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

February 20, 2001

Mr. William A. Eaton
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SUBJECT: GRAND GULF NUCLEAR STATION, UNIT 1 - SITE-SPECIFIC WORKSHEETS FOR USE IN THE NUCLEAR REGULATORY COMMISSION'S SIGNIFICANCE DETERMINATION PROCESS (TAC NO. MA6544)

Dear Mr. Eaton:

Enclosed to this letter is the site-specific Risk-Informed Inspection Notebook for Grand Gulf Nuclear Station, Unit 1 (GGNS). The notebook incorporates the updated Significance Determination Process (SDP) Phase 2 Worksheets that our inspectors will be using to characterize and risk-inform inspection findings. This document is a key implementation tool within the reactor safety SDP in the reactor oversight process. The notebook is publically available through the Nuclear Regulatory Commission (NRC) Agencywide Documents Access and Management System.

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. A subsequent site visit was conducted by the NRC to verify and update plant equipment configuration data and to collect site-specific risk information from your staff. The enclosed document reflects the results of this visit.

The Phase 2 Worksheets, contained within the enclosure, have incorporated much of the information we obtained during our site visits. While the Phase 2 Worksheets have been verified by our staff to include the site-specific data that we have collected to date, we will continue to assess their accuracy as they are used and will update them based on comments by our inspectors and your staff.

The staff encourages you to provide additional comments if you identify areas for which the Phase 2 Worksheets give inaccurate (high or low) significance determinations. Any written comments may be provided in accordance with 10 CFR 50.4, "Written communications" with copies to the Chief, Probabilistic Safety Assessment Branch, Office of Nuclear Reactor Regulation (NRR), and Chief, Inspection Program Branch, NRR. We will continue to assess SDP accuracy and update the document based on continuing experience with the program.

We will coordinate our efforts through your licensing or risk organizations as appropriate. If you have any questions, please contact me at 301-415-2623.

Sincerely,

S. Patrick Sekerak

S. Patrick Sekerak, Project Manager, Section 1
Project Directorate IV & Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-416

Enclosure: As stated

cc w/o encl: See next page

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/RA/

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RISK-INFORMED INSPECTION NOTEBOOK FOR

GRAND GULF NUCLEAR STATION

UNIT 1

BWR-6, GE, WITH MARK III CONTAINMENT

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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 Grand Gulf Unit 1 Nuclear Station.

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

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

CONTENTS

TABLES

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 (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 Grand Gulf Unit 1 Nuclear Station .

1.1 INITIATING EVENT LIKELIHOOD RATINGS

Table 1 presents the applicable initiating events for this plant and their estimated likelihood ratings corresponding to the exposure time for degraded conditions. The initiating events are grouped into rows based on their frequency. As mentioned earlier, loss of offsite power 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 Grand Gulf Unit 1 Nuclear Station

Row	Approximate Frequency	Example Event Type	Estimated Likelihood Rating		
I	> 1 per 1-10 yr	Reactor Trip (TRANS), Loss of Power Conversion System (TPCS) includes; Loss of condenser, Closure of MSIVs, Loss of feedwater, etc.	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	Loss Of Instrument Air (LOIA), Loss of ESF AC division 1 or 2 (LAC1 or LAC2), Loss of ESF DC division 1or 2 (LDC1 or LDC2)	C	D	E
IV	1 per 10^3 - 10^4 yr	Small LOCA (SLOCA), Medium LOCA (MLOCA), Loss of Plant Service Water with Failure to align SSW B to CCW heat exchanger (LPSW)	D	E	F
V	1 per 10^4 - 10^5 yr	Large LOCA (LLOCA), ATWS	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).

Grand Gulf I - 7 - Rev. 0, Jan. 2, 2001

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 Grand Gulf Unit I

Affected System	Major Components	Support Systems	Initiating Event Scenarios
Reactor Vessel Depressurization System ADS/SRVs	Self-actuating and power-operated safety relief valves 8 ADS/SRV and 12 SRVs	Divisions 1 & 2 ESF 125 V-DC; Primary air supply by accumulators, Instrument Air System maintains air pressure normally - IA backed up by Nitrogen bottle connections	Transient, TPCS, LOOP, IORV, SLOCA, MLOCA, ATWS, LOIA, LAC1, LAC2, LPSW, LDC1, LDC2
Control Rod Drive Hydraulic System (CRDH)	Two CRD MD pumps and piping	Division 1 &2 ESF 4160 V AC, BOP AC, Divisions 1 and 2 ESF DC, CCW, Instrument Air (required for enhanced flow mode only 2/2 pumps)	Transient, TPCS, LOOP, LPSW
Standby Liquid Control (SLC)	Two SLC MD pumps and explosive valves	Division 1 & 2 ESF 480 VAC	ATWS
RHR/ LPCI Residual Heat Removal/ (Low Pressure Coolant Injection) Trains A, B, and C	Three RHR MD pumps A, B, and C, MOVs, heat exchangers for trains A and B	Divisions 1 &2 Engineered Safety Features (ESF) 4160 VAC and 480 VAC and 125 VDC Div I to LPCI Train A, Div II to Trains B and C, SSW Train A to LPCI Train A, SSW Train B to LPCI Trains B and C, Level instrumentation for auto actuation, SPC or CS needed to maintain NPSH for LLOCA & MLOCA	Transient, TPCS, SLOCA, IORV, MLOCA, LLOCA, LOOP, ATWS, LPSW, LAC1, LDC1, LAC2, LDC2
RHR/SPC (Suppression Pool Cooling) Trains A and B	Two MD Pumps A and B, MOVs, heat exchangers	Divisions 1 &2 ESF 4160 V-AC and 480 V-AC, ESF 125 V-DC, SSW	All
RHR/CS (Containment Spray) Trains A and B	Two MD Pumps A and B, MOVs, heat exchangers	Divisions 1 & 2 ESF 4160 VAC and 480VAC, ESF 125 VDC, SSW	All
Low Pressure Core Spray (LPCS)	one MD Pump, MOVs	Division 1 ESF4160 VAC and 480 VAC, ESF DC Div I, ECCS Pump Room HVAC (pump can operate approximately 10 to 12 hours without HVAC), Level instrumentation for auto actuation, SPC or CS needed to maintain NPSH for LLOCA & MLOCA	All

Table 2 (Continued)

Affected System	Major Components	Support Systems	Initiating Event Scenarios
High Pressure Core Spray (HPCS)	One MD pump, MOVS	Division 3 ESF 4160 VAC and 480 VAC, ESF DC Div III, ECCS Room HVAC, Level instrumentation for auto actuation, SPC or CS needed to maintain NPSH for LLOCA & MLOCA	All
Suppression Pool Makeup (SPMU)	Two trains of two MOVs per train	ESF AC, ESF DC , Vessel level and drywell pressure instrumentation for auto actuation	SLOCA, IORV, MLOCA, LLOCA
Reactor Core Isolation Cooling (RCIC)	One TD pump, MOVs	ESF DC Div I, ESF DC Div II (for redundant actuation logic and Level 8 protection instrumentation) (Steam tunnel cooling not required based on new calculation)	Transient, TPCS, SLOCA, IORV, LOOP, LOIA, LAC1, LAC2, LDC2, LPSW
DC Power System ESF DC BOP DC	Divs. 1, 2, and 3 DC Power buses, BOP DC Power buses, batteries	ESF Power and Distribution BOP Power and Distribution	All
Power Conversion System (PCS)	35% capacity turbine bypass, 4 main steam lines, two MSIVs per line, two TD feedwater pumps, three MD condensate pumps, three MD condensate booster pumps	500 KV (offsite power), 120 VAC (non class 1E), 480 VAC (non class 1E), Turbine Building Cooling Water (TBCW), Circulating Water, Instrument Air, Steam Tunnel HVAC	Transient, TPCS, SLOCA , IORV, ATWS
Containment Venting	4 AOVs	120 VAC ESF, 125 VDC ESF, Instrument Air	ATWS (Not Needed for Core damage prevention in other initiators)
Standby Service Water (SSW) A, B, and C	Three MD pumps, headers, MOVs	ESF AC and ESF DC Div I to SSW A, Div II to SSW B, Div III to SSW C, SSW pump house ventilation (Div 1 to SSW-A and C, Div 2 to SSW-B)	All
SSW / RHR X-TIE	One train of MOVs	ESF AC Div II, SSW Train B, Applicable portion of RHR B	All except LDC2, and LAC2

Table 2 (Continued)

Affected System	Major Components	Support Systems	Initiating Event Scenarios
Component Cooling Water (CCW)	Three MD pumps, headers, MOVs	ESF AC Div 2 (Train B CCW pump), BOP AC, ESF DC Div2 (Train B CCW pump), BOP DC (DC required to start pumps - pumps normally operating - DC not modeled), SSW B (alternate source of cooling water under certain conditions), PSW	Transient, TPCS, LOOP, LOIA, LAC1, LDC1, LAC2, LDC2, LPSW
Turbine Building Cooling Water (TBCW)	Three MD pumps, headers, MOVs	BOP AC, BOP DC (DC required to start standby pump), PSW	Transient, SLOCA, IORV, ATWS
Plant Service Water (PSW)	8 MD pumps	ESF AC, BOP AC, ESF DC, BOP DC (DC required to start pumps - pumps normally operating - DC not modeled), Instrument Air	LPSW
Instrument Air / Service Air (IA/SW)	2 MD centrifugal compressors, dryers	ESF Divisions 1 &2 AC Power, BOP AC Power, ESF Divisions 1 & 2 DC Power, BOP DC Power, TBCW, SSWB (unit 1 IA compressor)	LOIA
Fire Water Injection	One MD pump, two DD pumps	ESF AC Div 1& 2 , ESF DC Div 1 & 2 (for auxiliary building isolation), BOP AC, Instrument Air, manual action	Transient, TPCS, SLOCA, IORV, MLOCA, LOOP
AC Power System	Three EDG, busses, two ESF transformers, 8 BOP transformers	ESF 125V-DC, SSW, EDG/ Switch gear HVAC	All
DG Rooms HVAC	One Fan per room, inlet and outlet dampers	ESF AC Div I, II, and III	LOOP
SSW Pump House HVAC (Trains A and B)	Two trains in "A" Room (Divisions 1 & 2), one Fan for "B" room , inlet and outlet dampers	ESF AC Div I and II to Train A, Div II to Train B	All

Table 2 (Continued)

Affected System	Major Components	Support Systems	Initiating Event Scenarios
ECCS Pump Rooms HVAC	Fan coil units with SSW cooling water	ESF AC Divs 1 and 3, SSW Trains A and C	All

Notes:

1. The above information is based upon the GGNS Response to Generic Letter 88-20, "Individual Plant Examination for Severe Accident Vulnerabilities" submitted to the NRC by letter dated December 23, 1992, and supplemental information provided by the Licensee based on the updated IPE.

