We will coordinate our efforts through your licensing or risk organizations as appropriate. If you have any questions, please contact me at 301-415-1364.

Sincerely,

/RA/

Douglas V. Pickett, Senior Project Manager, Section 2
Project Directorate III
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-440

Enclosure: As stated

cc: See next page

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

April 3, 2001

Mr. John K. Wood
Vice President - Nuclear, Perry
FirstEnergy Nuclear Operating Company
P.O. Box 97, A200
Perry, OH 44081

SUBJECT: SITE-SPECIFIC WORKSHEETS FOR USE IN THE NUCLEAR REGULATORY COMMISSION'S SIGNIFICANCE DETERMINATION PROCESS

Dear Mr. Wood:

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

The 1999 Pilot Plant review effort clearly indicated that significant site-specific design and risk information was not captured in the Phase 2 worksheets forwarded to you by our letter dated December 10, 1999. Subsequently, a site visit was conducted by the NRC to verify and update plant equipment configuration data and to collect site-specific risk information from your staff. The enclosed document reflects the results of this visit.

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

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

We will coordinate our efforts through your licensing or risk organizations as appropriate. If you have any questions, please contact me at 301-415-1364.

Sincerely,

Douglas V Pickett

Douglas V. Pickett, Senior Project Manager, Section 2
Project Directorate III
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-440

Enclosures: As stated

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RISK-INFORMED INSPECTION NOTEBOOK FOR

PERRY NUCLEAR POWER PLANT

UNIT 1

BWR-6, GE, WITH MARK III CONTAINMENT

Prepared by

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NOTICE

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

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ABSTRACT

This notebook contains summary information to support the Significance Determination Process (SDP) in risk-informed inspections for the Perry Nuclear Power Plant, Unit 1.

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

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

CONTENTS

TABLES

FIGURES

1. INFORMATION SUPPORTING SIGNIFICANCE DETERMINATION PROCESS (SDP)

SECY-99-007A (NRC, March 1999) describes the process for making a Phase-2 evaluation of the inspection findings. 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 (LIA),
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 Perry Nuclear Power Plant, Unit 1.

1.1 INITIATING EVENT LIKELIHOOD RATINGS

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

Table 1 Categories of Initiating Events for Perry Nuclear Power Plant

Row	Approximate Frequency	Example Event Type	Estimated Likelihood Rating		
I	> 1 per 1-10 yr	Reactor Trip (TRANS), Loss of Power Conversion System[1] (Loss of condenser, Closure of MSIVs, Loss of feedwater)	A	B	C
II	1 per 10-10^2 yr	Loss of offsite power[2], Inadvertent or stuck open SRVs[3], LIA	B	C	D
III	1 per 10^2 - 10^3 yr	LSW	C	D	E
IV	1 per 10^3 - 10^4 yr	Small LOCA (RCS rupture), Medium LOCA (RCS rupture), LEAC	D	E	F
V	1 per 10^4 - 10^5 yr	Large LOCA (RCS rupture), ATWS[4]	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		

Notes:

1. Transient with loss of power conversion system have a frequency of 1.62 per year based on updated IPE.
2. Loss of offsite power has a frequency of 6.09E-2 per year based on updated IPE.
3. Inadvertent Opening of Relief Valve (IORV) has a frequency of 1.4E-1 per year based on updated IPE.
4. 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.

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 Perry Nuclear Power Plant, Unit 1

Affected System	Major Components	Support Systems	Initiating Event Scenarios
Reactor Pressure Vessel Depressurization ADS/SRVs	8/19 ADS SRVs 11/19 power-operated SRVs, Air accumulators	120 VAC vital power, ESF Class 1E Train A and Train B 125 VDC; Safety-Related Instrument Air System (SRIA)	All except LLOCA
Standby Liquid Control (SLC)	2 MD pumps, explosive valves	ESF AC Div 1 to SLC A, ESF AC Div 2 to SLC B	ATWS
Residual Heat Removal/Low Pressure Coolant Injection RHR/LPCI Train A	1 MD pump, MOVs	Div 1 - Emergency AC Power, Train A Class 1E DC Power, Train A Emergency Closed Cooling (ECCA), Train A ECCS Pump Room Cooling	All
RHR/LPCI Train B	1 MD pump, MOVs	Div 2 - Emergency AC Power, Train B Class 1E DC Power, Train B Emergency Closed Cooling (ECCB), Train B ECCS Pump Room Cooling	
RHR/LPCI Train C	1 MD pump, MOVs	Div 2 - Emergency AC Power, Train B Class 1E DC Power, Train C ECCS Pump Room Cooling, ECCB	
RHR/SPC (Suppression Pool Cooling) Trains A and B	2 MD pumps, 2 Heat exchangers, MOVs	See RHR LPCI A and LPCI B	All
RHR/CSC (Containment Spray Cooling) Trains A and B	2 MD pumps, 2 heat exchangers, MOVs	See RHR LPCI A and LPCI B	All
Low Pressure Core Spray (LPCS)	1 MD pump, MOVs	ESF AC Div 1, ESF DC Class 1E Div 1, ECCS Pump Room HVAC, ECCA	All except LEAC

Table 2 (Continued)

Affected System	Major Components	Support Systems	Initiating Event Scenarios
High Pressure Core Spray (HPCS)	1 MD pump, 1 dedicated (Div 3) diesel-generator, MOVs	ESF AC Div 3, ESF DC Div 3, ECCS Pump Room HVAC, Train C of Emergency Closed Cooling (ECC-C)	All
Reactor Core Isolation Cooling (RCIC)	1 STD pump, MOVs	ESF DC Class 1E Div 1, ECCS Pump Room HVAC, ECCA	All except MLOCA/LLOCA
Emergency Closed Cooling (ECC);Train A and Train B	2 MD pumps, 2 Heat exchangers, Surge tank, MOVs	EDG Div 1/ 2, ESF Class 1E DC Train A/B, ESW A/B	All
Emergency Service Water (ESW) Trains A/B/C (Train C dedicated to HPCS)	3 MD pumps, MOVs	EDG Div ½/3	All
Service/Instrument Air (IA)	1 MD service air and 1 MD instrument air compressor per unit	Nuclear Closed Cooling	LIA
Safety-Related Instrument Air (SRIA)	1 MD SR IA compressor supplying 2 safety-related trains per unit	ESW	All
Diesel Fire Pump (DFP) RPV Injection	1 DD fire pump (1 MD fire pump not credited in IPE)		Transient, TPCS, SLOCA, IORV, LOOP, LEAC
ESF Class 1E DC Power Div ½/3	Batteries/DC bus Chargers/DC bus Reserve chargers (2 sets per division)	EDG Div ½/3	All

Table 2 (Continued)

Affected System	Major Components	Support Systems	Initiating Event Scenarios
EDGs Div1/2/3 (Div 3 dedicated to High Pressure Core Spray Diesel Generator System)	3 EDGs, fuel oil, jacket water cooling, lube oil	ESF 125 VDC Div ½/3,ESW Train A/B/C, EDG Ventilation Train A/B/C	LOOP, LEAC
Suppression Pool Makeup (SPMU) / Drywell Vacuum Relief	Piping, MOVs, Drywell vacuum relief MOVs, check valves	ESF 120 VAC Power, ESF 480 VAC Power	ATWS [(3)]
Diesel Generator Building Ventilation (DGV) Trains A/B/C	Air fans, Motor-operated exhaust louvers, Recirculation dampers, duct work	EDG Div ½/3	LOOP, LEAC
Power Conversion System (PCS):	Main steam lines, Isolation valves, 2 TD reactor feed pumps 1 MD reactor feed pump		Transient, SLOCA, IORV, MLOCA, LOOP, ATWS
Turbine Bypass (TBP - 35% capacity)		Instrument Air	
Main Steam Isolation Valves (MSIVs)			
Feedwater	3 MD condensate booster pumps	Instrument Air	
Condensate	3 MD hotwell pumps	Instrument Air,	
Condensate Transfer Alternate Injection	2 MD condensate transfer pumps	ESF AC Power (RHR dependency), Instrument Air, Condensate Storage Tank (CST)	

