Final Precursor Analysis

Accident Sequence Precursor Program ---Office of Nuclear Regulatory Research

Oyster Creek	Loss of 4.16 kV Emergency Bus 1C Due to Ground Fault in Normally Energized Underground Cable	
Event Date:5/20/2003	LER 219/03-002	$\Delta CDP^1 = 1.4\text{x}10^{-06}$

May 23, 2005

Condition Summary

On May 20, 2003, with the plant operating at 100%, the emergency bus 1C normal supply breaker tripped and locked out, de-energizing the bus. Subsequent investigation by AmerGen determined that the breaker trip was due to a ground fault in one of the cables that connect the “1C” bus to the associated, No. 1 EDG output breaker. The loss of bus “1C” resulted in the loss of certain system components required for normal operation and accident mitigation. The loss of one of two emergency buses also led to a technical specification required shutdown of the plant. This was achieved via a controlled down-power and a manual scram at 9:43 a.m., approximately 9 hours after the event. Cold shutdown was achieved at 7:13 p.m. of the same day.

Cable failure was the result of water intrusion into the “1C” cable between the insulation and the insulation shield. Apparently, underground water filtered through the conduit and cable jacket, degrading the cable insulation and causing the cable to short to ground. The cable that failed in May 2003 was manufactured by Anaconda. Prior to this event, Oyster Creek had experienced an additional ten in-service, medium voltage cable failures. Of these, six were failures of Anaconda Unishield type cables. A seventh failed cable was also Unishield type manufactured by Cablec, after their purchase of the Anaconda company. Based on a chart prepared by the licensee, the Anaconda and Cablec cable failures were either due to water intrusion or manufacturing defects that, over time, caused the cables to fail. Water intrusion and breakdown of the cable insulation was the cause of a 1996 failure of a cable associated with the No. 2 EDG output breaker to 4160 volt emergency bus “1D”. This cable, like the “1C” cable, was located within an underground cable vault structure between the EDG building and the TB. Water intrusion was also the failure mode that caused a cable supplying power to the 1B2 480V unit substation to short to ground and the supply breaker to trip on November 11, 2001. This cable was also manufactured by Anaconda and had only been in service for about five years, but in this case, the cable was “buried” in a sand bed that runs under the TB basement floor.

Including the May 2003 failure, Oyster Creek has had 11 medium voltage, in-service cable failures. Of the earlier 10 failures, six involved Anaconda cable and three of the

[1] Since this condition did not involve an actual initiating event, the parameter of interest is the measure of the incremental increase between the conditional probability for the period in which the condition existed and the nominal probability for the same period but with the condition nonexistent and plant equipment available. This incremental increase or “importance” is determined by subtracting the CDP from the CCDP. This measure is used to assess the risk significance of hardware unavailabilities especially for those cases where the nominal CDP is high with respect to the incremental increase of the conditional probability caused by the hardware unavailability.

six Anaconda failures were associated with cables that supply power from the two EDGs to the 4160 V emergency busses through the underground concrete vaults. In addition, two of the 10 failures (one in 1975 and the other in 1977) involved cables running in these same vaults from the two EDGs. However, these cables were manufactured by GE Vulkene and the failures were attributed to lightning strikes. The 4160 volt “1C” cable that failed in May 2003 had been installed in 1977 after one of these failures. During their analysis of the May 2003 cable failure, AmerGen’s engineering organization assessed whether water entered into the cable vault structure. They concluded that, prior to 1991, rain water could enter the cable vault from an opening in the floor at the switchgear in the EDG building. (Note: Much of the roof of the EDG building is grating open to the environment to permit air flow into the building to support EDG operation and cooling.) Rainwater spillage into the TB basement was clearly evident from the vault associated with the 1D bus. In 1991, a modification installed a concrete dam around the power conduit at the floor line in the EDG building to prevent water entrance into the conduits from either diesel. However, AmerGen’s 2003 apparent cause analysis noted that by the time the rain water intrusion was corrected, there had been many years of water exposure to the cables. The licensee’s apparent cause review stated that this “likely was the contributory factor for the EDG 1 cable failure.”

Analysis Results

- **Condition Importance (ΔCDP)**

The condition importance is calculated to be 1.4E-06.

- **Dominant sequences**

Table 1 shows the contributors to event importance.

- **Results tables**

Attachment A contains the details of the analysis and results tables.

Modeling Assumptions

- **Analysis type**

The ASP analysis is performed using the plant SPAR model. The plant condition of loss of 4160 1C emergency bus is imposed on the model.

An event occurring within a time interval before or after the failure of the 1C bus could be affected by this failure, if the mission time of the event occurring includes the time of the bus failure. Thus, the ASP evaluation looks at both the time period before and after the bus failure. The time interval before the bus failure is taken as 24 hours: if an initiating event occurred within a 24-hour time interval before the bus failure, it's mission time would have included the bus failure. The time interval after the bus failure is studied in detail by the SDP phase three analysis (Reference 2). The results of the SDP analysis are summarized below. See also Table 1.

1. Analysis for the 24-Hour Time period before failure

The model is quantified for a 24-hour period; that any potential initiating event that could have occurred during the 24-hour mission time preceding the failure would have created additional plant risk. Note that no automatic trip was generated. The resulting condition importance is calculated to be 3.9E-07.