2. The overall core damage frequency for internal events and flooding is 1.72E-5 per reactor-year based on the December 23, 1992 IPE submittal

3. Both the LPCI and HPCS pumps are capable of pumping saturated condition at atmospheric pressure. So neither failure of suppression pool or success of containment venting could impact their operation.

1.3 SDP WORKSHEETS

This section presents the SDP worksheets to be used in the Phase 2 evaluation of the inspection findings for the Grand Gulf Unit I Nuclear Station. 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 SRV (IORV)
5. Medium LOCA (MLOCA)
6. Large LOCA (LLOCA)
7. Loss of Off-site Power (LOOP)
8. Anticipated Transients Without Scram (ATWS)
9. Loss of Instrument Air (LOIA)
10. Loss of ESF DC Bus 11DA Div-1 (LDC1)
11. Loss of ESF DC Bus 11DB Div-2 (LDC2)
12. Loss of ESF AC Bus 15AA Div-1 (LAC1)
13. Loss of ESF AC Bus 15AB Div-2 (LAC2)
14. Loss of Plant Service Water with Failure to Align SSW "B" to CCW Heat Exchangers (LPSW)
15. Interfacing System LOCA (ISLOCA)

Table 3.1 SDP Worksheet for Grand Gulf Unit I — Transients (Reactor Trip) (TRANS)

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

Safety Functions Needed:	**Full Creditable Mitigation Capability for Each Safety Function:**
Power Conversion System (PCS)	1/2 Feedwater pumps and 1/3 Condensate/Condensate Booster pump combinations and 1/4 MS lines with the condenser and turbine bypass (operator action = 2)
Early Inventory Control High Pressure Core Spray (HPCS)	HPCS (1 train)
Early Inventory Control Reactor Core Isolation Cooling (RCIC)	RCIC (1 ASD train)
Early Inventory Control CRD Pumps (EICRD)	2/2 CRD pumps (operator action = 2) [1]
Depressurization (DEP)	4/20 SRVs manually opened (operator action = 3) [2]
Low Pressure Injection (LPI)	1/3 RHR trains in LPCI Mode (1 multi-train system) or 1/1 LPCS pumps (1 train system) or 1/1 Standby Service Water (SSW) cross-tie (operator action = 1)
Residual Heat Removal Suppression Pool Cooling (RHR)	1/2 RHR pumps and corresponding 1/2 RHR heat exchangers in suppression pool cooling (SPC) mode ,operator action = 4, limited by hardware failure (1 multi-train system)
Late Inventory CRD (LICRD)	1/2 CRD pumps (operator action = 2) [1]
Late Depressurization (LDEP)	{4/20 SRVs manually opened and [(1/3 condensate /Condensate booster pumps if RX Pressure $\leq$ 400 psi or 1/1 SSW cross-tie or 1/3 Firewater pumps if RX pressure <150 psi]} (operator action = 2)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 Trans - PCS- HPCS - RHR - LICRD - LDEP (6)			
2 Trans - PCS - HPCS - RCIC - LPI (8)			

3 Trans - PCS - HPCS-RCIC - DEP - EICRD (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. According to GGNS IPE Tables 3.1-6 to 3.1-8, operation of both control rod drive pumps (CRD), i.e., at maximized flow, is only successful when the vessel is at high pressure. CRD would actually only be asked after DEP failed as it is not likely that operators would rely on CRD if a larger capacity low pressure system could be available. One CRD pump is sufficient if CRD is only used in the long term, i.e. when coolant makeup has been provided for a long time. The event trees show enhanced CRD (2 pump operation) as a high pressure injection source only if depressurization fails.

2. Worksheets consider that Depressurization (DEP) using SRVs requires operator action. The GGNS IPE Table 3.3.-7 assigns a failure probability for failure to depressurize (DEP) of 3.0E-04, $\leq$ 3.5 mins. A credit of 3 for this operator action is given based on generic BWR data.

Table 3.2 SDP Worksheet for Grand Gulf Unit I — Transients without PCS (TPCS)[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 Control High Pressure Core Spray (HPCS)	HPCS (1 train)
Early Inventory Control Reactor Core Isolation Cooling (RCIC)	RCIC (1 ASD train)
Early Inventory Control CRD Pumps (EICRD)	2/2 CRD pumps (operator action = 2) [2]
Depressurization (DEP)	4/20 SRVs manually opened (operator action = 3) [3]
Low Pressure Injection (LPI)	1/3 RHR trains in LPCI Mode (1 multi-train system) or 1/1 LPCS pumps (1 train system) or 1/1 Standby Service Water (SSW) cross-tie (operator action = 1)
Residual Heat Removal Suppression Pool Cooling (RHR)	1/2 RHR pumps and corresponding 1/2 RHR heat exchangers in suppression pool cooling (SPC) mode, operator action = 4, limited by hardware failure (1 multi-train system)
Late Inventory CRD (LICRD)	1/2 CRD pumps (operator action = 2) [2]
Late Depressurization (LDEP)	{4/20 SRVs manually opened and [1/1 SSW cross-tie or 1/3 Firewater pumps if RX pressure <150 psi]} (operator action = 2)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 TPCS- HPCS - RHR - LICRD - LDEP (6)			
2 TPCS - HPCS - RCIC - LPI (8)			
3 TPCS - HPCS-RCIC - DEP - EICRD (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. The transient event tree is used for this worksheet.

2. According to GGNS IPE Tables 3.1-6 to 3.1-8, operation of both control rod drive pumps (CRD), i.e., at maximized flow, is only successful when the vessel is at high pressure. CRD would actually only be asked after DEP failed as it is not likely that operators would rely on CRD if a larger capacity low pressure system could be available. One CRD pump is sufficient if CRD is only used in the long term, i.e. when coolant makeup has been provided for a long time. The event trees show enhanced CRD (2 pump operation) as a high pressure injection source only if depressurization fails.

3. Worksheets consider Depressurization (DEP) using SRVs requires operator action. The GGNS IPE Table 3.3.-7 assigns a failure probability for failure to depressurize (DEP) of 3.0E-04, $\leq$ 3.5 mins. A credit of 3 for this operator action is given based on generic BWR data.

Table 3.3 SDP Worksheet for Grand Gulf Unit I — 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)	1/2 Feedwater pumps and 1/3 Condensate/Condensate Booster pump combinations and 1/4 MS lines with the condenser and turbine bypass (operator action = 2)
Early Inventory Control High Pressure Core Spray (HPCS)	HPCS (1 train system)
Early Inventory Control Reactor Core Isolation Cooling (RCIC)	RCIC (1 ASD train)
Depressurization (DEP)	4/20 SRVs manually opened (operator action = 3)
Low Pressure Injection (LPI)	1/3 RHR trains in LPCI Mode (1 multi-train system) or 1/1 LPCS pumps (1 train system)
Suppression Pool Make up (SPMU)[1]	1/2 suppression pool makeup (1 multi-train system)
Containment Heat Removal (CHR)	1/2 RHR pumps and corresponding 1/2 RHR heat exchangers in suppression pool cooling (SPC) mode, operator action = 4, limited by hardware failure (1 multi-train system)
Late Depressurization (LDEP)	4/20 SRVs manually opened (operator action = 3)
Late Inventory Makeup (LI)	{1/3 Condensate Injection if RX Pressure ≤ 400 psi or 1/1 Standby Service Water (SSW) cross-tie or 1/3 Firewater pumps (operator action = 2) [2]

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 SLOCA - PCS - SPMU - LI (4, 8, 15)			
2 SLOCA -PCS -SPMU - LDEP (5,9)			

3 SLOCA - PCS - HPCS- CHR - LI (11)			
4 SLOCA - PCS - HPCS - CHR - LDEP (12)			
5 SLOCA - PCS - HPCS - RCIC - LPI - LI (17)			
6 SLOCA - PCS - HPCS - RCIC - DEP (18)			

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. SPMU is needed to make up the suppression pool inventory that is lost to the break in the drywell. NPSH for ECCS pumps could be challenged with a break and no SPMU.