Table 2 (Continued)

Affected System	Major Components	Support Systems	Initiating Event Scenarios
Containment Venting 1. Fuel Pool Closed Cooling (FPCC) 2. RHR Containment Spray Venting	Skimmers, Surge tank, Spent fuel pool cooling and cleanup, MOVs Containment spray headers MOVs	ESF AC Power ESF AC Power	Transients, TPCS, SLOCA, IORV, MLOCA, LLOCA, LOOP, LEAC, ATWS
Emergency Pump Room Cooling (EPRC) E12A (LPCI A) E12B (LPCI B) E12C (LPCI C) E21 (LPCS) E22 (HPCS) E51 (RCIC)	MD pumps, MOVs, MD fans	EDG Div 1, ECC Train A EDG Div 2, ECC Train B EDG Div 2, ECC Train B EDG Div 1, ECC Train A Emergency AC Div 3, ESW Train C Emergency AC Div 1, ECC Train A	All
Nuclear Closed Cooling Water (NCCW)	3 MD pumps, MOVs, 3 heat exchangers	AC, Service Water, Instrument Air	LIA

Table 2 (Continued)

Affected System	Major Components	Support Systems	Initiating Event Scenarios
Service Water (SW)	4 MD pumps, MOVs, {4 100% capacity}	Non Class 1E DC, AC	LSW

Notes:

1. The above information is based upon the Perry Response to Generic Letter 88-20, "Individual Plant Examination for Severe Accident Vulnerabilities" submitted to the NRC by letter dated July 15, 1992. Additional information obtained through the NRC site visit and licensee's comments were also incorporated.

2. PSA, Rev. 2 October 1998, CDF 1.57E-5 per reactor year.

3. Licensee indicated that the operation of SPMU is not required for all sizes of LOCAs and all possible scenarios per their calculations.

1.3 SDP WORKSHEETS

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

1. Transients (Reactor Trip) (TRANS)
2. Transients w/o PCS (TPCS)
3. Small LOCA (SLOCA)
4. Inadvertent Opening of a Relief Valve (IORV)
5. Medium LOCA (MLOCA)
6. Large LOCA (LLOCA)
7. Loss Of Offsite Power (LOOP)
8. Anticipated Transients Without a Scram (ATWS)
9. Loss of Instrument Air (LIA)
10. Loss of Service Water (LSW)
11. LOOP with Loss of One EAC (LEAC)
12. Interfacing System LOCA and LOCAs Outside Containment (ISLOCA/LOC).

Table 3.1 SDP Worksheet for Perry Nuclear Power Plant, Unit 1 — Transients (Reactor Trip) (TRANS)

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Power Conversion System (PCS)	½ Turbine Driven feed pumps or 1/1 Motor Driven feed pump if RX pressure > 400 psi and 1/3 hotwell pump, 1/3 condensate booster pumps, and 1 reactor feed booster pump, and 1/ 4 Main Steam lines and 35% Capacity Turbine Bypass and operable condenser (operator action = 2)
High Pressure Core Spray System (HPCS)	HPCS pump (1 train)
Reactor Core Isolation Cooling (RCIC)	RCIC pump (1 ASD train) [(1)]
Depressurization (DEP)	5/19 safety relief valves (SRVs) (auto ADS is inhibited) (operator action = 3) [(2)]
Low Pressure Injection (LPI)	1/3 RHR pumps in LPCI mode (1 multi-train system) or 1/1 LPCS pumps (1 train)
Containment Heat Removal (CHR)	½ RHR pumps in suppression pool cooling (SPC) or containment spray (CS) mode (operator action = 2) [(3)]
Containment Venting (CV)	½ Cont. Venting paths (operator action = 2) [(4)]
Late Depressurization and Inventory Makeup (LDEP)	Depressurization 5/19 SRVs and inject via ½ Condensate Transfer Alternate Injection trains (RX pressure < 75 psi) or fire water cross-tie (RX pressure <120 psig) (operator action = 2) [(5)]

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

3 TRANS - PCS - HPCS - RCIC - LPI (10)			
4 TRANS - PCS - HPCS - RCIC - DEP (11)			
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. Main Feed Water could be used for initial injection if the loss of PCS has not affected that portion of the system. SDP work sheet conservatively assumes that the loss of PCS implies loss of both turbine driven and motor driven feed pump.

2. RPV depressurization during transient is assigned a HEP value of 1.0E-3 in the IPE.

3. The IPE assigns two HEP values for use of RHR for containment pressure control (0.1 for supp. Pool cooling, and 0.01 for the other means). A HEP credit of 2 is given for all means of containment heat removal in the SDP sheet.

4. Licensee used a HEP value of 1E-4 for containment venting, however generic HEP credit of 2 is given for containment venting for the SDP worksheets.

5. The actions required for LDEP is all combined to one "operator action". The Fire water cross tie is quite a demanding operator action which requires local alignment of the valves.

Table 3.2 SDP Worksheet for Perry Nuclear Power Plant, Unit 1 — Transients w/o PCS (TPCS)

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
High Pressure Core Spray System (HPCS)	HPCS pump (1 train)
Reactor Core Isolation Cooling (RCIC)	RCIC pump (1 ASD train) [(1)]
Depressurization (DEP)	5/19 safety relief valves (SRVs) (auto ADS is inhibited) (operator action = 3)
Low Pressure Injection (LPI)	1/3 RHR pumps in LPCI mode(1 multi-train system) or 1/1 LPCS pumps (1 train)
Containment Heat Removal (CHR)	½ RHR pumps in suppression pool cooling (SPC) or containment spray (CS) mode (operator action = 2)
Containment Venting (CV)	½ Cont. Venting paths (operator action = 2)
Late Depressurization and Inventory Makeup (LDEP)	Depressurization (5/19 SRVs) inject via ½ Condensate Transfer Alternate Injection trains (RX pressure < 75 psi) or fire water cross tie (RX pressure <120 psig) (operator action = 2) [2]

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 TPCS - CHR - CV (4,8)			
2 TPCS - HPCS - CHR - LDEP (7)			
3 TPCS - HPCS - RCIC - LPI (10)			

3 TPCS - HPCS - RCIC - DEP (11)			
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 transient event tree is used for this worksheet. Main Feed Water could be used for initial injection if the loss of PCS has not affected that portion of the system. SDP sheet conservatively assumes that the loss of PCS implies loss of both turbine driven and motor driven feed pumps.

2. The actions required for LDEP is all combined to one "operator action". The Fire water cross tie is quite a demanding operator action which requires local alignment of the valves.

Table 3.3 SDP Worksheet for Perry Nuclear Power Plant, Unit 1 — Small LOCA (SLOCA)

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Power Conversion System (PCS)	½ Turbine Driven feed pumps or 1/1 Motor Driven feed pump if Rx pressure > 400 psi and 1 hotwell pump, 1 condensate booster pump and 1 reactor feed booster pump and 1/4 Main Steam lines and 35% Capacity Turbine Bypass and operable condenser (operator action = 2)
High Pressure Core Spray (HPCS)	HPCS pump (1 train)
Reactor Core Isolation Cooling (RCIC)	RCIC pump (1 ASD train)
Depressurization (DEP)	4/19 safety relief valves (SRVs) (operator action = 3)
Low Pressure Injection (LPI)	1/3 RHR pumps in LPCI mode(1 multi-train system) or 1/1 LPCS pumps (1 train)
Containment Heat Removal (CHR)	{½ RHR pumps in suppression pool cooling (SPC) or in containment spray (CS) mode} (operator action = 2) (1)
Containment Venting (CV)	½ Containment Venting paths (operator action = 2) (2)
Late Depressurization (LDEP)	Depressurization (4/19 SRVs) and inject via ½ Condensate Transfer Alternate Injection trains from CST (RX pressure < 75 psi) or fire water cross tie (RX pressure <120 psig) (operator action = 2)

Circle Affected Functions	**Recovery or Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 SLOCA - PCS - CHR - CV (4,8)			
2 SLOCA - PCS - HPCS - CHR - LDEP (7)			
3 SLOCA - PCS - HPCS - RCIC - LPI (10)			

4 SLOCA - PCS - HPCS - RCIC - DEP (11)			
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. Licensee has performed calculations to show that the operation of SPMU dump valves are not required for all possible LOCA scenarios. However, The SPMU dump valves are signaled to open by a LOCA signal in series with 30 minutes timer. During small LOCA the Lo-Lo suppression pool trip is not expected to occur within this time delay.