This condition would have also impacted events that could have followed external events and shutdown events that if occurred during the previous 24–hour period, would have had the failure impacting their mission time. Since the SDP analysis already looked at the same events following the failure, and concluded that the risk is small, this subject is not pursued any further.

2. Analysis for the at-power time period following the failure

A 10-hour time period is used to estimate the plant risk during the at-power period following the onset of the condition. Internal events that could randomly occur during this time window are considered. The resulting condition importance is calculated to be 1.6E-07.

3. Reactor Trip due to failure

The reactor trip due to the failure (imposed by the technical specifications) is also considered and its importance is calculated given by modeling that a transient has occurred (with frequency of 1.0). The resulting event importance is calculated to be 3.6E-07.

4. Events at Shutdown

While the plant is operated in shutdown conditions for a 130-hour period with 1C bus unavailable, initiating events that could have contributed to plant risk have been evaluated and the condition importance due to 5 such initiating events is calculated to be 4.9E-07.

5 External Events

The contribution of importance of external events is taken from Reference 2 as 4.4E-09

- **Modeling assumptions**

  Key modeling assumptions. The key modeling assumptions are listed below and discussed in detail in the following sections. These assumptions are important contributors to the overall results.

  1. During shutdown period, isolation condenser could be credited for decay heat removal, as modeled in the at-power operation in the SPAR models.

     Other assumptions. Other assumptions are stated in the analysis as they are introduced.

- **Modifications to fault tree models**

See attachment A for details.

- **Basic event probability changes**

See attachment A for details.

- **Sensitivity analyses**

None made.

- **SPAR model updates**

No SPAR model updates are made.

References

1. LER: 03-002-00 DATED 7/17/2003. Oyster Creek Unit 1: Completion of reactor shutdown required by tech specs due to a cable fault.

2. SDP: EA- 04-033. SERP date: 2/5/04 SERP Worksheet for SDP-Related Finding at Oyster Creek Generating Station Failure of Cable in 4160 Volt Vital Bus.

3. Inspection report: EA-04-033 dated 3/15/2004. Final significance determination for a white finding and notice of violation (NRC Inspection Report 05000219/2003005) Oyster Creek generating station.

4. Email from Wayne Schmidt to Selim Sancaktar, Dated 5/18/05 7:34AM Subject: Re: Oyster Creek 4160 Bus 1C loss

5. Station Blackout Risk Evaluation for NPPs (Draft) INEEL/EXT-04-02525, January 2005.

Table 1 Summary of Contributors to Condition Importance						
	Plant Mode / Event Type	**Time Window**	**Condition CDF**	**Base CDF**	**Importance**	**% Importance**
1	Power Operation preceding condition - Random Initiating events	24	1.45E-04	3.63E-06	3.87E-07	27.7%
2	Power Operation post condition - Random Initiating events	10	1.45E-04	3.63E-06	1.61E-07	11.5%
3	Manual Scram - Transient	--	3.60E-07		3.60E-07	25.7%
4	Shutdown operation - total	130	3.66E-05	3.63E-06	4.89E-07	35%
5	External Events	164			6.2E-10[1]	<0.1%
				Sum =	**1.40E-06**	100.0%

1 From Final SDP (Reference 2) (3.31E-08 *160/8760 = 6.2E-10)

Attachment A. ASP Analysis Documentation

This section documents the ASP analysis calculations made for the plant condition.

This is a condition event, where the cable in question was not monitored against this failure cause. Thus, the cable could have failed anytime during the year (or the previous years). If the cable failed during the 24-hour mission time following any potential initiating event, it would have caused loss of mitigating equipment, such as:

Diesel Generator 1
Reactor Protection System 1
Core spray Main and Booster Pumps A and D
Containment Spray pumps A and B
Emergency Service Water Pumps A and B.

Other equipment powered from bus 1D were operable. No automatic trip occurred. Plant was manually shutdown later in accordance with the technical specifications.

1 & 2. ASP Analysis for the 34-hour time window before manual shutdown.

The 24-hour time window before the occurrence of the condition, and the 10-hour time window after the condition but before the manual trip are combined into a 34-hour case for ASP analysis. Then, the plant SPAR model is used to quantify the condition importance for the 34-hour period.

During this analysis, it is observed that the plant condition coupled with the random initiating event of Loss of DC Bus B results in a core damage end state. However, as a minimum, an operator recovery action to open the isolation condenser valve(s) exist, as discussed in Attachment B. This recovery action is credited in the ISO fault tree (see Figure A-1) by introducing the basic event ISO-XHE-MOV-REC, which is AND-GATED with the loss of DC Bus A gate (CDP-PNLC). This operator action is set to IGNORE in the base case, and is assigned a HEP value in the conditional case.

The following basic events were set to failure (TRUE) in the plant SPAR model to simulate the loss of 1C bus and the EDG connection to it:

ACP-BAC-LP-1C
EPS-DGN-TM-DG1

The base case is run with SAPHIRE and the conditional case is run with GEM. The results are summarized in Table C-1, which is the GEM output.