2. Due to dependency among operator actions required for performing LI, all represented by one operator action.

Table 3.4 SDP Worksheet for Grand Gulf Unit I — Stuck Open SRV (IORV)[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)	1/2 Feedwater pumps and 1/3 Condensate/Condensate Booster pump combinations and 1/4 MS lines with the condenser and turbine bypass (operator action = 2)
Early Inventory Control High Pressure Core Spray (HPCS)	HPCS (1 train system)
Early Inventory Control Reactor Core Isolation Cooling (RCIC)	RCIC (1 ASD train)
Depressurization (DEP)	3/20 SRVs manually opened (operator action = 3)
Low Pressure Injection (LPI)	1/3 RHR trains in LPCI Mode (1 multi-train system) or 1/1 LPCS pumps (1 train system)
Suppression Pool Make up (SPMU)[1]	1/2 suppression pool makeup (1 multi-train system)
Containment Heat Removal (CHR)	1/2 RHR pumps and corresponding 1/2 RHR heat exchangers in suppression pool cooling (SPC) mode, operator action = 4, limited by hardware failure (1 multi-train system)
Late Depressurization (LDEP)	3/20 SRVs manually opened (operator action = 3)
Late Inventory Makeup (LI)	{1/3 Condensate Injection if RX Pressure $\leq$ 400 psi or 1/1 Standby Service Water (SSW) cross-tie or 1/3 Firewater pumps (operator action = 2) [2]

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 IORV - PCS - SPMU - LI (4, 8, 15)			
2 IORV -PCS -SPMU - LDEP (5,9)			

3 IORV - PCS - HPCS- CHR - LI (11)			
4 IORV - PCS - HPCS - CHR - LDEP (12)			
5 IORV - PCS - HPCS - RCIC - LPI - LI (17)			
6 IORV - PCS - HPCS - RCIC - DEP (18)			

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

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

Notes:

1. The SDP sheet could be used for one or two stuck open SRV. When used for two stuck open SRV then condensate and fire water can not be credited for LI. The HEP value for LI then should be changed to credit of 1 reflecting the lack of these other options. Small LOCA Event Tree is used for this worksheet.

2. SPMU is needed to make up the suppression pool inventory that is lost to the break in the drywell. NPSH for ECCS pumps could be challenged with a break and no SPMU.

3. Due to dependency among operator actions required for performing LI, all represented by one operator action.

Table 3.5 SDP Worksheet for Grand Gulf Unit I — 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 Control (EI)	HPCS (1 train)
Depressurization (DEP)	3/20 SRVs (operator action = 3)
Low Pressure Injection (LPI)	1/3 RHR trains in LPCI mode (1 multi-train system) or 1/1 LPCS train (1 train system)
Containment Heat Removal (CHR)	1/2 RHR pumps and corresponding 1/2 RHR heat exchangers in suppression pool cooling (SPC) mode, operator action = 4, limited by hardware failure (1 multi-train system)
Suppression Pool Make up (SPMU)[1]	1/2 suppression pool makeup (1 multi-train system)
Late Inventory, Makeup (LI)	1/1 SSW cross-tie to RHR injection (operator action = 1)[2]

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 MLOCA - EI - LPI - LI (4)			
2 MLOCA - EI - DEP (5)			
3 MLOCA - SPMU - LI (7)			
4 MLOCA - SPMU - DEP (8)			

5 MLOCA - CHR - LI (10)			
6 MLOCA - CHR - 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. SPMU is needed to make up the suppression pool inventory that is lost to the break in the drywell. NPSH for ECCS pumps could be challenged with a break and no SPMU.

2. In late inventory (LI) operator actions using condensate pumps or firewater pumps are not considered in the GGNS event trees. A credit of one is given to LI function for MLOCA to reflect the limited hardware available for manual alignment.

Table 3.6 SDP Worksheet for Grand Gulf Unit I — 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)[1]	{Vapor suppression system (VSS) passive operation of suppression pool and vacuum breakers} (1 multi-train system)
Early Inventory Control (EI)	HPCS (1 train system) or 1/3 RHR trains in LPCI mode (1 multi-train system) or 1/1 LPCS train (1 train system) [2]
Suppression Pool Make up (SPMU)[1]	1/2 suppression pool makeup (1 multi-train system)
Containment Heat Removal (CHR)	1/2 RHR pumps and corresponding 1/2 RHR heat exchangers in suppression pool cooling (SPC) mode, operator action = 4, limited by hardware failure (1 multi-train system)
Late Inventory, Makeup (LI)	1/1 SSW cross-tie to RHR injection (operator action = 1)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 LLOCA - EI - LI (3)			
2 LLOCA - SPMU - LI (5)			
3 LLOCA - CHR - LI (7)			
4 LLOCA - EC - LI (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. SPMU is needed to make up the suppression pool inventory that is lost to the break in the drywell. NPSH for ECCS pumps could be challenged with a break and no SPMU. EC function is not modeled in the Licensee's IPE. It is included in this work sheet consistent with the SDP generic assumptions and guidelines in contrast to licensee's position.

2. Condensate is not credited in this sequence since makeup to the hotwell may not be sufficient.

Table 3.7 SDP Worksheet for Grand Gulf Unit I — Loss of Offsite Power (LOOP)

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

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Emergency AC Power Div 1 or Div 2 DGs (EAC1&2)	1/ 2 EDGs (1 multi-train system)
Div 3 Emergency DG (EDG3)	1/1 Div 3 EDG and the associated power distribution (1 train system)
High Pressure Core Spray Pump (HPCS)	HPCS pump and the associated DG 3 (1 train system)
Recovery of Offsite Power within 1 Hour (REC1)	Recovery of AC source (operator action = 1) (1)
HPCS DG Div 3 X-Tie to Div 1 or Div 2 (DGX)	Cross-tie Div 3 DG to Div 1 or Div 2 AC (operator action = 1) (2)
Reactor Core Isolation Cooling (RCIC) (6)	RCIC (1ASD train)
Depressurization (DEP)	4/20 SRVs manually opened (operator action = 3)
Low Pressure Injection (LPI)	1/1 RHR train in LPCI mode depending on which division is cross tied, operator action = 3 but limited by the hardware failure (1 train system)
Containment Heat Removal (CHR)	1/1 RHR train in SPC or CS mode depending on which division is cross tied, operator action = 4 but limited by hardware failure (1 train system)
Recovery of Offsite Power within 8 Hours (REC8)	Recovery of offsite power (operator action = 1) (3)
Late injection (LI) (4,5)	1/1 SSW if DG3 cross tied to Div 2 or 1/2 Diesel driven fire water pump (operator action = 1)
Low Pressure Injection, when EAC1&2 success (LPI2)	1/3 RHR trains in LPCI Mode (1 multi-train system) or 1/1 LPCS pumps (1 train system) or 1/1 Standby Service Water (SSW) cross-tie (operator action =1)
Residual Heat Removal Suppression Pool Cooling, when EAC1&2 success (RHR)	1/2 RHR pumps and corresponding 1/2 RHR heat exchangers in suppression pool cooling (SPC) mode, operator action = 4, limited by hardware failure (1 multi-train system)
Late Inventory CRD, when EAC1&2 success (LICRD)	1/2 CRD pumps (operator action = 2)
Early Inventory CRD, when EAC1&2 success (EICRD)	2/2 CRD pumps (operator action = 2)
Late Depressurization, when EAC1&2 success (LDEP)	{4/20 SRVs manually opened and [1/1 SSW cross-tie or 1/3 Firewater pumps if RX pressure <150 psi]} (operator action = 2)

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

1 LOOP - HPCS - RHR - LICRD - LDEP (1,2) 2 LOOP - HPCS - RCIC - LPI2 (1,2)			
3 LOOP - HPCS - RCIC - DEP - EICRD (1,2)			
4 LOOP - EAC1&2 - REC1 - HPCS - CHR -REC8 (6)			
5 LOOP - EAC1&2 - REC1 - HPCS - LPI - REC8 - LI (10) (NOTE CHR SUCCESS BUT LPI FAILED SHARED COMPONENTS NOT AFFECTED)			
6 LOOP - EAC1&2 - REC1 - HPCS - RCIC - DEP (11)			
7 LOOP - EAC1&2 - REC1- HPCS - DGX - REC8 (13)			
8 LOOP -EAC1&2 - REC1 - HPCS - DGX -RCIC (14)			
9 LOOP - EAC1&2 - REC1- EDG3 - REC8 (16)			

10 LOOP - EAC1&2 - REC1 - EDG3 - RCIC (17)			

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

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

Notes:

1. In the GGNS IPE 0.78 is the credit taken for restoring offsite power in one hour (0.22 failure probability). Due to limitation of the SDP this recovery action is credited as 0.1 (not conservative).

2. Cross-tying of the Div3 diesel generator to Div 1 or Div 2 is only credited if HPCS injection fails and DG3 operates. IPE assumes that HPCS is capable of operating without CHR for more than 24 hours. Even though the SDP does not limit the success to 24 hours mission, it was decided to fully credit the Licensee's assumption and comments.

3. The failure to recovery offsite power within 1 hour is based on the time to core damage when there is no reactor pressure vessel injection. The failure to recover offsite power within 8 hours is based on the 6 hours running time for the RCIC systems using the condensate storage tank (CST) as the suction source after which time pump suction must be transferred to the suppression pool which is then at a high temperature. The 2 hour additional time to reach 8 hours takes into consideration the reduced reactor decay heat and also the time to core damage at that point if no reactor pressure vessel injection occurs after 6 hours. (See GGNS IPE pages 3.4-3 and 3.4-8). Further more the failure of REC8 is about 2E-2. Sequences showed in this SDP sheet explicitly shows REC1 and REC8 in combination. To avoid sever under estimation REC8 is credited as operator action = 1, such that the result of the multiplication of REC1 and REC8 remains meaningful.