2. Licensee used a HEP value of 1E-4 for containment venting, however generic HEP credit of 2 is given for containment venting for the SDP worksheets.

Table 3.4 SDP Worksheet for Perry Nuclear Power Plant, Unit 1 — IORV (Inadvertent opening of a Relief Valve)[(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:
Power Conversion System (PCS)	½ Turbine Driven feed pumps or 1/1 Motor Driven feed pump if Rx pressure > 400 psi and 1 condensate pump, 1 condensate booster pump and 1 reactor feed booster pump and 1/4 Main Steam lines and 35% Capacity Turbine Bypass and operable condenser (operator action = 2)
High Pressure Core Spray (HPCS)	HPCS pump (1 train)
Reactor Core Isolation Cooling (RCIC)	RCIC pump (1 ASD train)
Depressurization (DEP)	4/19 safety relief valves (SRVs) (operator action = 3)
Low Pressure Injection (LPI)	1/3 RHR pumps in LPCI mode (1 multi-train system) or 1/1 LPCS pumps (1 train)
Containment Heat Removal (CHR)	{½ RHR pumps in suppression pool cooling (SPC) or in containment spray (CS) mode} (operator action = 2)
Containment Venting (CV)	½ Containment Venting paths (operator action = 2)[(2)]
Late Depressurization (LDEP)	Depressurization (4/19 SRVs) and use of ½ Condensate Transfer Alternate Injection (RX pressure < 75 psi) or fire water cross-tie (RX pressure <120 psig) (operator action = 2)

Circle Affected Functions	Recovery or Failed Train	Remaining Mitigation Capability Rating for Each Affected Sequence	Sequence Color
1 IORV - PCS - CHR - CV (4,8)			
2 IORV - PCS - HPCS - CHR - LDEP (7)			
3 IORV - PCS - HPCS - RCIC - LPI (10)			

3 IORV - PCS - HPCS - RCIC - DEP (11)			

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 small LOCA event tree is used for this SDP sheet. The IORV initiating event frequency is about 0.14 per year based on IPE.

2. Licensee used a HEP value of 1E-4 for containment venting, however generic HEP credit of 2 is given for containment venting for the SDP worksheets.

Table 3.5 SDP Worksheet for Perry Nuclear Power Plant, Unit 1 — 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 (HPCS)	HPCS (1 train)
Depressurization (DEP)	3/19 safety relief valves (SRVs) (auto ADS is inhibited) (operator action = 3) (1)
Low Pressure Injection (LPI)	{[1/3 RHR pumps in LPCI mode] or [1/1 LPCS pumps] or [Injection via ½ Condensate Transfer Alternate Injection if RX pressure <= 75 psi]} (operator action = 2) (2)
Containment Heat Removal (CHR)	{½ RHR pumps in suppression pool cooling (SPC) mode or containment spray (CS) mode (operator action = 2)
Containment Venting (CV)	½ Containment Venting paths (operator action = 2) (3,4)
Late Inventory (LI)	use of ½ Condensate Transfer Alternate Injection (RX pressure < 75 psi) (operator action = 2)

Circle Affected Functions	**Recovery or Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 MLOCA - CHR - CV (3, 6, 11)			
2 MLOCA - HPCS - LPI - LI (8,10)			
3 MLOCA - HPCS - DEP (12)			

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

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

Notes:

1. For a medium LOCA, opening of 3 SRVs is sufficient for emergency depressurization.

2. Condensate Transfer Alternate Injection provides 2,000 gpm @ 75 psig using the Condensate Transfer System (CTS) flush connection to the RHR shutdown cooling to FDW line. This alignment requires one local valve to be operated in the Auxiliary Building. The HEP value for this action could not be found in the IPE.

3. Licensee has performed calculations to show that the operation of SPMU dump valves are not required for all possible LOCA scenarios. However, The SPMU dump valves are signaled to open by a LOCA signal in series with 30 minutes timer. During small LOCA the Lo-Lo suppression pool trip is not expected to occur within this time delay.

4. Licensee used a HEP value of 1E-4 for containment venting, however generic HEP credit of 2 is given for containment venting for the SDP worksheets.

Table 3.6 SDP Worksheet for Perry Nuclear Power Plant, Unit 1 — Large LOCA (LLOCA)

Estimated Frequency (Table 1 Row) ________	**Exposure Time** __________	**Table 1 Result (circle): A B C D E F G H**	
Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**		
Early Containment Control (EC)	Stuck open vacuum breaker (1 train)		
Early Inventory (EIHP)	HPCS (1 train) or 1/3 RHR pumps in LPCI mode (1 multi-train system) or 1/1 LPCS pumps (1 train)		
Containment Heat Removal (CHR)	½ RHR (A or B) pumps in SPC or CS mode (operator action = 2) [(1)]		
Containment Venting (CV)	½ Containment Venting paths (operator action = 2)		
Circle Affected Functions	**Recovery or Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 LLOCA - CHR - CV (3)			
2 LLOCA - EIHP (4)			
3 LLOCA - EC (5)			
Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event:			
If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use.			

Notes:

1. Licensee indicated that the operation of SPMU is not required for all sizes of LOCAs and all possible scenarios per their calculations.

Table 3.7 SDP Worksheet for Perry Nuclear Power Plant, Unit 1 — Loss Of Offsite Power (LOOP)

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Emergency Power Div 1 or Div 2 Dgs (EAC1&2)	½ EDGs (1 multi-train system)
High Pressure Core Spray (HPCS)	HPCS pump (1 train)
Reactor Core Isolation Cooling (RCIC)	RCIC pump (1 ASD train)
Diesel Fire Pump (DFP)	DEP with 5/19 SRVs and 1/1 Diesel Firewater pump to be cross tied for injection (operator action = 2) [1]
Recovery of Offsite Power within 3 Hours (REC3)	Recovery of AC source in less than 3 hrs (operator action = 1) [2]
Recovery of Offsite Power within 7 Hours (REC7)	Recovery of AC source in less than 7 hrs prior to battery depletion (operator action = 2)[3]
Emergency Depressurization (DEP)	DEP with 5/19 SRVs (operator action = 3)
Low Pressure Injection (LPI)	1/3 RHR pumps in LPCI mode(1 multi-train system) or 1/1 LPCS pumps (1 train)
Containment Heat Removal (CHR)	½ RHR (A or B) pumps in SPC or CSC mode (operator action = 2)
Containment Venting (CV)	½ Containment Venting paths (operator action = 2)
Late Depressurization and Inventory Makeup (LDEP)	Depressurization (5/19 SRVs) and inject via fire water cross tie (RX pressure <120 psig) (operator action = 2)

Circle Affected Functions:	**Recovery or Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 LOOP - HPCS - RCIC - LPI (1)			

2 LOOP - HPCS - RCIC - DEP (1)			
3 LOOP - HPCS - CHR - LDEP (1,11)			
4 LOOP - CHR - CV (1, 4, 8,12)			
5 LOOP - EAC - REC7 (5, 13)			
6 LOOP - EAC - HPCS - DFP - REC3 (14)			
7 LOOP - EAC - HPCS - RCIC[(4)] (15)			

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

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

Notes:

1. The Fire Water Cross-Tie provides 100 gpm @ 120 psig or 800 gpm @20 psig using the ESW cross-tie into the RHR B Shutdown Cooling to Feedwater line. The alignment requires several local valves to be operated. This action is only credited if RCIC is initially available. The IPE HEP value for this action varies from 5E-2 to 5E-3. A HEP credit of 2 is given in the SDP worksheet. Fire water can also be cross-tied to the HPCS injection line.