3. Initiating Event Analysis for Manual Shutdown.

The plant condition introduced an additional plant risk in terms of a manual shutdown due to tech spec requirements. This is modeled with a transient event tree in the SPAR model, using GEM initiating event analysis to quantify the event importance. All initiating event frequencies other than that of TRANS are set equal to zero. The initiating event frequency for TRANS is set equal to 1. In addition, the following three basic event probabilities are modified, as in the above cases:

ACP-BAC-LP-1C	set to failure (TRUE)
EPS-DGN-TM-DG1	set to failure (TRUE)
ISO-XHE-MOV-REC	set to 4.2E-02 (in the base case, it is set equal to IGNORE).

The GEM output is given in Table C-2.

4. ASP Analysis for the 130-hour time window during shutdown

The plant remained in the shutdown mode for a 130-hour period with the faulted bus condition. During this period, a random occurrence of events such as LOOP, loss of the DC bus B, loss of the running RHR train, loss of SWS, and loss of intake structure would have created additional plant risk. It is assumed that:

1. The above-listed five initiating events would present the most risk (other events such as LOCAs) presenting lesser risk;

2. Isolation condenser would provide decay heat removal if the RHR is lost (SPAR models, and Reference 2);

3. In case of a LOOP and SBO, offsite power must be recovered within 20 hours (Reference 2).

Event Trees:

For each of the five shutdown events listed above, event trees are constructed. These event trees are given as Figures A-2 through A-7. The event trees are constructed by using the same event tree rules as their corresponding at-power SPAR event trees.

Initiating Event Frequencies:

The initiating event frequencies for a year of operation are calculated as follows:

Shutdown Initiating Events	IE Frequency (per year)	
IE-LOOP-sd	3.31E-02	1
IE-TRANS-sd	5.00E-06	2
IE-LODCB-sd	2.50E-03	1
IE-LOIS-sd	7.50E-03	1
IE-LOSWS-sd	4.00E-04	1

Notes:

1. From at-power SPAR model
2. Failure of a RHR pump to run for 8760 hours
5E-06 failure to run per hour from SPAR model

Fault Trees:

As shown in the event tree nodes of Figures A-2 through A-7, the following new fault trees are introduced:

SDC - shutdown cooling - has three subtrees named SDC-A, SDC-B, SDC-c.

ISO - as discussed in Attachment B. ISO1 is the same as ISO.

AC-20 - AC power recovery in 20 hours; used as a scalar without developing the fault tree.

The fault tree pictures are given as Figures A-8 through A-11. Modification in ISO is shown in Figure A-1. AC-20 does not have any structure.

Basic Events:

The fault tree AC-20 is assigned failure to recover offsite power probability of 0.069 from Table 3.3 of Reference 5.

Five change sets are used to set the values of various basic events to run the five shutdown events using SAPHIRE for a year of operation. These basic event values are shown in Table A-1. Note that the 130-hour mission time is introduced later on to calculate the condition importance.

Calculations:

Five SAPHIRE runs are made, each with one of the change sets defined in table A-1. These runs gave the CDF from a shutdown event for a 8760-hour period (one year). These values are then multiplied by the factor 130/8760. The total condition importance is calculated by summing the results and subtracting the base at-power risk for 130-hours.

The shutdown condition importance is calculated as 4.9E-07. The summary of the calculations is given as follows:

	Plant Mode / Event Type	Initiating Event Frequency (per year)	Time Window	Condition CDF	Base CDF	Importance
LOOP	IE-LOOP-sd	3.31E-02	130	2.96E-07		4.39E-09
Loss of Running RHR	IE-TRANS-sd	5.00E-06	130	4.02E-06		5.97E-08
Loss of DC Bus B	IE-LODCB-sd	2.50E-03	130	1.40E-07		2.08E-09
Loss of Intake Structure	IE-LOIS-sd	7.50E-03	130	3.05E-05		4.53E-07
Loss of SW	IE-LOSWS-sd	4.00E-04	130	1.63E-06		2.42E-08
Base at-power operation			130		3.63E-06	-5.39E-08
	Shutdown operation - total			3.66E-05	3.63E-06	**4.89E-07**

5. Contribution from External Events

The contribution to the condition importance from external events is calculated in Reference 2 as 4.37E-09. Since this value is very small, even an order of magnitude change would not affect the results. Thus, this value is used as is for the ASP analysis.

Condition Importance

The condition importance can be calculated as the sum of contributions from the five calculations given above. The sum is 1.4E-06 and the details are shown in Table 1 of the main body of this report.