4. The GGNS IPE also considers station blackout (SBO) as occurring 3 hours after loss of offsite power (LOOP) if there are failures of the HVAC systems in the EDG and standby service water (SSW) pump rooms. In such cases, core damage is expected to occur after 4 hours. These sequences are conservatively accounted for by the 1 hour recovery time to restore offsite power. (See GGNS IPE page 3.4-3)

5. The HPCS Div 3 emergency diesel generator, when cross-tied to Div 1 or Div 2 AC power, is credited with providing Div 1 or Div 2 standby service water and Div 1 or Div 2 RHR for both coolant injection or decay heat removal. (See GGNS IPE page 3.1-15)

6. The licensee's comment indicate the possibility of credit for late depressurization with RCIC in extended SBO scenarios and failure of EDG3 and consequential failure of HPCS. This highly difficult success path is not credited in this SDP sheet . The elimination of this success path is not expected to affect the evaluation process for inspection finding.

Table 3.8 SDP Worksheet for Grand Gulf Unit I — 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)	19/20 SRVs (1 train system)
Recirculation Pump Trip (RPT)	Manual or automatic trip of recirculation pumps (1 multi-train system)
Inhibit ADS and HPCS (INH)	Operator inhibits ADS and HPCS (operator action = 3) (1a, 2b)
Reactivity Control (SLC)	1/2 SLC pumps and valves (operator action = 3) (2a)
High Pressure Injection (HPCS)	HPCS injection and level control (operator action = 1)
Depressurization (DEP)	4/20 SRVs manually opened (operator action = 3) (1b)
Low Pressure Injection (LPI)	1/3 Condensate Pumps (operator action = 2) or 1/3 RHR pumps in LPCI mode (1 multi-train system) or 1/1 LPCS pump (1 diverse train) or 1/1 SSW cross-tie (operator action = 1)
Containment Heat Removal (CHR)	1/2 RHR pumps in SPC or 4/4 Containment venting valves open (operator action = 3) (3)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 ATWS - OVERP (10)			
2 ATWS - SLC (7)			

3 ATWS - RPT (9)			
4 ATWS - HPCS - LPI (5)			
5 ATWS - HPCS - DEP (6)			
6 ATWS - INH (8)			
7 ATWS - CHR (2, 4)			
Identify any operator recovery actions that are credited to directly restore the degraded equipment or initiating event: If operator actions are required to credit placing mitigation equipment in service or for recovery actions, such credit should be given only if the following criteria are met: 1) sufficient time is available to implement these actions, 2) environmental conditions allow access where needed, 3) procedures exist, 4) training is conducted on the existing procedures under conditions similar to the scenario assumed, and 5) any equipment needed to complete these actions is available and ready for use.			

Notes:

1. For ATWS:
   a. During an ATWS event, although HPCS starts automatically together with RCIC at RPV Level 2, HPCS is secured to prevent relatively cold unborated water from being sprayed directly on the core.
   b. The GGNS IPE description for ATWS does not indicate how many SRVs are required to open for depressurization.

2. Human event probabilities (HEPs) are under 1E-2 in GGNS IPE:

a. SLC during ATWS - 7.0E-4, - 5 mins.
b. INH - Failure to inhibit ADS and HPCS during ATWS - 1.0E-5, - 2 mins.

The values used in the SDP sheets are modified based the HEP values of similar plants.

3. The worksheets consider containment venting to be a demanding operator action. GGNS IPE Table 3.3-7 assigns a failure probability of 2.4E-3 with an error factor of 10 for failure to bypass containment isolation within 45-60 minutes. The combined HEP for CHR is given a credit of 3.

Table 3.9 SDP Worksheet for Grand Gulf Unit I — Loss of Instrument Air (LOIA)[1]

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

Safety Functions Needed:	Full Creditable Mitigation Capability for Each Safety Function:
Power Conversion System (PCS)	Failed by the initiator
Early Inventory Control High Pressure Injection (HPCS)	Motor Driven independent HPCS (1 train)
Early Inventory Control High Pressure Injection (RCIC)	Turbine Driven RCIC Train (1 ASD train)
Early Inventory Control CRD Pumps (EICRD)	Failed by the initiator
Depressurization (DEP)	4/20 SRVs manually opened (operator action = 3)[2]
Low Pressure Core Injection/Spray (LPI)	1/3 RHR trains in LPCI Mode (1 multi-train system) or 1 / 1 LPCS pumps (1 train system)
RHR- Suppression Pool Cooling or Containment Spray (CHR)	1/2 RHR pumps and corresponding 1/2 RHR heat exchangers in suppression pool cooling (SPC) or containment spray mode (CS); operator action = 4, but limited by hardware failure (1 multi-train system)
Late Inventory CRD (LICRD)	Failed by the initiator
Late Depressurization (LDEP)	4/20 SRVs manually opened for controlled depressurization and [1/1 SSW cross-tie or 1/3 Firewater pumps if RX pressure <150 psi] (operator action = 2)

Circle Affected Functions	Recovery of Failed Train	Remaining Mitigation Capability Rating for Each Affected Sequence	Sequence Color
1 LOIA - HPCS - CHR - LDEP (4)			
2 LOIA - HPCS - RCIC - LPI (6)			
3 LOIA - HPCS - RCIC - 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. Frequency of Loss of Instrument Air is estimated to be about 2.0E-3 per year. It will causes an Scram due to opening of the Scram inlet and outlet valves and closure of vent and drain valves. It also induces MSIV closure, loss of feed water controller, aux. Building Isolation, and loss of PSW system. In terms of SDP sheets the effects can be summarized as: Transient with loss of PCS, No CRD flow, No condensate coolant injection, and No containment venting.

2. Worksheets consider Depressurization (DEP) using SRVs as an operator action with a credit of 3 based on survey of BWRs; GGNS IPE Table 3.3.-7 assigns a failure probability for failure to depressurize (DEP) of 3.0E-04, $\leq$ 3.5 mins.

Table 3.10 SDP Worksheet for Grand Gulf Unit I — Loss of ESF DC Bus 11DA Div-1(LDC1) (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)	Failed by the initiator
Early Inventory Control High Pressure Injection (HPCS)	Motor Driven independent HPCS (1 train)
Early Inventory Control High Pressure Injection (RCIC)	Failed by the initiator
Early Inventory Control CRD Pumps (EICRD)	Failed by the initiator
Depressurization (DEP)	4/20 SRVs manually opened (operator action = 3) (2)
Low Pressure Core Injection/Spray (LPI)	1/2 RHR trains in LPCI Mode (1 multi-train system)
RHR-Suppression Pool Cooling or Containment Spray (CHR)	1/1 RHR pumps and corresponding 1/1 RHR heat exchangers in suppression pool cooling (SPC) or containment spray mode (CS), operator action = 4, limited by hardware failures (1 train system)
Late Inventory CRD (LICRD)	Failed by the initiator
Late Depressurization (LDEP)	4/20 SRVs manually opened for controlled depressurization and [1/1 SSW cross-tie or 1/3 Firewater pumps if RX pressure <150 psi] (operator action = 2)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 LDC1 - HPCS - CHR - LDEP (4)			
2 LDC1 - HPCS - LPI (6)			
3 LDC1 - HPCS - 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. The loss of ESF DC bus 11DA is modeled in this SDP worksheet. Loss of DC bus 11DA is assumed to be a long recovery fault (i.e. repair time of 8 to 12 hours). The frequency of Loss of one division DC is estimated to be 6E-3 per year based on original IPE. It will causes LOIA due aux. Building Isolation, and therefore a Scram due to opening of the Scram inlet and outlet valves and closure of vent and drain valves. It also induces MSIV closure, loss of feed water controller, aux. Building Isolation, and loss of PSW system. In terms of SDP worksheets the effects can be summarized as: Transient with loss of PCS, No CRD flow, No condensate coolant injection, No containment venting, loss of RHR train A, loss of LPCS, loss of SSW-A, loss of SLC-A, and loss of RCIC. The event tree for LOIA was used for this initiator.

2. Worksheets consider Depressurization (DEP) using SRVs as an operator action; GGNS IPE Table 3.3.-7 assigns a failure probability for failure to depressurize (DEP) of 3.0E-04, $\leq$ 3.5 mins.

Table 3.11 SDP Worksheet for Grand Gulf Unit I — Loss of ESF DC Bus 11DB Div-2(LDC2)[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)	Failed by the initiator
Early Inventory Control High Pressure Injection (HPCS)	Motor Driven independent HPCS (1 train)
Early Inventory Control High Pressure Injection (RCIC)	Turbine Driven RCIC Train (1 ASD train)
Early Inventory Control CRD Pumps (EICRD)	Failed by the initiator
Depressurization (DEP)	4/20 SRVs manually opened (operator action = 3)[2]
Low Pressure Core Injection/Spray (LPI)	1/1 RHR trains in LPCI Mode (1 train system)
RHR-Suppression Pool Cooling or Containment Spray (CHR)	1/1 RHR pumps and corresponding 1/1 RHR heat exchangers in suppression pool cooling (SPC) or containment spray mode (CS), operator action = 4, limited by hardware failures (1 train system)
Late Inventory CRD (LICRD)	Failed by the initiator
Late Depressurization (LDEP)	4/20 SRVs manually opened for controlled depressurization and 1/3 Firewater pumps if RX pressure <150 psi] (operator action = 1)[3]

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 LDC2 - HPCS - CHR - LDEP (4)			
2 LDC2 - HPCS - RCIC - LPI (6)			
3 LDC2 - HPCS - RCIC - 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. The loss of ESF DC bus 11DB is modeled in this SDP worksheet. Loss of DC bus 11DB is assumed to be a long recovery fault (i.e. repair time of 8 to 12 hours). The frequency of Loss of one division DC is estimated to be 6E-3 per year based on original IPE. It will causes LOIA due aux. Building Isolation, and therefore a Scram due to opening of the Scram inlet and outlet valves and closure of vent and drain valves. It also induces MSIV closure, loss of feed water controller, aux. Building Isolation, and loss of PSW system. In terms of SDP worksheets the effects can be summarized as: Transient with loss of PCS, No CRD flow, No condensate coolant injection, No containment venting, loss of RHR trains B&C, loss of LPCS, loss of SSW-B, loss of SLC-B, and loss of capability for SSW crosstie. The event tree for LOIA was used for this initiator.