2. After 3 hours without offsite power and failure of the Division 1 and 2 EDGS, if HPCS has failed but RCIC has operated successfully, the suppression pool temperature limit of 185°F will be exceeded and RCIC fails so that offsite power must be recovered or the fire water Cross-tie using the diesel fire pump successfully established. The recovery of offsite power or some source of AC is designated as a human action with HEP credit of 1. The IPE value for recovery of offsite power or an AC source in 3 hours is 0.08.

3. After 7 hours without offsite power, the station batteries fail so that emergency depressurization is no longer possible since the SRVs depend on DC power. This recovery is designated as an operator action with a credit of 2 in the SDP worksheet.

4. After 0.4 hours (24 minutes) without offsite power and failure of the Division 1 and 2 EDGs, if HPCS and RCIC both fail to provide reactor pressure vessel level control, the reactor must be depressurized using 5 of 19 SRVs to permit use of the diesel fire pump as a RPV injection source through the fire water cross-tie. The SDP sheet does not credit this success path. The use of the diesel driven fire pump is only credited in SBO scenarios where RCIC operated successfully and AC was not restored in three hours.

Table 3.8 SDP Worksheet for Perry Nuclear Power Plant, Unit 1 — 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)	19/19 SRVs (1 train system) (1)
Recirculation Pump Trip (RPT)	Manual or automatic trip of recirculation pumps (1 multi-train system)
Feedwater (FW)	{[1/1 Motor FW Pump or ½ Turbine FW Pumps] and 1 hotwell pump and 1 condensate booster pump and 1 feedwater booster pump and, 1/4 Main Steam lines and 35% Capacity Turbine Bypass and operable condenser}(operator action = 2) (2)
Inhibit ADS and HPCS and Perform Lvl Control (INH)	Operator inhibits ADS and HPCS and controls RPV level (operator action = 2) (3)
Reactivity Control and Level Control (SLC)	½ SLC pumps and valves (operator action = 1) (4)
Depressurization (DEP)	8/19 SRVs (operator action = 2) (5)
Suppression Pool Makeup (SPMU)	½ suppression pool make up train (1 multi-train system)
Low Pressure Injection (LPI)	1/3 RHR pumps in LPCI mode (1 multi-train system) or 1/1 LPCS pumps} (1 train) (6)
Containment Heat Removal (CHR)	½ RHR (A or B) pumps in SPC or CSC mode (operator action = 2) or ½ Containment Venting paths (operator action = 1)

Circle Affected Functions:	**Recovery or Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 ATWS - SLC (2, 8)			
2 ATWS - FW - CHR (4)			

3 ATWS - FW - LPI (5)			
4 ATWS - FW - SPMU (6)			
5 ATWS - FW - DEP (7)			
6 ATWS - FW - INH (9)			
7 ATWS - RPT (10)			
8 ATWS - OVERP (11)			

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

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

Notes:

1. For an ATWS, SRVs are required to cycle as necessary to prevent RPV overpressurization. Operation of all SRVs are required per Licensee comment to prevent the early pressure peak due to most sever ATWS scenario. If emergency depressurization is required, then conservatively eight (8) of 19 SRVs are necessary for success. The eight SRVs assumed required for depressurization is based on a conservative estimate that at the top of active fuel (TAF) with RPT, the power level is approximately 20%.

2. For an ATWS, the Turbine Driven Feed Pumps are potentially available if offsite AC power and PCS are available and the MSIVs are open. The Motor Feed Pump is available if offsite power is available.

3. The HEP value in the IPE for operator fails to Inhibit ADS in ATWS scenarios varies from 3.6E-2 to 3.8 E-3. A HEP credit of 2 is assigned in the SDP worksheet.

4. IPE assigns HEP values of 1.25E-3 for SLC initiation and 5E-2 for level control and maintaining Boron inventory. A HEP credit of 1 is given in the SDP worksheet.

5. The HEP value in the IPE for operator failure to perform emergency depressurization during ATWS is 1.4E-2.

6. For an ATWS, LPCI flow is directed through the Feedwater Return throttle valve to inject outside the shroud.

Table 3.9 SDP Worksheet for Perry Nuclear Power Plant, Unit 1 — Loss Of Instrument Air (LIA)(1)

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

<u>**Safety Functions Needed:**</u>	<u>**Full Creditable Mitigation Capability for Each Safety Function:**</u>
High Pressure Core Spray (HPCS)	HPCS pump (1 train)
Reactor Core isolation Cooing (RCIC)	Turbine Driven RCIC pump (1 ASD train)
Depressurization (DEP)	5/19 safety relief valves (SRVs) (auto ADS is inhibited) (operator action = 3)
Low Pressure Injection (LPI)	1/3 RHR pumps in LPCI mode (1 multi-train system), 1/1 LPCS pump (1 train), or Injection via ½ Feed booster pump alternate injection (operator action = 1)
Containment Heat Removal (CHR)	½ RHR pumps in suppression pool cooling (SPC) or containment spray (CS) mode (operator action = 2)
Containment Venting (CV)	½ Containment Venting paths (operator action = 2)

<u>**Circle Affected Functions**</u>	<u>**Recovery of Failed Train**</u>	<u>**Remaining Mitigation Capability Rating for Each Affected Sequence**</u>	<u>**Sequence Color**</u>
1 LIA - CHR - CV (3)			
2 LIA - HPCS - CHR (5,9)			
3 LIA - HPCS - RCIC - LPI (7)			
4 LIA - HPCS - RCIC - DEP (8)			

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

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

Note:

1. Upon loss of instrument air, plant scram is expected as a result of either MSIV closure or high water level in scram discharge volume (closure of vent and drain valves). The early depressurization is available due to back up air accumulators but late depressurization is not credited. The frequency of Loss of Instrument air is estimated to be 9.2E-2.

Table 3.10 SDP Worksheet for Perry Nuclear Power Plant, Unit 1 — Loss of Service Water (LSW)[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 Pressure Core Spray (HPCS)	HPCS pump (1 train)
Reactor Core Isolation Cooling (RCIC)	RCIC pump (1 ASD train)
Depressurization (DEP)	5/19 safety relief valves (SRVs) (auto ADS is inhibited) (operator action = 3)
Low Pressure Injection (LPI)	1/3 RHR pumps in LPCI mode (1 multi-train system) or 1/1 LPCS pump (1 train)
Containment Heat Removal (CHR)	½ RHR pumps in suppression pool cooling (SPC) or containment spray (CS) mode (operator action = 2)
Containment Venting (CV)	½ Containment Venting paths (operator action = 2)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 LSW - CHR - CV(3)			
2 LSW -HPCS -CHR (5,9)			
3 LSW - HPCS - RCIC - LPI (7)			
4 LSW - HPCS - RCIC - DEP (8)			

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

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

Note:

1. Loss of SW will result in loss of steam tunnel cooling which in turn causes the reactor scram and MSIV closure and in 30 minutes RCIC isolation. If loss of SW is not recovered shortly would result in loss of Instrument air and the consequences as defined in the previous sheet. The frequency of LSW is 1.0E-3 per the IPE. The event tree of loss of instrument air is used for this SDP worksheet.

Table 3.11 SDP Worksheet for Perry Nuclear Power Plant, Unit 1 — LOOP with Loss of One EAC (LEAC)(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 Pressure Core Spray (HPCS)	HPCS pump (1 train)
Reactor Core Isolation Cooling (RCICS)	RCIC pump (1 ASD train)
Depressurization (DEP)	5/19 safety relief valves (SRVs) (auto ADS is inhibited) (operator action = 3)
Low Pressure Injection (LPI)	½ pumps in LPCI mode (1 multi-train system)
Containment Heat Removal (CHR)	1/1 RHR pumps in suppression pool cooling (SPC) or containment spray (CS) mode (operator action = 2)
Containment Venting (CV)	½ Cont. Venting paths (operator action = 2)
Late Inventory Makeup (LDEP)	Depressurization (5/19 SRVs) fire water cross-tie (RX pressure < 120 psig) (operator action = 2)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 LEAC - CHR - CV (4,8)			
2 LEAC - HPCS - CHR - LDEP (7)			
3 LEAC - HPCS - RCIC - LPI (10)			
4 LEAC - HPCS - RCIC - DEP (11)			

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 initiator is LOOP with loss of emergency AC bus (or the associated EDG). Division 1 of EAC is selected for the purpose of this SDP sheet which affects LPCIA and LPCS among one train of all other AC driven safety systems. Division 2 of EAC would have affected two trains of LPCI but not LPCS. The event tree used for this SDP worksheet is the same as that of the transient. LOOP with loss of one DC is not considered significant since this is a three division design in emergency DC system. The transient event tree is used for this SDP worksheet.

