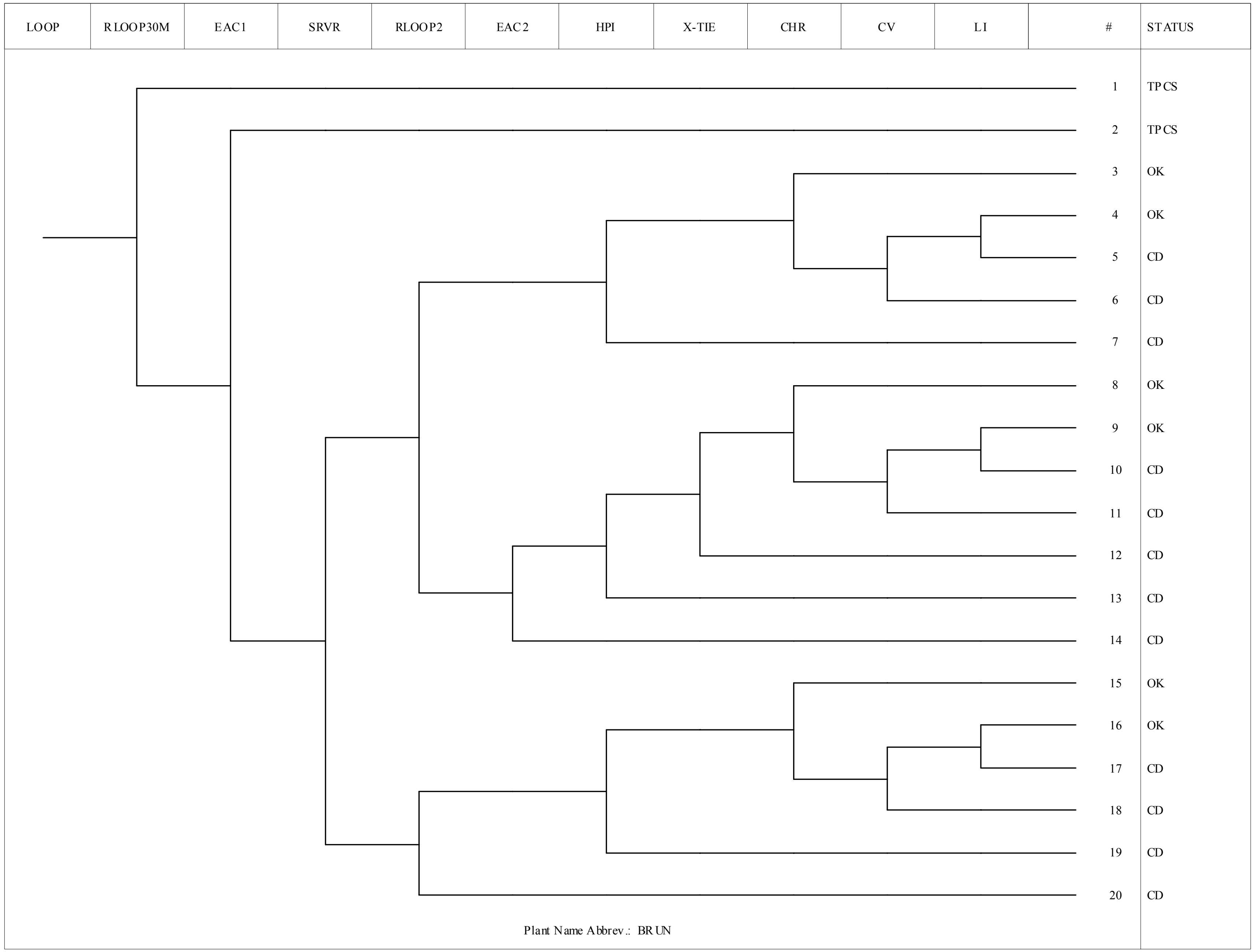
Plant Name Abbrev.: BRUN