2. Worksheets consider Depressurization (DEP) using SRVs as an operator action; GGNS IPE Table 3.3.-7 assigns a failure probability for failure to depressurize (DEP) of 3.0E-04, $\leq$ 3.5 mins.

3. The reduced HEP value for LI function reflects the loss of capability for SSW crosstie.

Table 3.12 SDP Worksheet for Grand Gulf Unit I — Loss of ESF AC Bus 15AA Div-1(LAC1)[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)	Failed by the initiator
Early Inventory Control High Pressure Injection (HPCS)	Motor Driven independent HPCS (1 train)
Early Inventory Control High Pressure Injection (RCIC)	Turbine Driven RCIC Train (1 ASD train)
Early Inventory Control CRD Pumps (EICRD)	Failed by the initiator
Depressurization (DEP)	4/20 SRVs manually opened (operator action = 3)[2]
Low Pressure Core Injection/Spray (LPI)	1/2 RHR trains in LPCI Mode (1 multi-train system)
RHR-Suppression Pool Cooling or Containment Spray (CHR)	1/1 RHR pumps and corresponding 1/1 RHR heat exchangers in suppression pool cooling (SPC) or containment spray mode (CS), operator action = 4, limited by hardware failures (1 train system)
Late Inventory CRD (LICRD)	Failed by the initiator
Late Depressurization (LDEP)	4/20 SRVs manually opened for controlled depressurization and [1/1 SSW cross-tie or 1/3 Firewater pumps if RX pressure <150 psi] (operator action = 2)

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 LAC1 - HPCS - CHR - LDEP (4)			
2 LAC1 - HPCS - RCIC - LPI (6)			
3 LAC1 - HPCS - RCIC - 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. The loss of ESF AC bus 15 AA is modeled in this SDP worksheet. The frequency of Loss of one division ESF AC or one division DC is estimated to be 5E-3 per year in the original IPE. It will causes LOIA and therefore a Scram due to opening of the Scram inlet and outlet valves and closure of vent and drain valves. It also induces MSIV closure, loss of feed water controller, aux. Building Isolation, and loss of PSW system. Therefore it is not necessary to model loss of one emergency AC coincident with LOOP. In terms of SDP sheets the effects can be summarized as: Transient with loss of PCS, No CRD flow, No condensate coolant injection, No containment venting, loss of RHR train A, loss of LPCS, loss of SSW-A, loss of SLC-A, and loss of SPMU-A. The event tree for LOIA was used for this initiator.

2. Worksheets consider Depressurization (DEP) using SRVs as an operator action; GGNS IPE Table 3.3.-7 assigns a failure probability for failure to depressurize (DEP) of 3.0E-04, $\leq$ 3.5 mins.

Table 3.13 SDP Worksheet for Grand Gulf Unit I — Loss of ESF AC Bus 15AB Div-2 (LAC2) [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)	Failed by the initiator
Early Inventory Control High Pressure Injection (HPCS)	Motor Driven independent HPCS (1 train)
Early Inventory Control High Pressure Injection (RCIC)	Turbine Driven RCIC Train (1 ASD train)
Early Inventory Control CRD Pumps (EICRD)	Failed by the initiator
Depressurization (DEP)	4/20 SRVs manually opened (operator action = 3) [2]
Low Pressure Core Injection/Spray (LPI)	1/1 RHR trains in LPCI Mode (1 train system) or 1/1 LPCS train (1 train system)
RHR- Suppression Pool Cooling or Containment Spray (CHR)	1/1 RHR pumps and corresponding 1/1 RHR heat exchangers in suppression pool cooling (SPC) or containment spray mode (CS); operator action = 4, but limited by hardware failure (1 train system)
Late Inventory CRD (LICRD)	Failed by the initiator
Late Depressurization (LDEP)	4/20 SRVs manually opened for controlled depressurization and [1/3 Firewater pumps if RX pressure <150 psi] (operator action = 1) [3]

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 LAC2 - HPCS - CHR - LDEP (4)			
2 LAC2 - HPCS - RCIC - LPI (6)			
3 LAC2 - HPCS - RCIC - 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. The loss of ESF AC bus 15AB is modeled in this SDP worksheets. Frequency of Loss of one division ESF AC or one division DC is estimated to be 5E-3 per year. It will causes LOIA and therefore an Scram due to opening of the Scram inlet and outlet valves and closure of vent and drain valves. It also induces MSIV closure, loss of feed water controller, aux. Building Isolation, and loss of PSW system. Therefore it is not necessary to model loss of one emergency AC coincident with LOOP. In terms of SDP sheets the effects can be summarized as: Transient with loss of PCS, No CRD flow, No condensate coolant injection, No containment venting, loss of RHR trains A&C, loss of SSW-B, loss of SLC-B, and loss of SPMU-B. The event tree for LOIA was used for this initiator.

2. Worksheets consider Depressurization (DEP) using SRVs as a high-stress operator action; GGNS IPE Table 3.3.-7 assigns a failure probability for failure to depressurize (DEP) of 3.0E-04, ≤ 3.5 mins.

3. The SSW train B cross tie to LPCI train B is assumed not to be available due to unavailability of SSW train B. Therefore, the LDEP operator action is changed to operator action = 1 to reflect this lack of option.

Table 3.14 SDP Worksheet for Grand Gulf Unit I — Loss of Plant Service Water with Failure to Align SSW "B" to CCW Heat Exchangers (LPSW) [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)	Failed by the initiator
Early Inventory Control High Pressure Injection (HPCS)	Motor Driven independent HPCS (1 train system)
Early Inventory Control High Pressure Injection (RCIC)	Turbine Driven RCIC Train (1 ASD train)
Early Inventory Control CRD Pumps (EICRD)	Failed by the initiator
Depressurization (DEP)	4/20 SRVs manually opened (operator action = 3) [2]
Low Pressure Core Injection/Spray (LPI)	1/2 RHR trains in LPCI Mode (1 multi-train system) or 1/1 LPCS train (1 train system)
RHR- Suppression Pool Cooling or Containment Spray (CHR)	1/1 RHR pumps and corresponding 1/1 RHR heat exchangers in suppression pool cooling (SPC) or containment spray mode (CS), operator action = 4 , limited by hardware failure (1 train system)
Late Inventory CRD (LICRD)	Failed by the initiator
Late Depressurization (LDEP)	4/20 SRVs manually opened for controlled depressurization and [1/3 Firewater pumps if RX pressure <150 psi] (operator action = 1) [3]

Circle Affected Functions	**Recovery of Failed Train**	**Remaining Mitigation Capability Rating for Each Affected Sequence**	**Sequence Color**
1 LPSW - HPCS - CHR - LDEP (4)			
2 LPSW - HPCS - RCIC - LPI (6)			

3 LPSW - HPCS - RCIC - 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. The loss of Plant service water will result in loss of cooling to TBCW and CCW. There is a possibility to align the SSW train B to CCW HXs avoiding loss of Instrument air and loss of CRDs. The frequency of loss of PSW is 6.0 E-3 per year. The frequency of Loss of PSW and failure to recover CCW cooling therefore is assumed to be 6.0E-4. It will causes LOIA and therefore an Scram due to opening of the Scram inlet and outlet valves and closure of vent and drain valves. It also induces MSIV closure, loss of feed water controller, aux. Building Isolation, and loss of PSW system. In terms of SDP sheets the effects can be summarized as: Transient with loss of PCS, No CRD flow, No condensate coolant injection, No containment venting. The event tree for LOIA was used for this initiator.

2. Worksheets consider Depressurization (DEP) using SRVs as an operator action; GGNS IPE Table 3.3.-7 assigns a failure probability for failure to depressurize (DEP) of 3.0E-04, $\leq$ 3.5 mins.

3. The SSW train B cross tie to LPCI train B is assumed not to be successful since the operator failed to use SSW to recover CCW (dependent human error). Therefore, the LDEP operator action is changed to operator action = 1 to reflect the use of fire water as the only viable option.

Table 3.15 SDP Worksheet for Grand Gulf — Interfacing System LOCA (ISLOCA)

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**
LPCI Lines	3 lines each with one check valve and one closed MOV in series. Two of the lines have normally open MOV that can be closed for isolation. A pressure indicator between the check valve and closed MOV could monitor potential for leakage.
LPCS System rupture	1 line with a check valve and normally closed MOV in series.
Feedwater Lines	2 feedwater lines each with 2 check valves
Main Steam Lines	4 lines each with 2 MSIVs

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.

Notes:

1. The initiation pathways defined are primarily based on NUREG/CR-5928, ISLOCA Research Program, Final Report, July 1993. Adjustments are made using available information from the PRAs/IPEs on plant-specific pathways.