Table 3.12 SDP Worksheet for Perry Nuclear Power Plant, Unit 1 — Interfacing System LOCA and LOCAs Outside Containment (ISLOCA/LOC)(1)

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**
Main Steam Lines	4 lines each with 2 MSIVs fail to close (1B21-F022 A,B,C,D and 1B21-F028 A,B,C,D)
MSIV	2 NC inboard MOV drains and 4 NC outboard MOVs (fail to remain close)
RCIC Injection Line (water side)	Two Check valves1E51-FO65, and 1E51-F066 fail to prevent backflow
RCIC (Steam side) and RHR - Steam Condensing	2 NO MOVs fail to close (1E51-F063 and 1G33-F004)
HPCS	A check valve fails to prevent back flow (1E22-F005) and a NC MOV fails to remain closed (1E22-F004)
Feedwater Lines	2 feedwater lines each with two check valves to prevent back flow (1N27-F559A,B and 1B21-FO32A,B)
SLC	Two check valves fail to prevent back flow (1C41-F006, 7)
Reactor Water Clean up (RWCU)	2 NO MOVs fail to close

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.

Note:

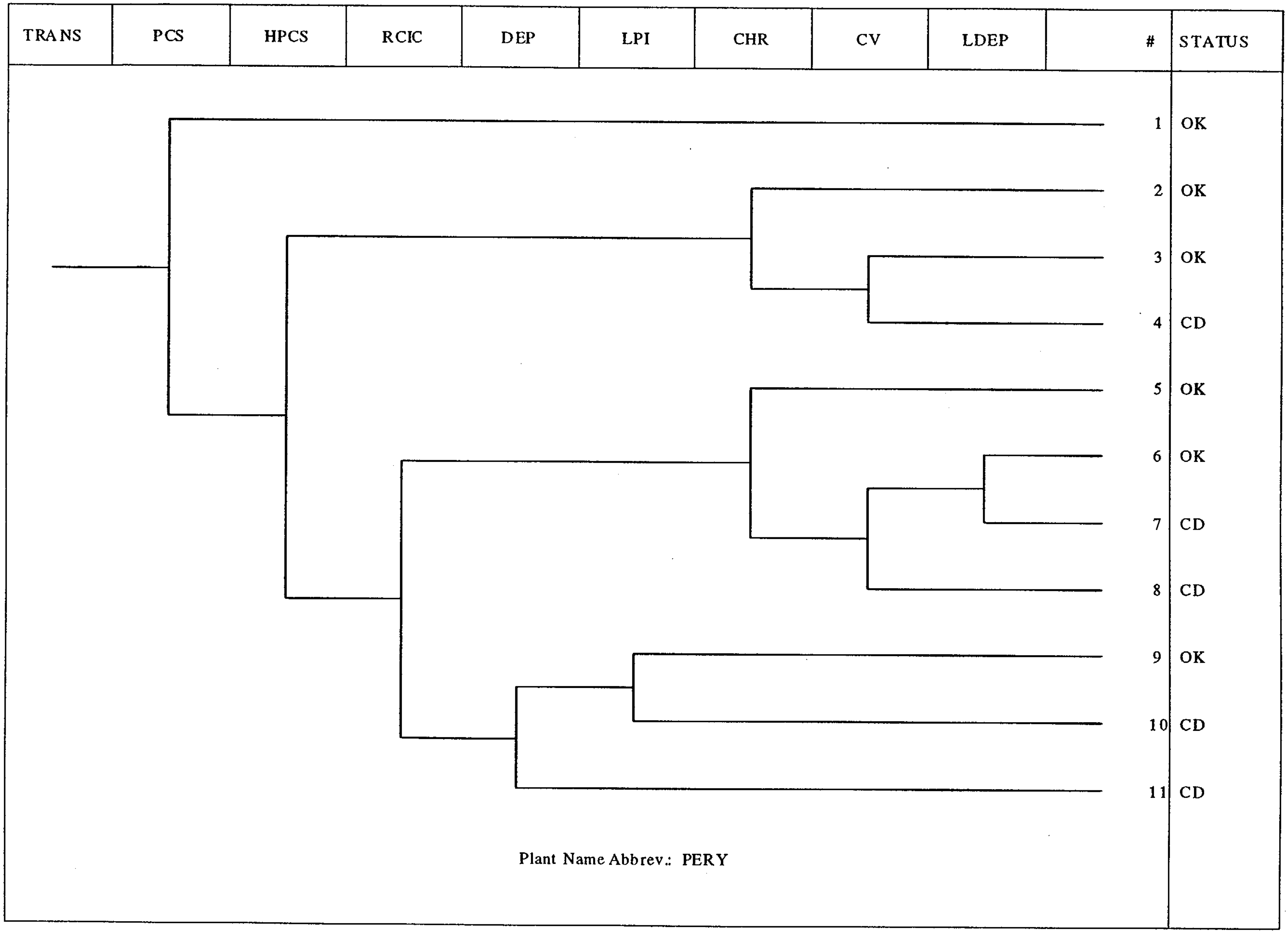
1. The ISLOCA paths identified in this sheet is based on the information provided in the IPE document Table 3.1.1-4 (July 15, 1992). Failure of the valves identified in the path by itself may not result in ISLOCA unless is accompanied by piper break. The ISLOCA contribution in this plant was not significant contribution to plant core damage frequency, therefore detail information was not available on scenario propagation.