Table A-1 Basic Event Changes for Shutdown Events - Using Change Sets in SAPHIRE

Change/Flag Set	Event	Calc. Type	Prob/Freq
CASE-1-SD	ACP-BAC-LP-1C	T	
IE-LOOP	EPS-DGN-TM-DG1	T	
	IE-IORV	1	0.00E+00
	IE-LCS-V-A	1	0.00E+00
	IE-LCS-V-B	1	0.00E+00
	IE-LLOCA	1	0.00E+00
	IE-LOCHS	1	0.00E+00
	IE-LOCW	1	0.00E+00
	IE-LODCB	1	0.00E+00
	IE-LOIS	1	0.00E+00
	IE-LOMFW	1	0.00E+00
	IE-LOOP	1	3.31E-02
	IE-LOSWS	1	0.00E+00
	IE-SLOCA	1	0.00E+00
	IE-TRANS	1	0.00E+00
CASE-2-SD	ACP-BAC-LP-1C	T	
IE-TRANS	EPS-DGN-TM-DG1	T	
	IE-IORV	1	0.00E+00
	IE-LCS-V-A	1	0.00E+00
	IE-LCS-V-B	1	0.00E+00
	IE-LLOCA	1	0.00E+00
	IE-LOCHS	1	0.00E+00
	IE-LOCW	1	0.00E+00
	IE-LODCB	1	0.00E+00
	IE-LOIS	1	0.00E+00
	IE-LOMFW	1	0.00E+00
	IE-LOOP	1	0.00E+00
	IE-LOSWS	1	0.00E+00
	IE-SLOCA	1	0.00E+00
	IE-TRANS	1	4.38E-02
	SDC-MDP-TM-TRNB	T	
CASE-3-SD	ACP-BAC-LP-1C	T	
IE-LODCB	EPS-DGN-TM-DG1	T	
	IE-IORV	1	0.00E+00
	IE-LCS-V-A	1	0.00E+00
	IE-LCS-V-B	1	0.00E+00
	IE-LLOCA	1	0.00E+00
	IE-LOCHS	1	0.00E+00
	IE-LOCW	1	0.00E+00
	IE-LODCB	1	2.50E-03
	IE-LOIS	1	0.00E+00
	IE-LOMFW	1	0.00E+00
	IE-LOOP	1	0.00E+00
	IE-LOSWS	1	0.00E+00
	IE-SLOCA	1	0.00E+00

	IE-TRANS	1	0.00E+00
CASE-4-SD	ACP-BAC-LP-1C	T	
IE-LOIS	EPS-DGN-TM-DG1	T	
	IE-IORV	1	0.00E+00
	IE-LCS-V-A	1	0.00E+00
	IE-LCS-V-B	1	0.00E+00
	IE-LLOCA	1	0.00E+00
	IE-LOCHS	1	0.00E+00
	IE-LOCW	1	0.00E+00
	IE-LODCB	1	0.00E+00
	IE-LOIS	1	7.50E-03
	IE-LOMFW	1	0.00E+00
	IE-LOOP	1	0.00E+00
	IE-LOSWS	1	0.00E+00
	IE-SLOCA	1	0.00E+00
	IE-TRANS	1	0.00E+00
CASE-5-SD	ACP-BAC-LP-1C	T	
IE-LOSWS	EPS-DGN-TM-DG1	T	
	IE-IORV	1	0.00E+00
	IE-LCS-V-A	1	0.00E+00
	IE-LCS-V-B	1	0.00E+00
	IE-LLOCA	1	0.00E+00
	IE-LOCHS	1	0.00E+00
	IE-LOCW	1	0.00E+00
	IE-LODCB	1	0.00E+00
	IE-LOIS	1	0.00E+00
	IE-LOMFW	1	0.00E+00
	IE-LOOP	1	0.00E+00
	IE-LOSWS	1	4.00E-04
	IE-SLOCA	1	0.00E+00
	IE-TRANS	1	0.00E+00