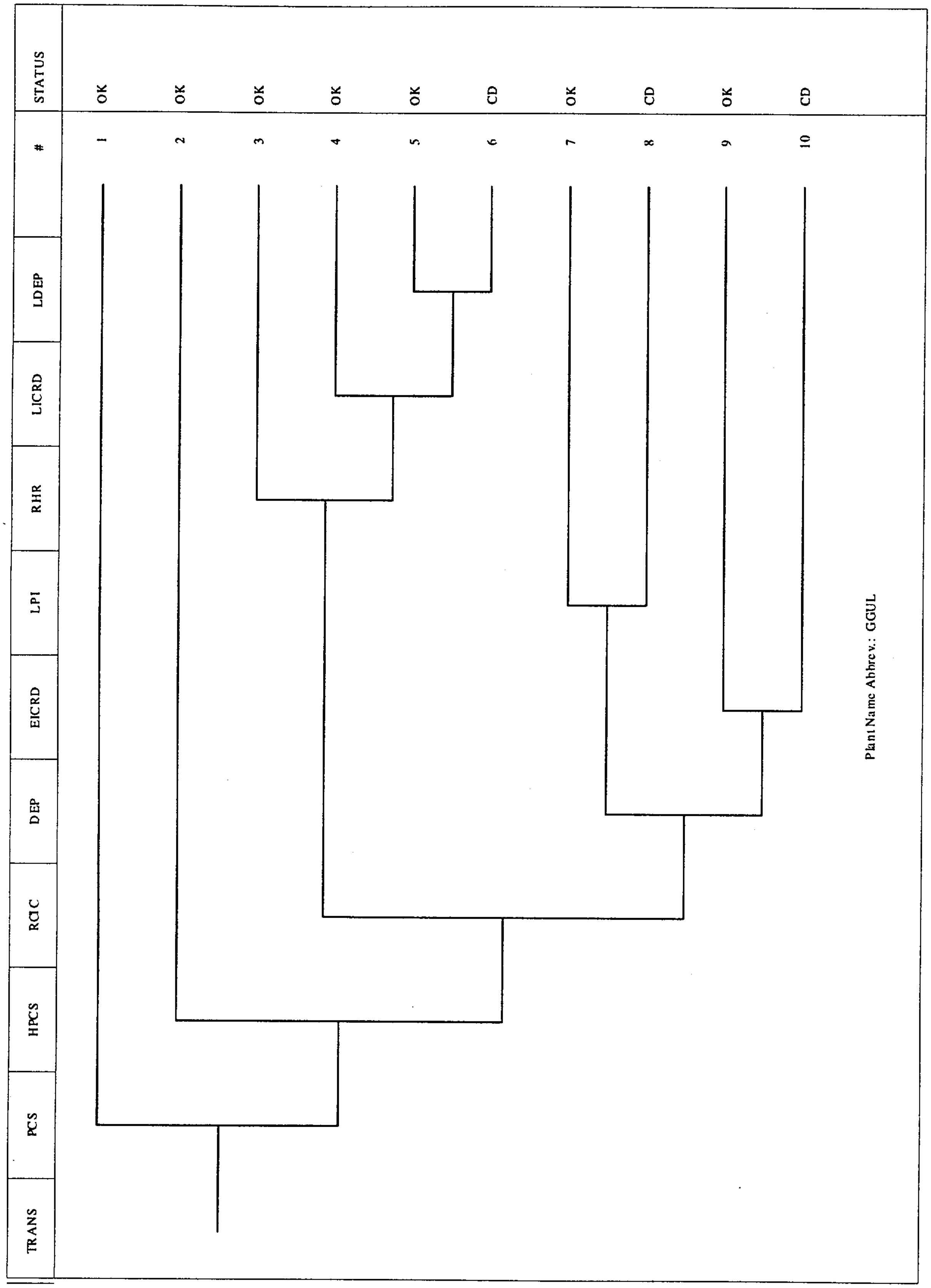
2. This worksheet is different from the other worksheets, in that ISLOCA is typically an unmitigated initiating event in most PRAs. Therefore the right side of the worksheet contains valves, whose failure may lead to an ISLOCA or LOC rather than mitigating systems to address an event in progress. As such, it is not intended to be referenced by the last column of Table 1.2, Initiators and System Dependency Table.