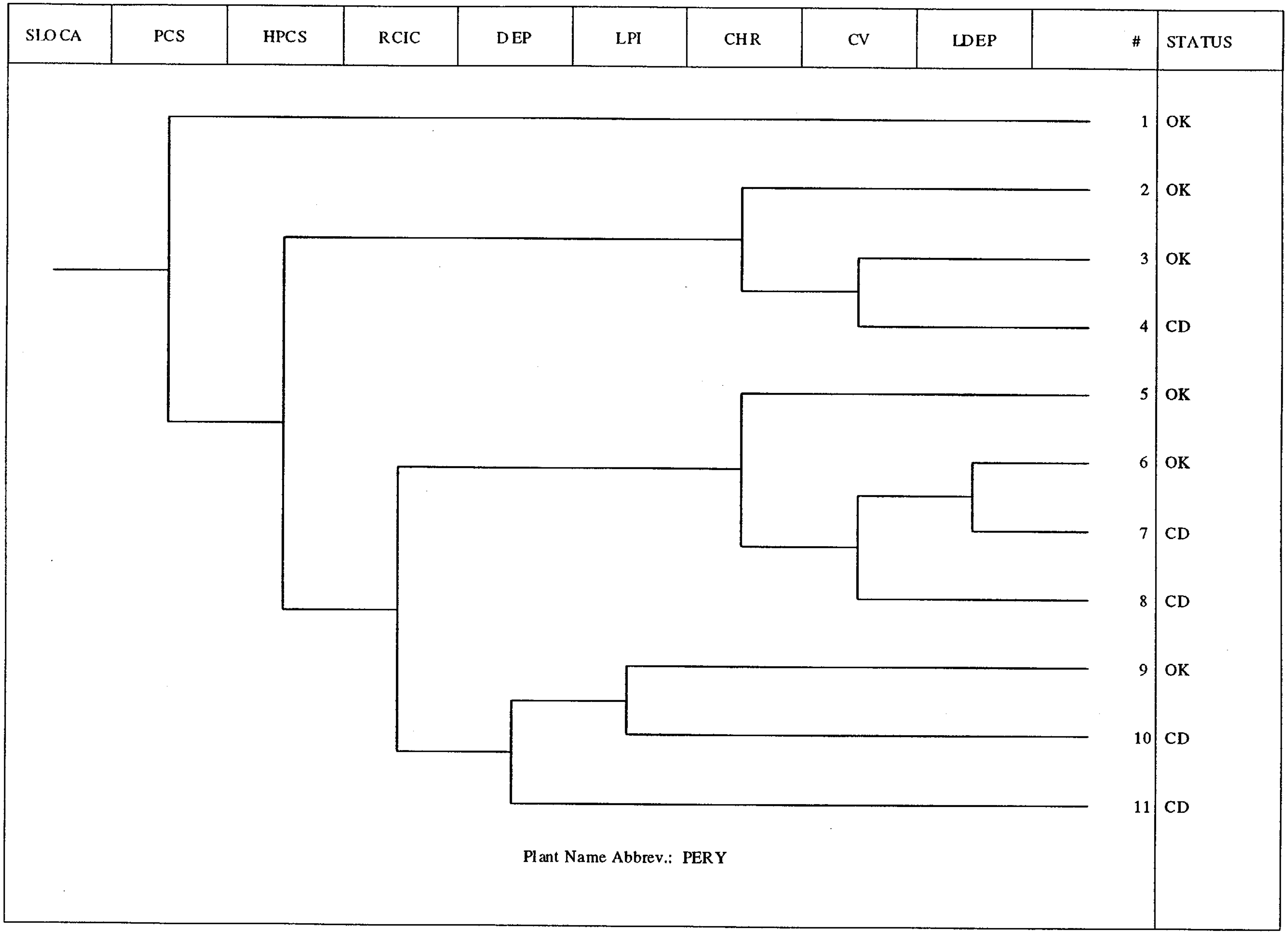
1.4 SDP Event Trees

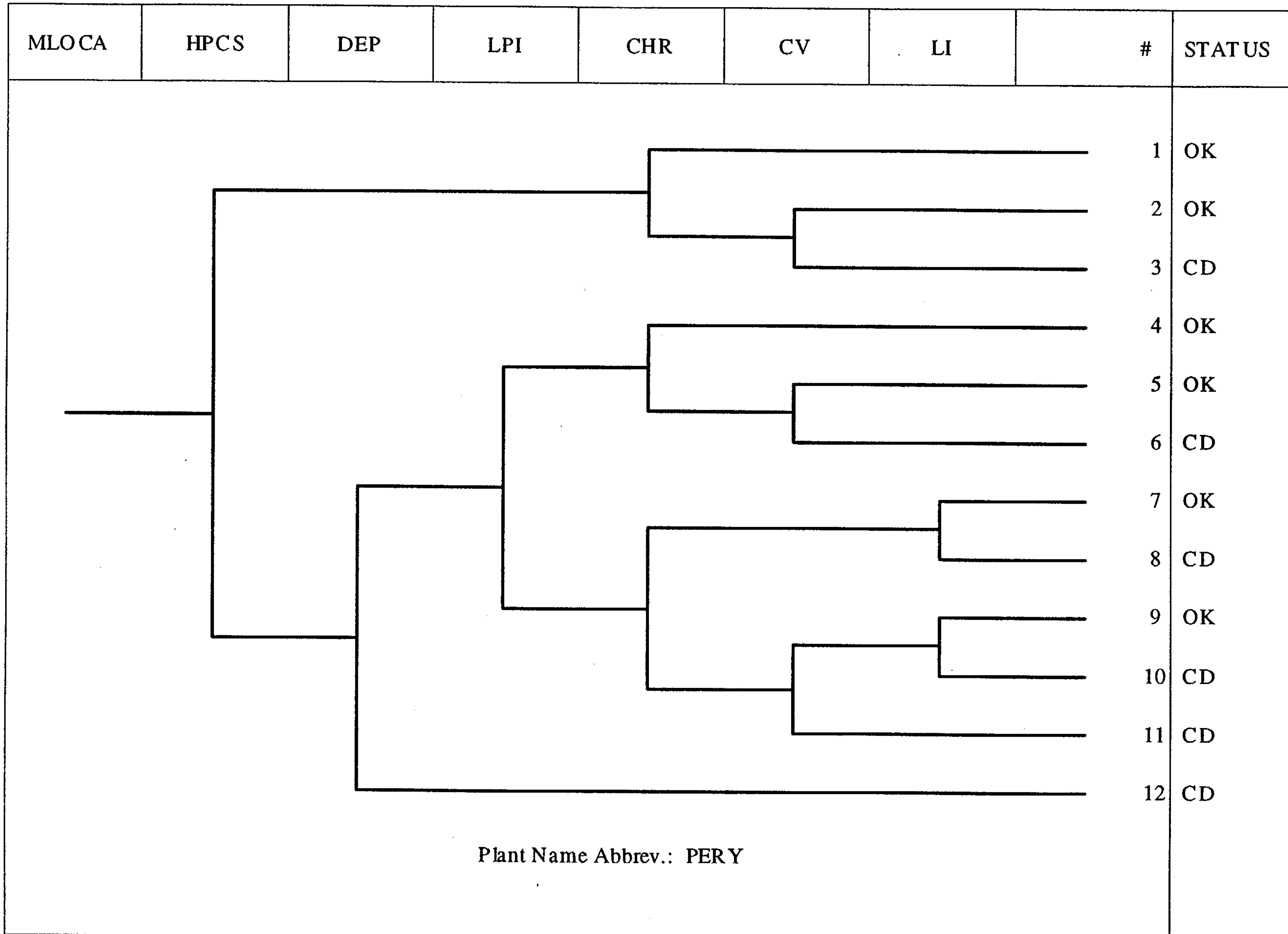
This section provides the simplified event trees, called SDP event trees, used to define the accident sequences identified in the SDP worksheets in the previous section. The event tree headings are defined in the corresponding SDP worksheets.

The following event trees are included:

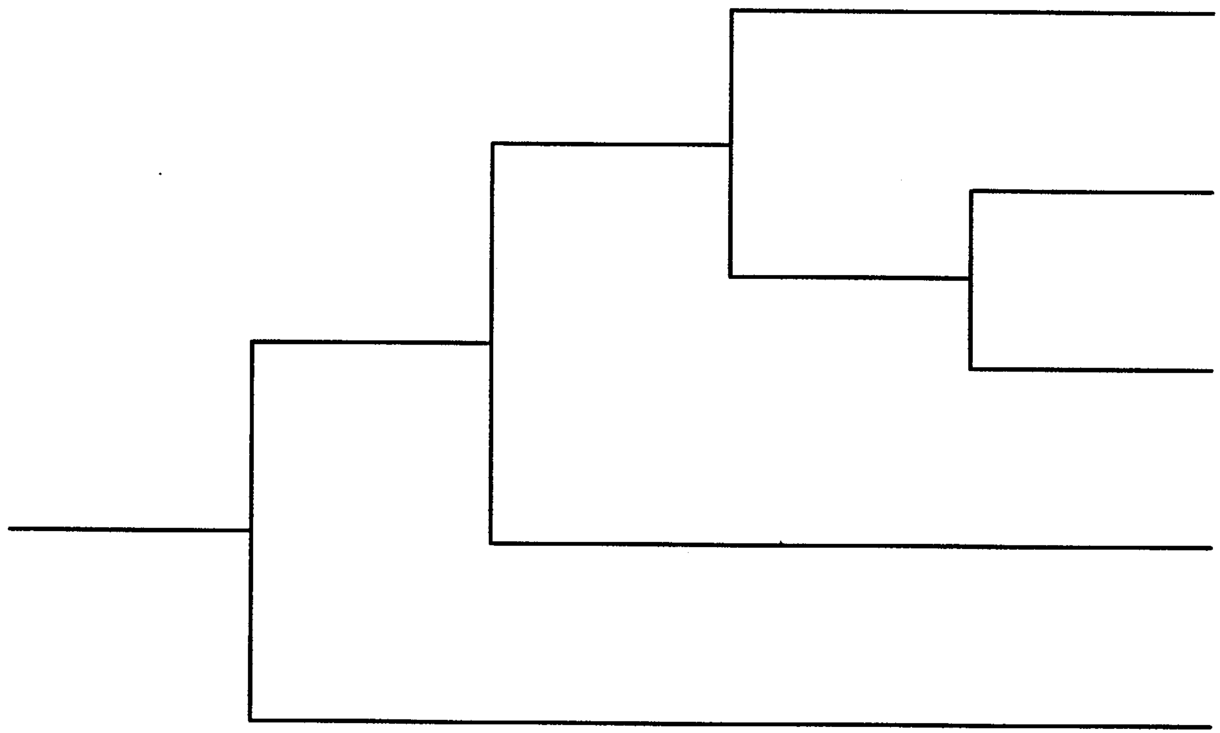
1. Transients (Reactor Trip) (TRANS)
2. Small LOCA (SLOCA)
3. Medium LOCA (MLOCA)
4. Large LOCA (LLOCA)
5. Loss of Offsite Power (LOOP)
6. Anticipated Transients Without Scram (ATWS)
7. Loss of Instrument Air (LIA)