Figure A-1 Modification to ISO Fault Tree

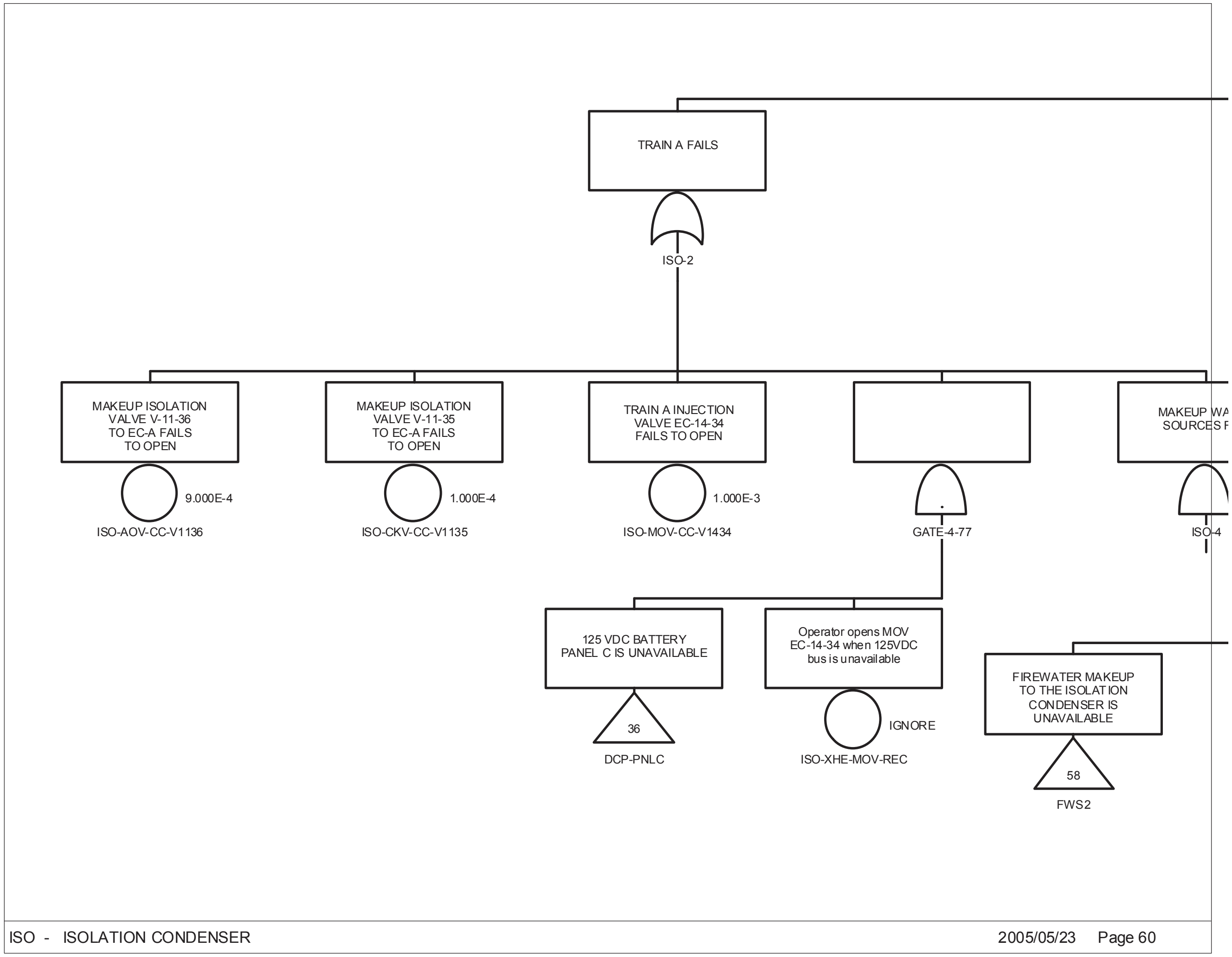


Figure A-2 LOSWS - SD Event Tree