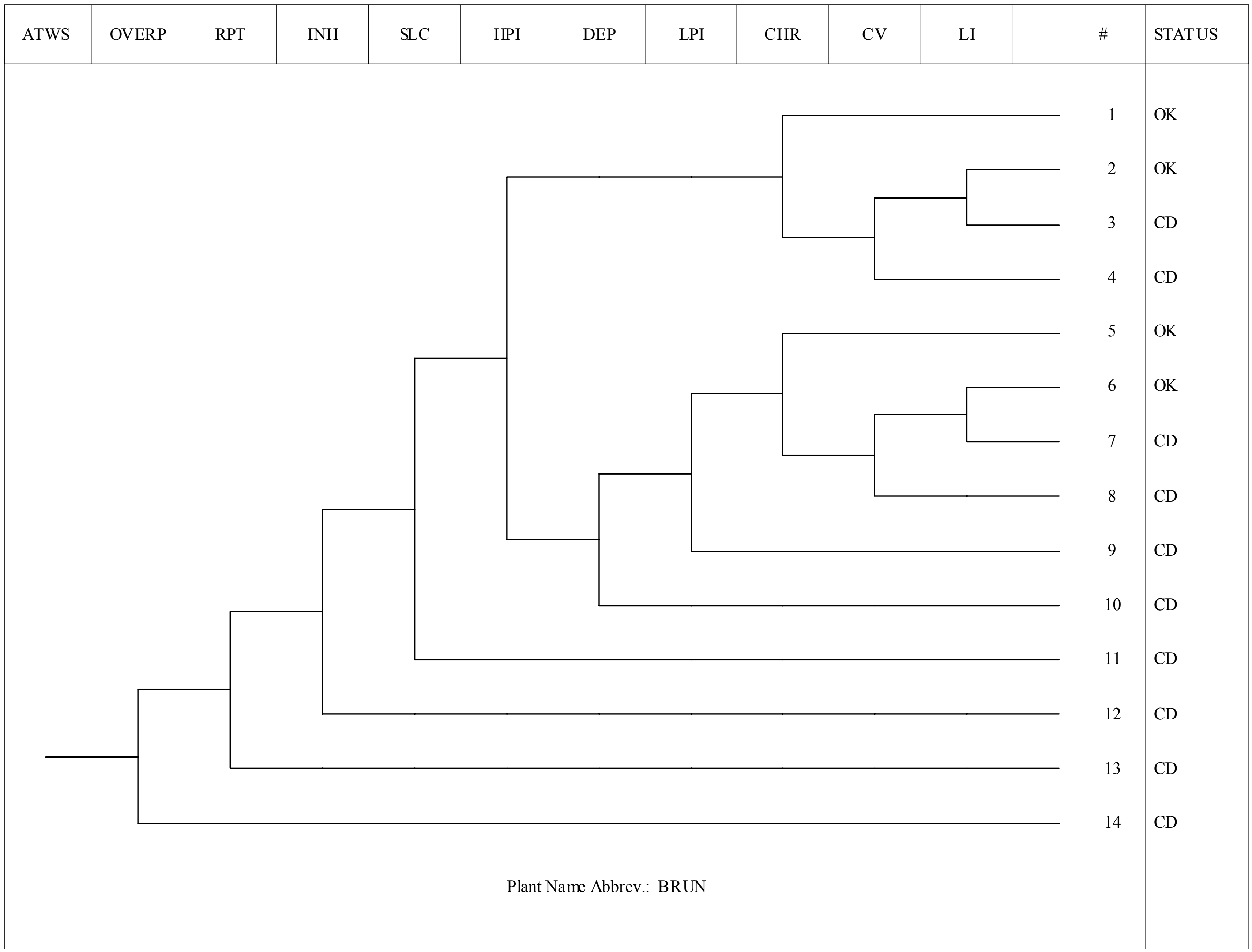
| LLOCA | LPI | CHR | # | STATUS |
|---|---|---|---|---|