TRANS
PCS
HPCS
RCIC
DEP
LPI
CHR
CV
LDEP
#
STATUS
1 OK
2 OK
3 OK
4 CD
5 OK
6 OK
7 CD
8 CD
9 OK
10 CD
11 CD
Plant Name Abbrev.: PERY

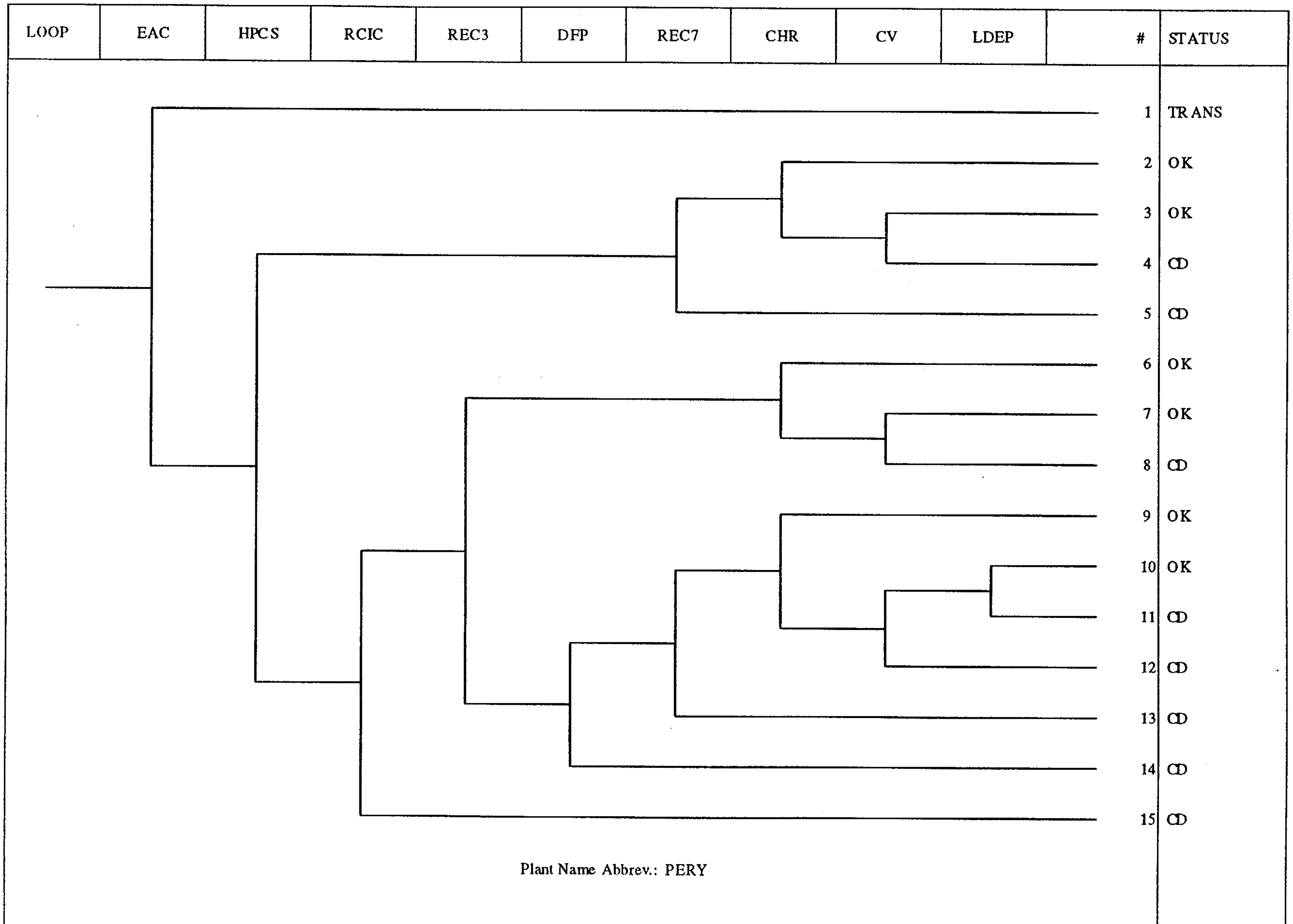

SLOCA
PCS
HPCS
RCIC
DEP
LPI
CHR
CV
LDEP
#
STATUS
1 OK
2 OK
3 OK
4 CD
5 OK
6 OK
7 CD
8 CD
9 OK
10 CD
11 CD
Plant Name Abbrev.: PERY