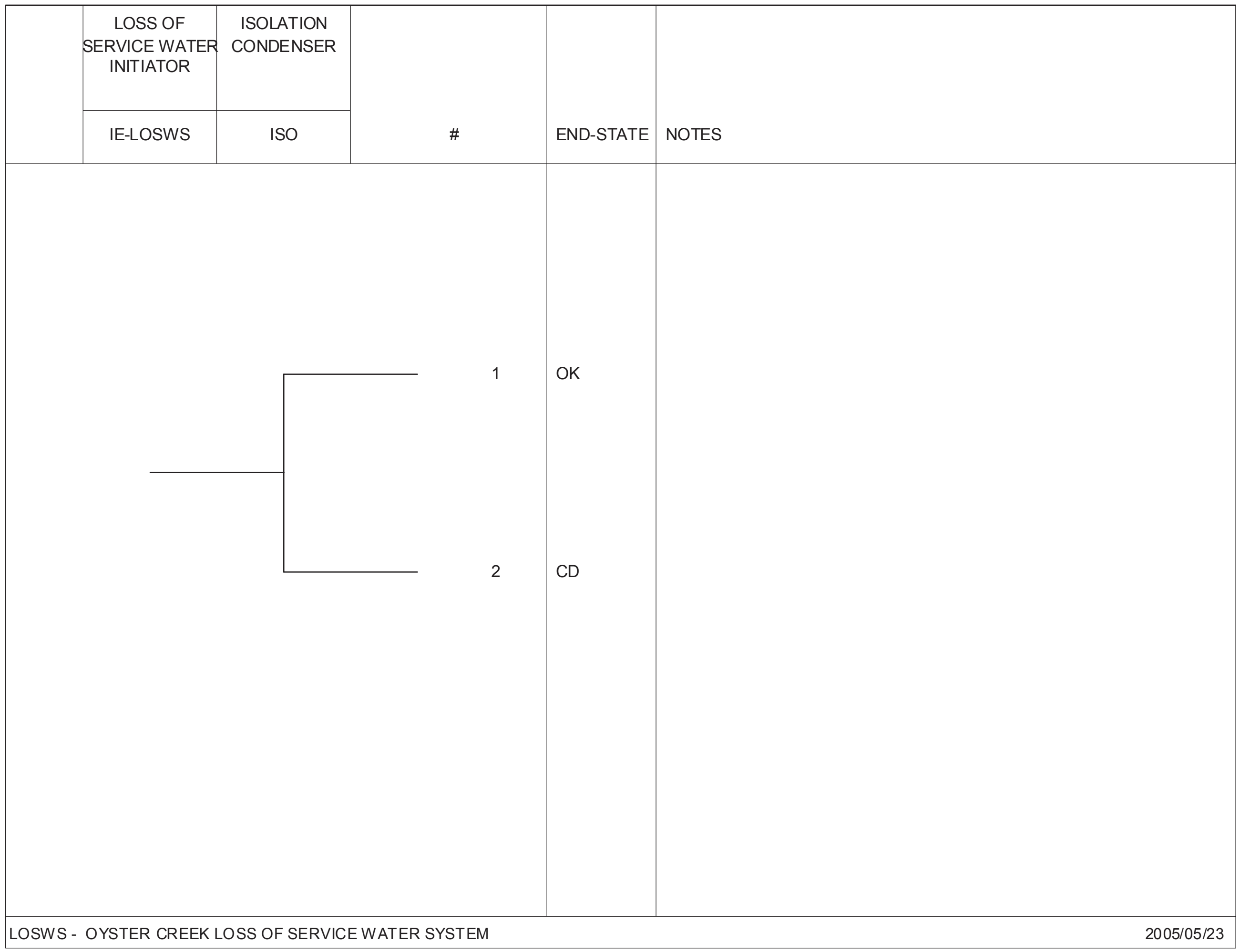


Figure A-3   LOOP - SD Event Tree

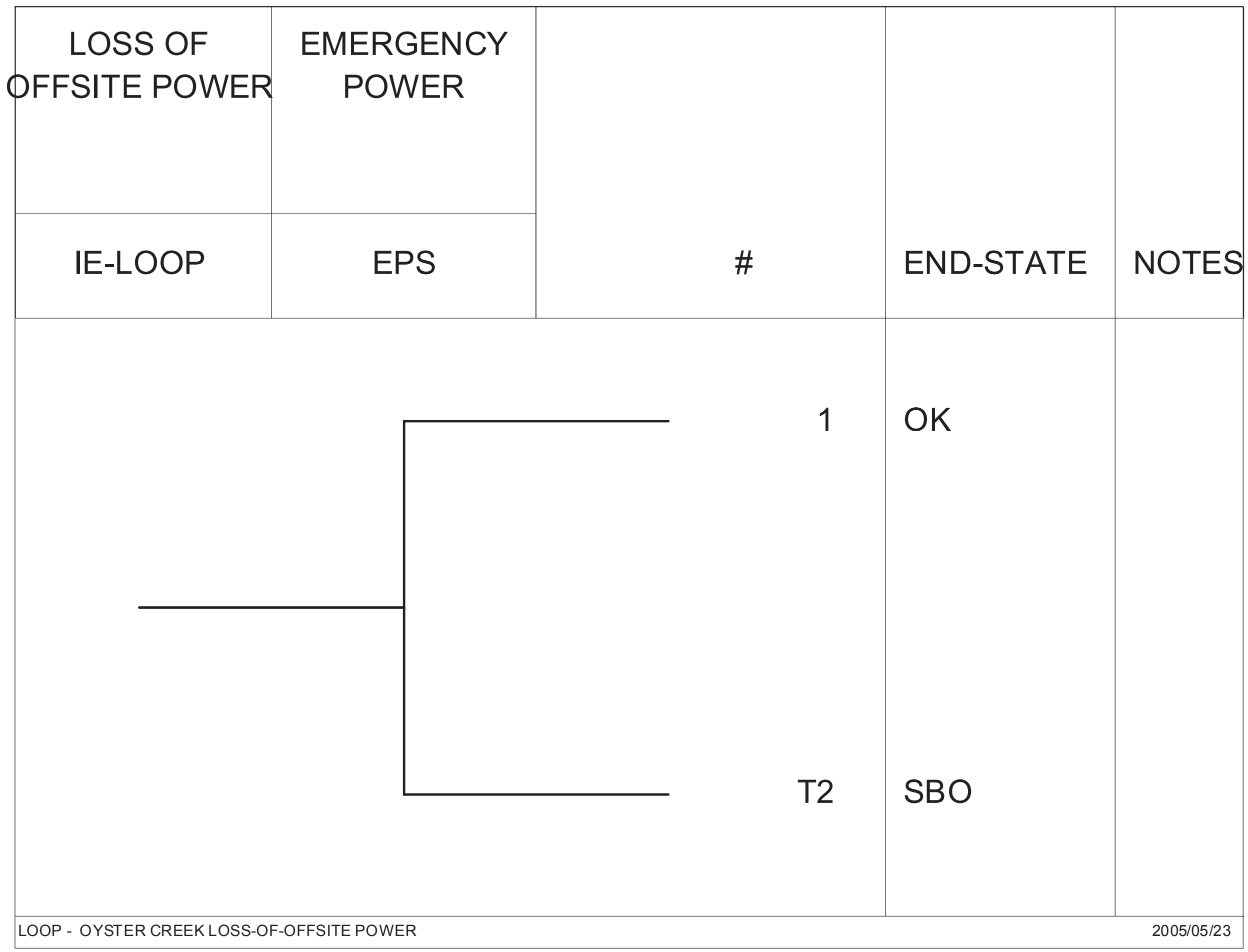