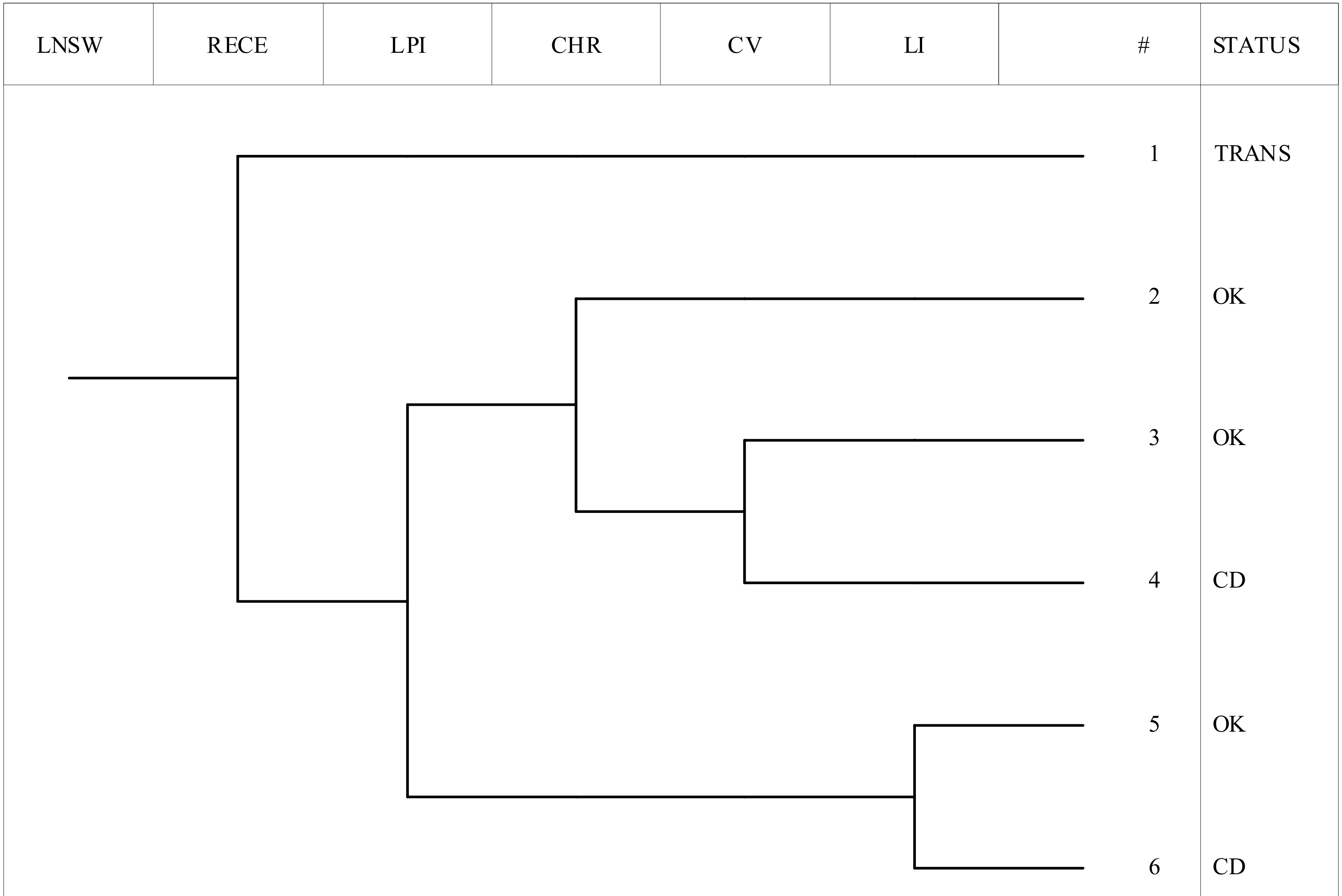


| # | STATUS |
|---|---|
| 1 | OK |
| 2 | CD |
| 3 | CD |

Plant Name Abbrev.: BRUN


LOOP
RLOOP30M
EAC1
SRVR
RLOOP2
EAC2
HPI
X-TIE
CHR
CV
LI
#
STATUS
1 TPCS
2 TPCS
3 OK
4 OK
5 CD
6 CD
7 CD
8 OK
9 OK
10 CD
11 CD
12 CD
13 CD
14 CD
15 OK
16 OK
17 CD
18 CD
19 CD
20 CD
Plant Name Abbrev.: BRUN