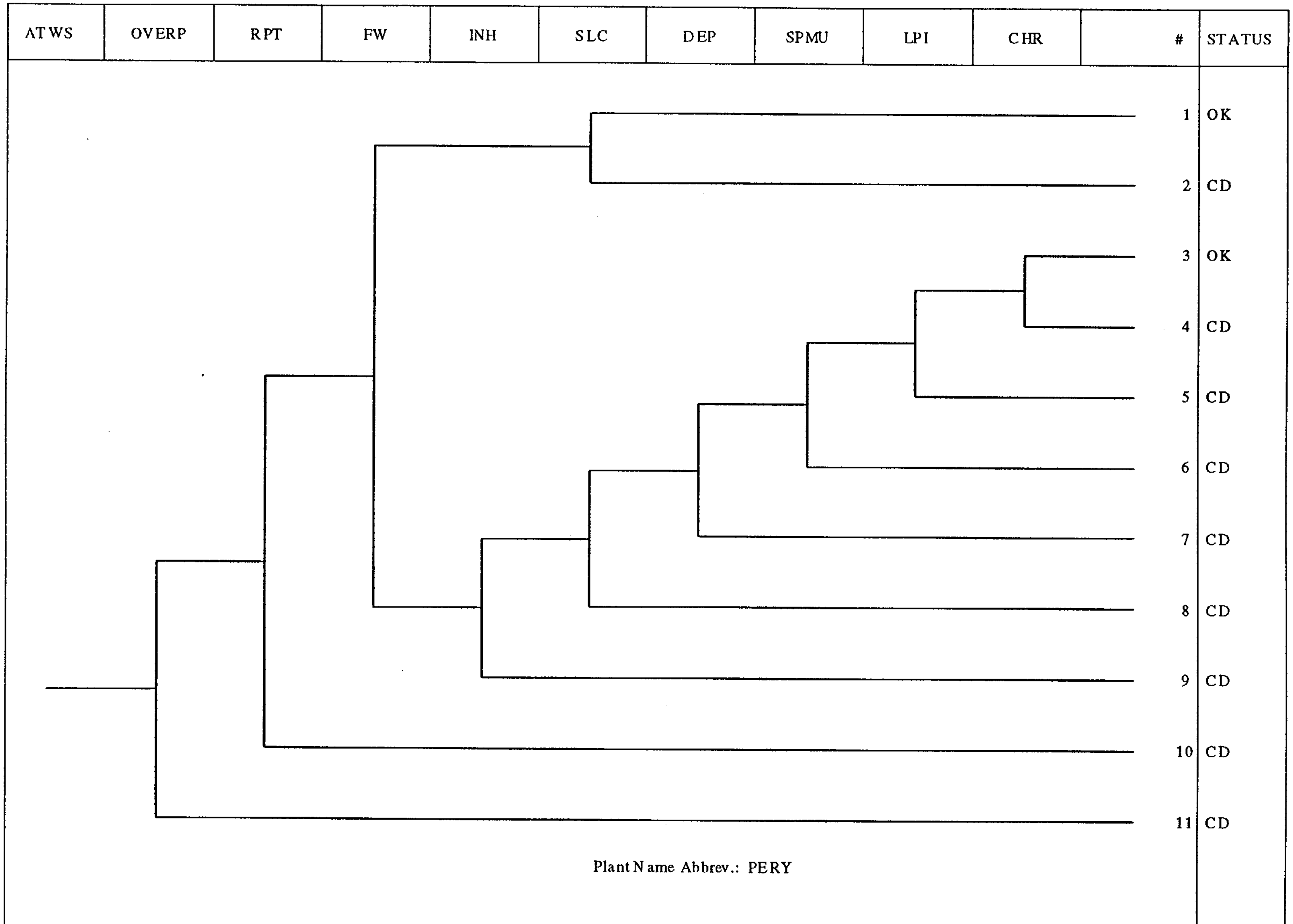

MLOCA
HPCS
DEP
LPI
CHR
CV
LI
#
STATUS
1 OK
2 OK
3 CD
4 OK
5 OK
6 CD
7 OK
8 CD
9 OK
10 CD
11 CD
12 CD
Plant Name Abbrev.: PERY

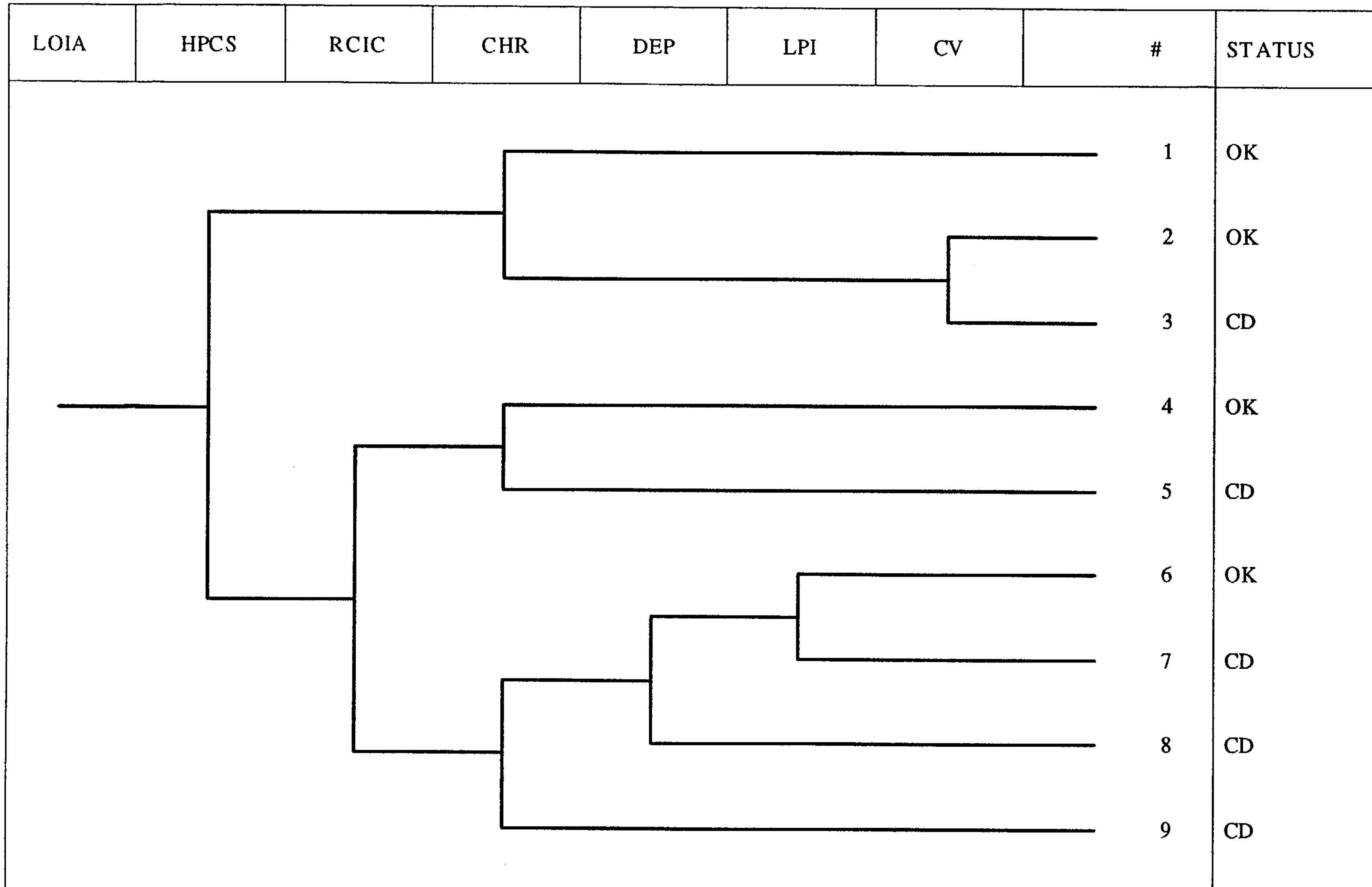
LLOCA	EC	EIHP	CHR	CV	#	STATUS
					1	OK
					2	OK
					3	CD
					4	CD
					5	CD



Plant Name Abbrev.: PERY


LOOP
EAC
HPCS
RCIC
REC3
DFP
REC7
CHR
CV
LDEP
#
STATUS
1 TRANS
2 OK
3 OK
4 CD
5 CD
6 OK
7 OK
8 CD
9 OK
10 OK
11 CD
12 CD
13 CD
14 CD
15 CD
Plant Name Abbrev.: PERY


ATWS
OVERP
RPT
FW
INH
SLC
DEP
SPMU
LPI
CHR
#
STATUS
1 OK
2 CD
3 OK
4 CD
5 CD
6 CD
7 CD
8 CD
9 CD
10 CD
11 CD
Plant Name Abbrev.: PERY



Plant Name Abbrev.: PERY

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

The Licensee has provided useful comments on the draft worksheets. The scope of licensee's comments included annotated comments on the draft SDP report, event trees for special initiators, and information on HEP values as denoted on the branches of the event trees. Licensee provided up to date event trees, and dependency matrix. 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 worksheets.

1. Passive failure of vapor suppression (EC) in Large LOCA was retained to assure consistency with other similar plants.

4. Additional clarification of success criteria were requested from the licensee through a conference call which took place during the week of January 8, 2001. The requested information were in regard of two areas:

    a) The success criteria on the number of SRVs required to overcome the early pressure peak in worst ATWS scenario. The licensee responded that 19 out of 19 is required.
    b) The success criteria for Suppression Pool Make Up (SPMU) was also requested. Licensee indicated that per their in-house analysis the operation of SPMU is not required for all sizes of LOCAs and all possible scenarios.

5. The licensee have provided separate event trees for Loss Of Offsite Power (LOOP), Station Black Out (SBO), and Transient with loss of PCS with one or two SRV stuck open. Per SDP work sheet guideline, separate event trees and work sheets have not been developed in this document. The significance of the mitigating systems involved in these event trees could be captured by the IORV, LOOP, and LEAC work sheets.

REFERENCES

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

2. Cleveland Electric Illuminating Company, "Perry Unit 1 – Individual Plant Examination Report," dated July, 1992.