Figure A-4 SBO - SD Event Tree

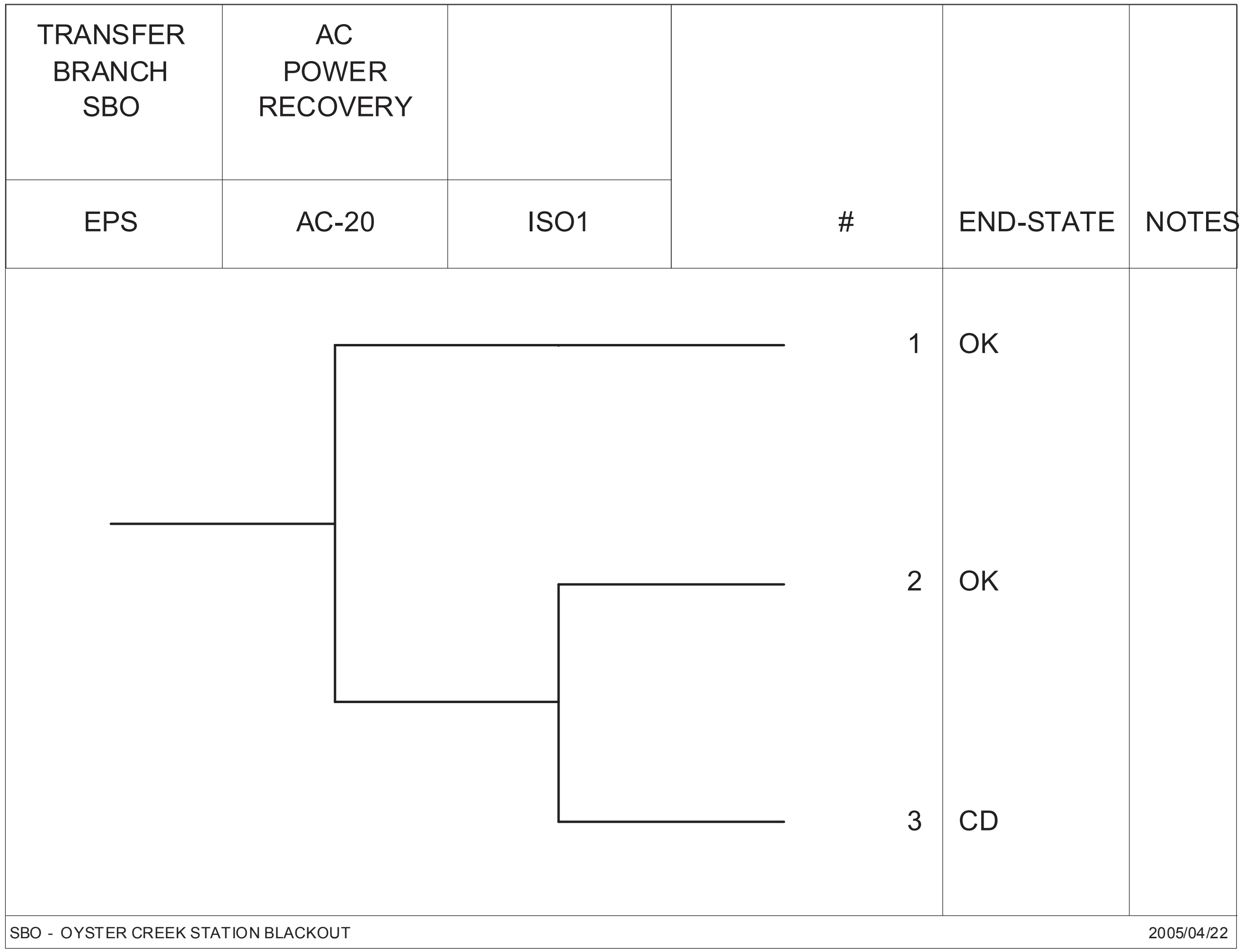


Figure A-5 LOIS - SD Event Tree

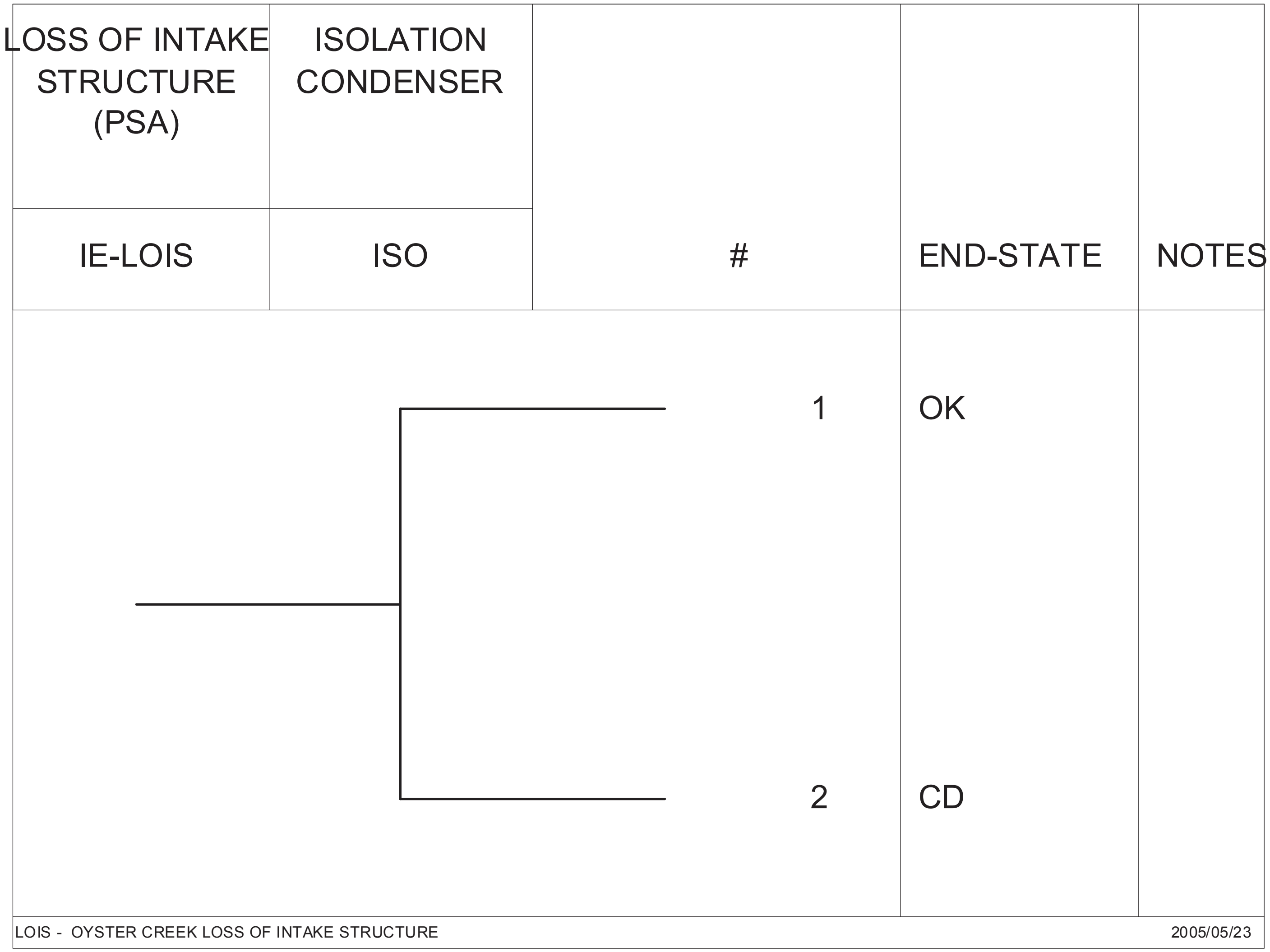