ATWS
OVERP
RPT
INH
SLC
HPI
DEP
LPI
CHR
CV
LI
#
STATUS
1 OK
2 OK
3 CD
4 CD
5 OK
6 OK
7 CD
8 CD
9 CD
10 CD
11 CD
12 CD
13 CD
14 CD
Plant Name Abbrev.: BRUN




Plant Name Abbrev.: BRUN

# 2. RESOLUTION AND DISPOSITION OF COMMENTS

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

## 2.1 GENERIC GUIDELINES AND ASSUMPTIONS (BWRs)

**Initiating Event Likelihood Rating Table**

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

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

2. Inclusion of special initiators:

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

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

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

4. LOCA outside containment (LOC):

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

**Initiating Event and System Dependency Table**

1. Inclusion of systems under the support system column:

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

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

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

**SDP Worksheets and Event Trees**

1. Crediting of non-safety related equipment:

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

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

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

3. Crediting system trains with high unavailability

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

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

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

5. Defining credits for operator actions:

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

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

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

7. Dependency among multiple operator actions:

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

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

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

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

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

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

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

11. Modeling vapor suppression success in different LOCA worksheets:

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

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

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

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

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

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

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

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

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

14. Recovery of losses of offsite power:

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

15. Mitigation capability for containment heat removal:

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

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

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

## 2.2 RESOLUTION OF PLANT-SPECIFIC COMMENTS

P. Wilson from NRC/NRR and M.A. Azarm from BNL met with Brunswick Licensee and PRA personnel on October 12-13, 2000. The Licensee provided useful comments on the draft worksheets. The special initiators, plant response, and the initiator impact were all discussed. A main focus of the visit was to better understand the electrical systems and the various ways they can support other front line and support systems. Other items included as a part of NRC review process were also discussed. Information on dependency matrix and detail drawing was requested and the response was received through an Email from the Licensee (Mr. K. Nicely) subsequent to the meeting. The licensee responses were reviewed and incorporated into the SDP worksheet to the extent possible within the framework, scope, and limitations of the SDP worksheets. The licensee's comment and feed back have significantly contributed to the improvement of this document.

1) Licensee's comments on the Initiator and System Dependency Tables reflecting the up to date plant specific system interactions, clarification notes, and plant specific acronyms were all incorporated.

2) Licensee's comments reflecting the current understanding of success criteria were all incorporated in the SDP sheets. Specifically, for Brunswick plant, the LPI is credited after containment venting. This is based on the plant EOP which requires venting in pressure controlled mode as footnoted in the work sheet.

3) Licensee indicated that the operation of LI function should be credited after failure of CHR and CV function. Brunswick plant has a unique containment design such that a containment failure as a result of loss of CHR and CV will not prevent continued operation of LI due to harsh environment.

4) Brunswick has a unique containment design such that failure of vacuum breakers to remain closed could fail the containment but not the torus, so this top event is not applicable. EC function therefore will not be questioned in the event trees for all sizes of LOCAs.

5) The information provided by the licensee on the impacts of special initiators on the plants systems and components were all incorporated in developing the SDP sheets for the special initiators and the associated Event trees.

6) The updated information on Human Error Probabilities (HEP values) were incorporated to the SDP work book for all cases where an explicit match could be found.

# REFERENCES


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

2. Carolina Power and Light Company, "Brunswick – Individual Plant Examination Report," dated August 1992.