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 Off-site Power (LOOP)
6. Anticipated Transients Without Scram (ATWS)
7. Loss of Instrument Air (LOIA)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PCS
HPCS
RCIC
DEP
EICRD
LPI
RHR
LICRD
LDEP
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STATUS
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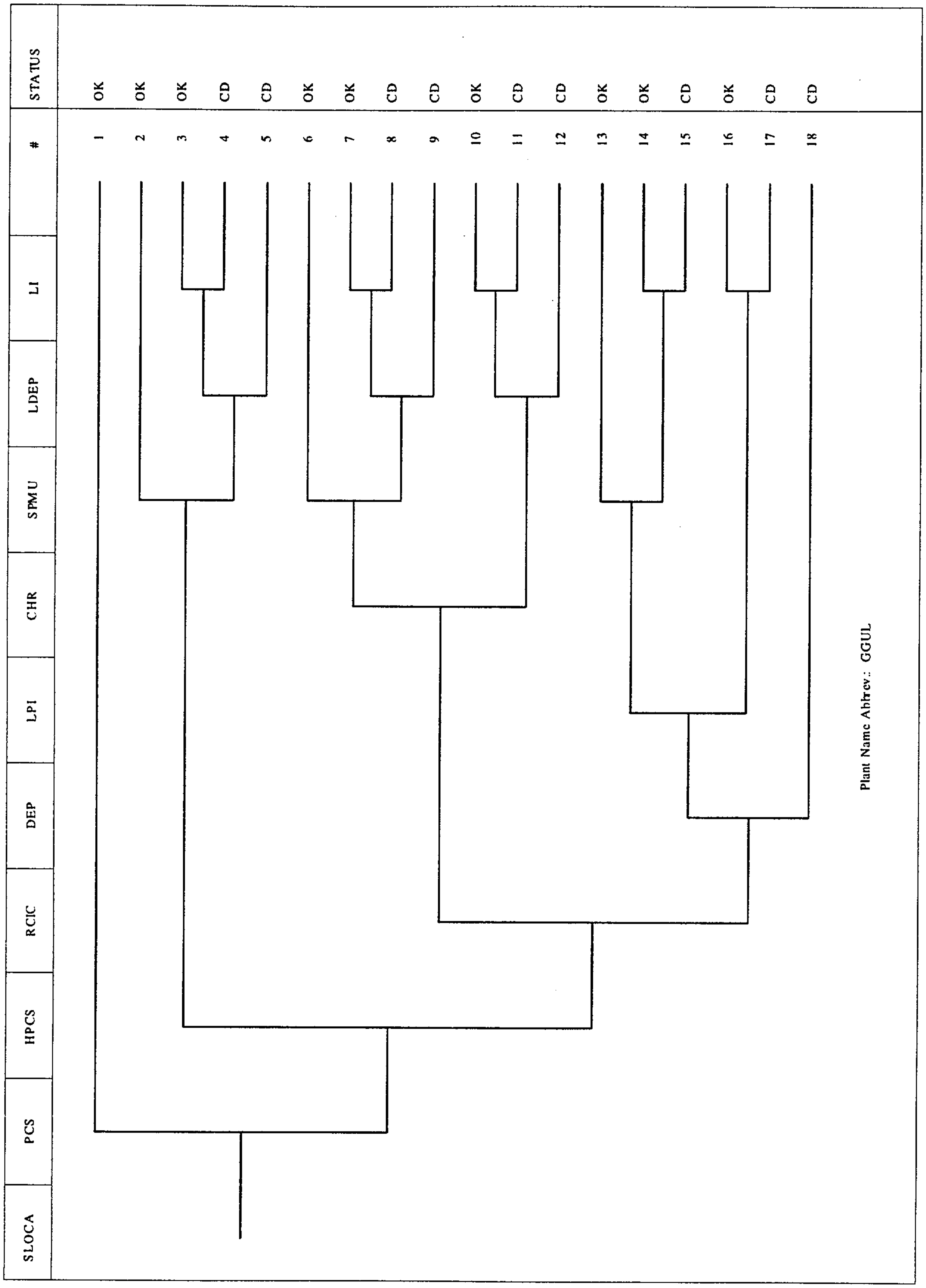
2 OK
3 OK
4 OK
5 OK
6 CD
7 OK
8 CD
9 OK
10 CD
Plant Name Abbrev.: GGUL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PCS
HPCS
RCIC
DEP
LPI
CHR
SPMU
LDEP
LI
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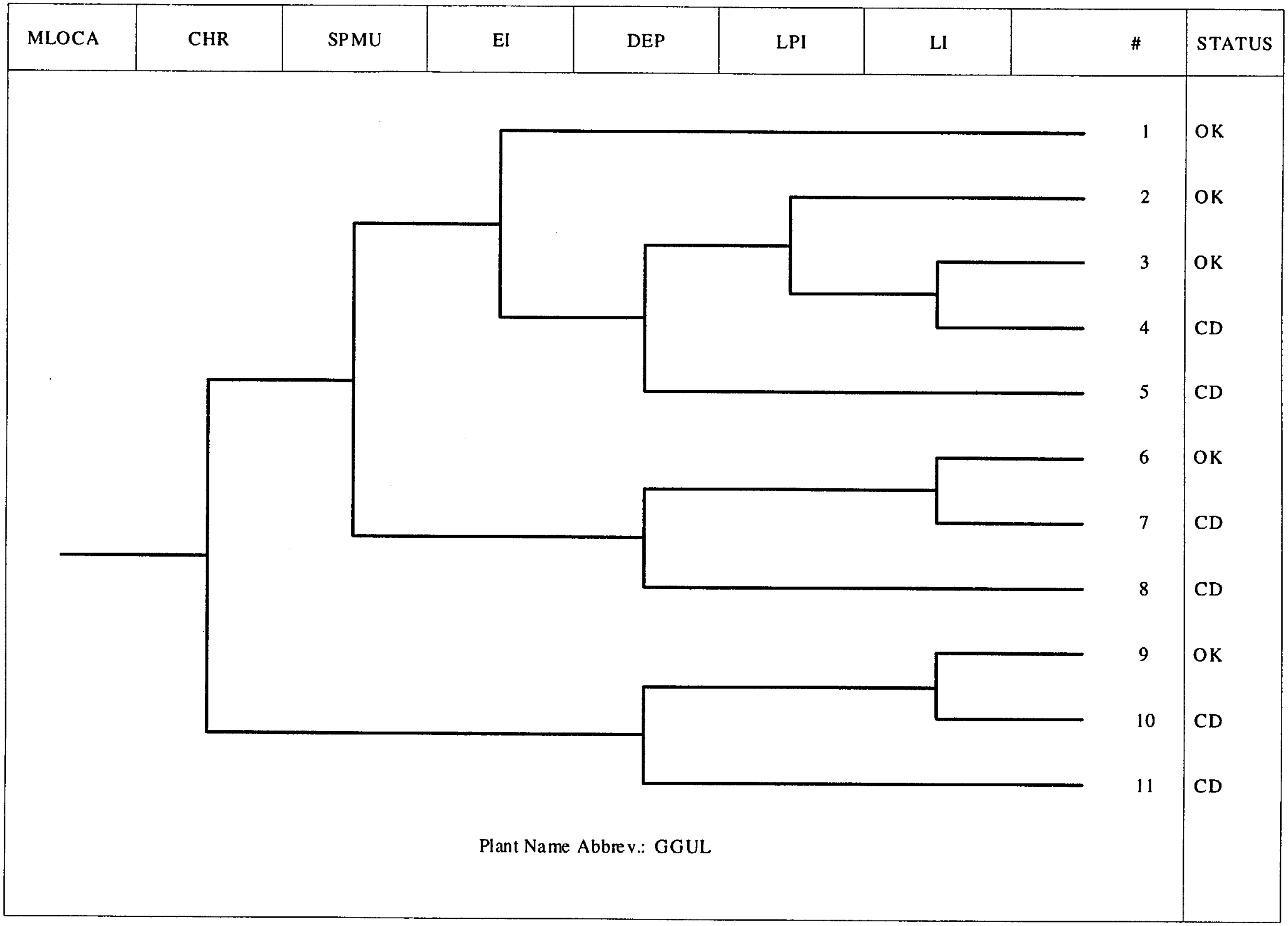
Plant Name Abbrev.: GGUL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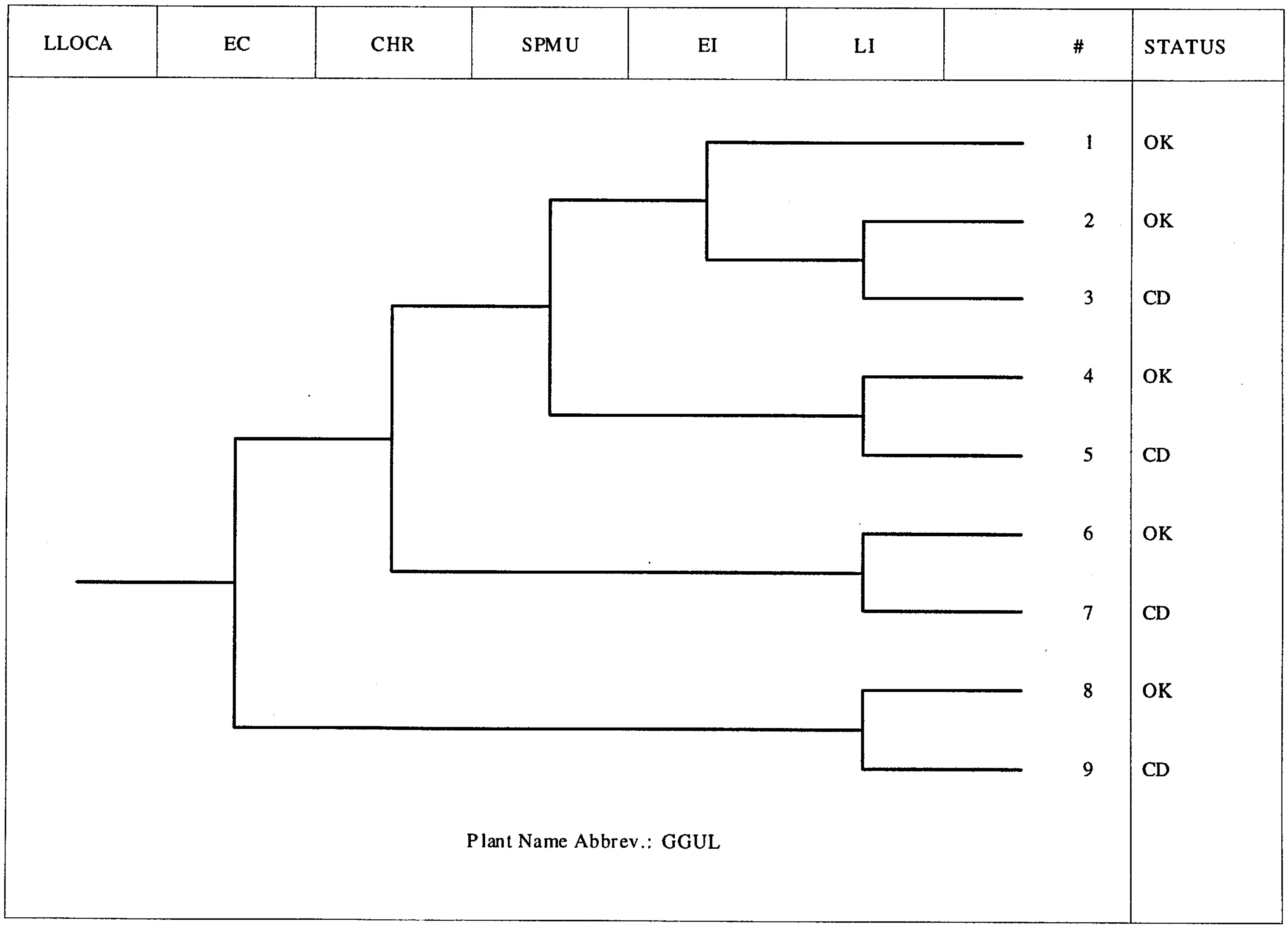
Plant Name Abbrev.: GGUL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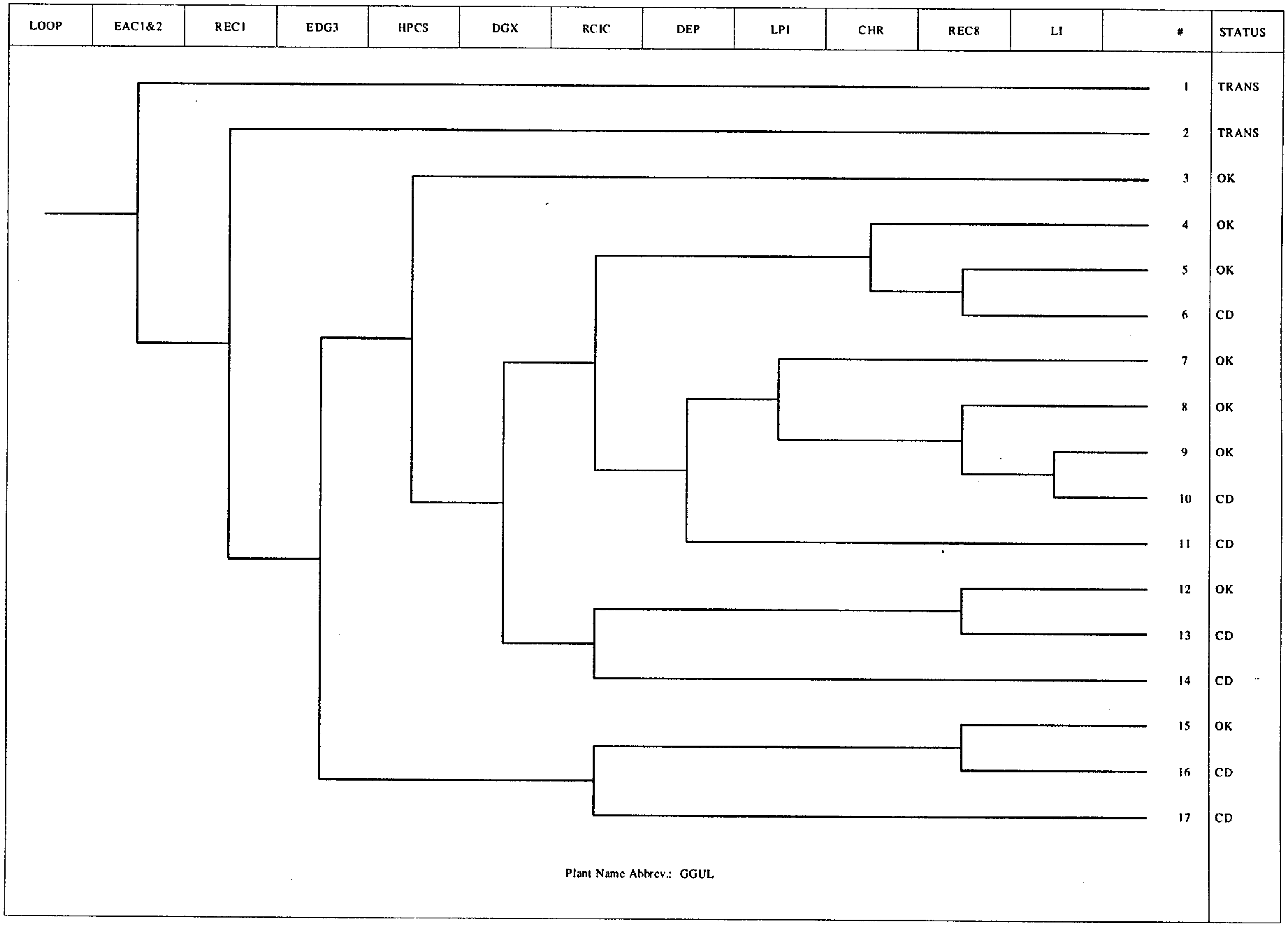
Plant Name Abbrev.: GGUL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EDG3
HPCS
DGX
RCIC
DEP
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CHR
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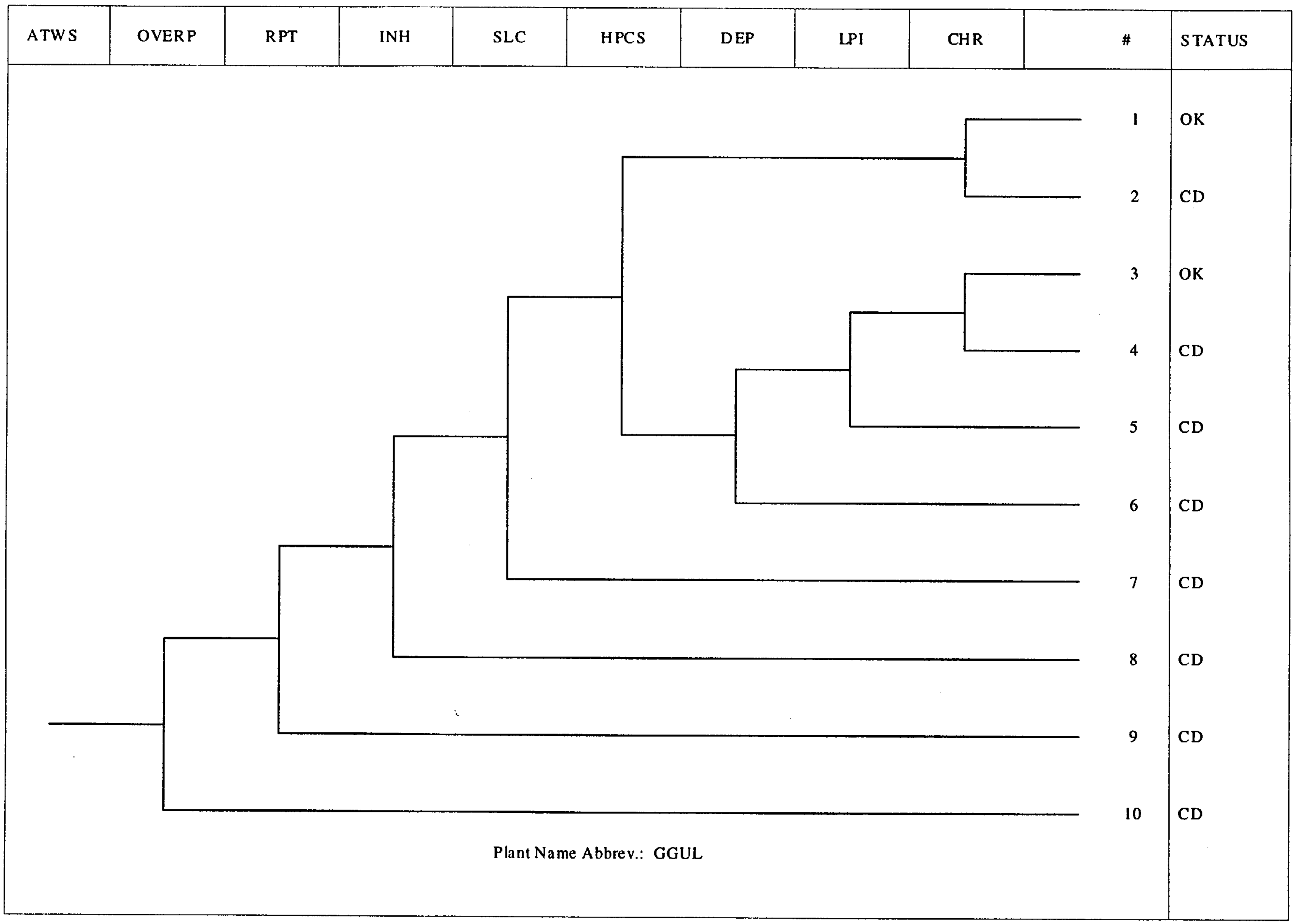
Plant Name Abbrev.: GGUL


ATWS
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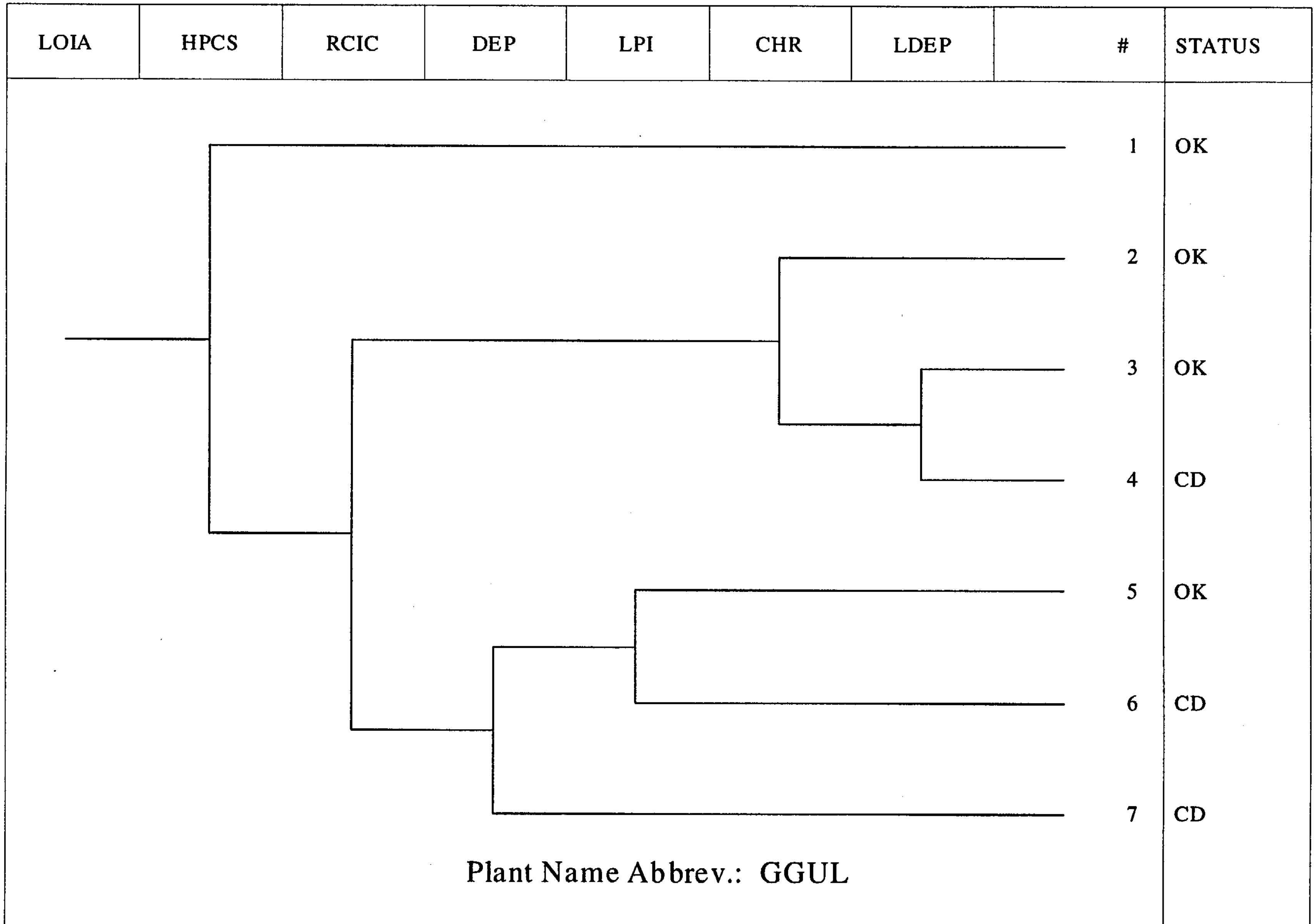
Plant Name Abbrev.: GGUL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CD
Plant Name Abbrev.: GGUL

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.

(2) 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 were limited to the worksheets included in draft SDP report, hence they did not include special initiators, ISLOCA, and HEP values. 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.

3. Licensee's comments on the SDP worksheets were either included as suggested or if deviated from, footnoted in the worksheet . The footnote typically includes the reasons why the recommendation is deviated from. Most notably are the following comments:

   a. The licensee's commented that late depressurization using RCIC followed by LI should be credited in scenarios involving LOOP for greater than 8 hours with all EDGs including DG3 failed (consequently no HPCS , LPCI, or CHR). This unlikely success path is not credited within the framework of the SDP sheets.

   b. Licensee's recommended sequences for small LOCA is modified to satisfy Boolean reduction rules used in the SDP.

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

4. The credit for operator actions were mostly determined based on similar plants and in some cases where plant specific updated information were available, they were footnoted.

REFERENCES

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

2. Entergy Operations, Inc., "Grand Gulf Unit 1 – Individual Plant Examination Report," dated February 1993.