Figure A-6 Loss of RHR - SD Event Tree

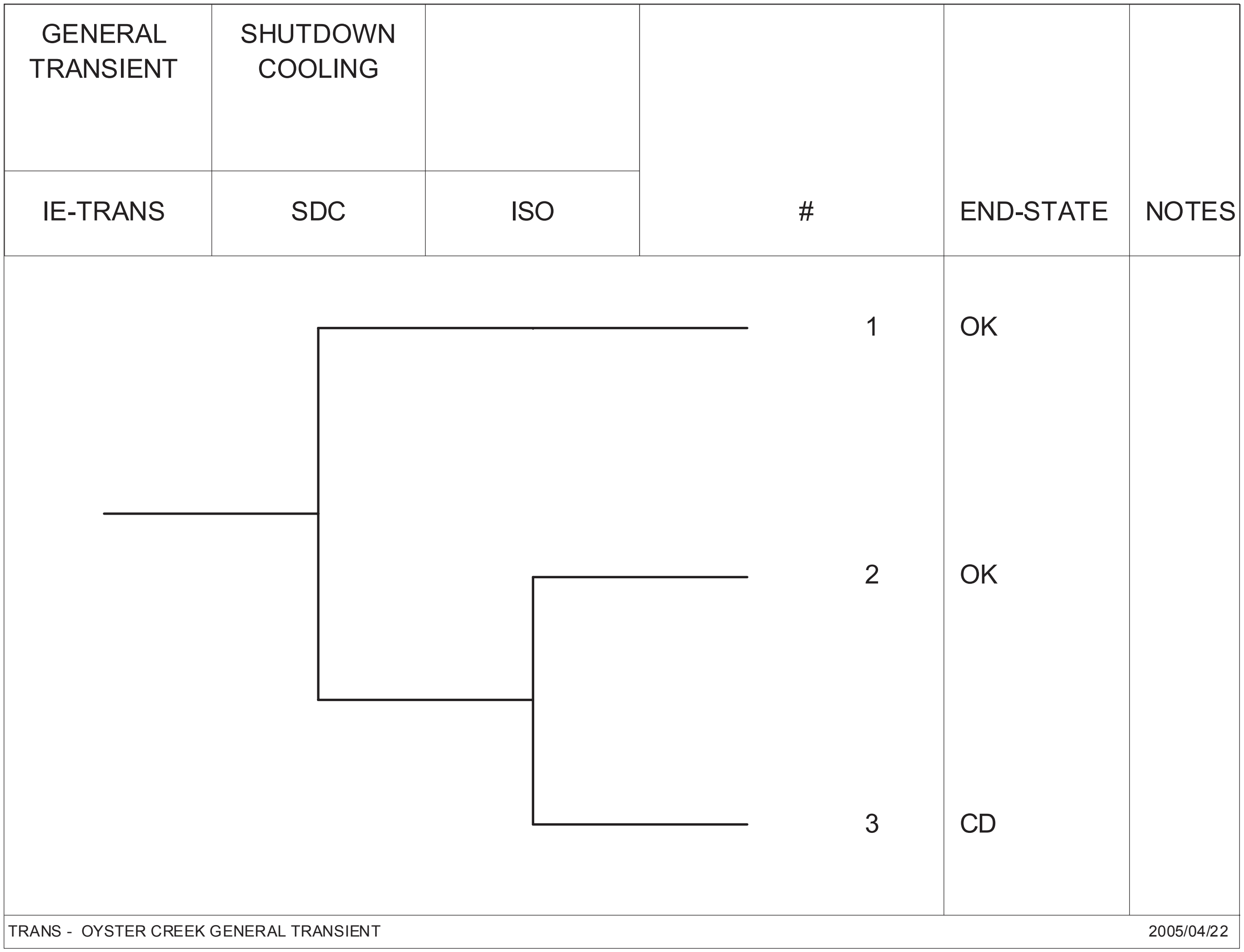


Figure 7 - LODCB - SD Event Tree

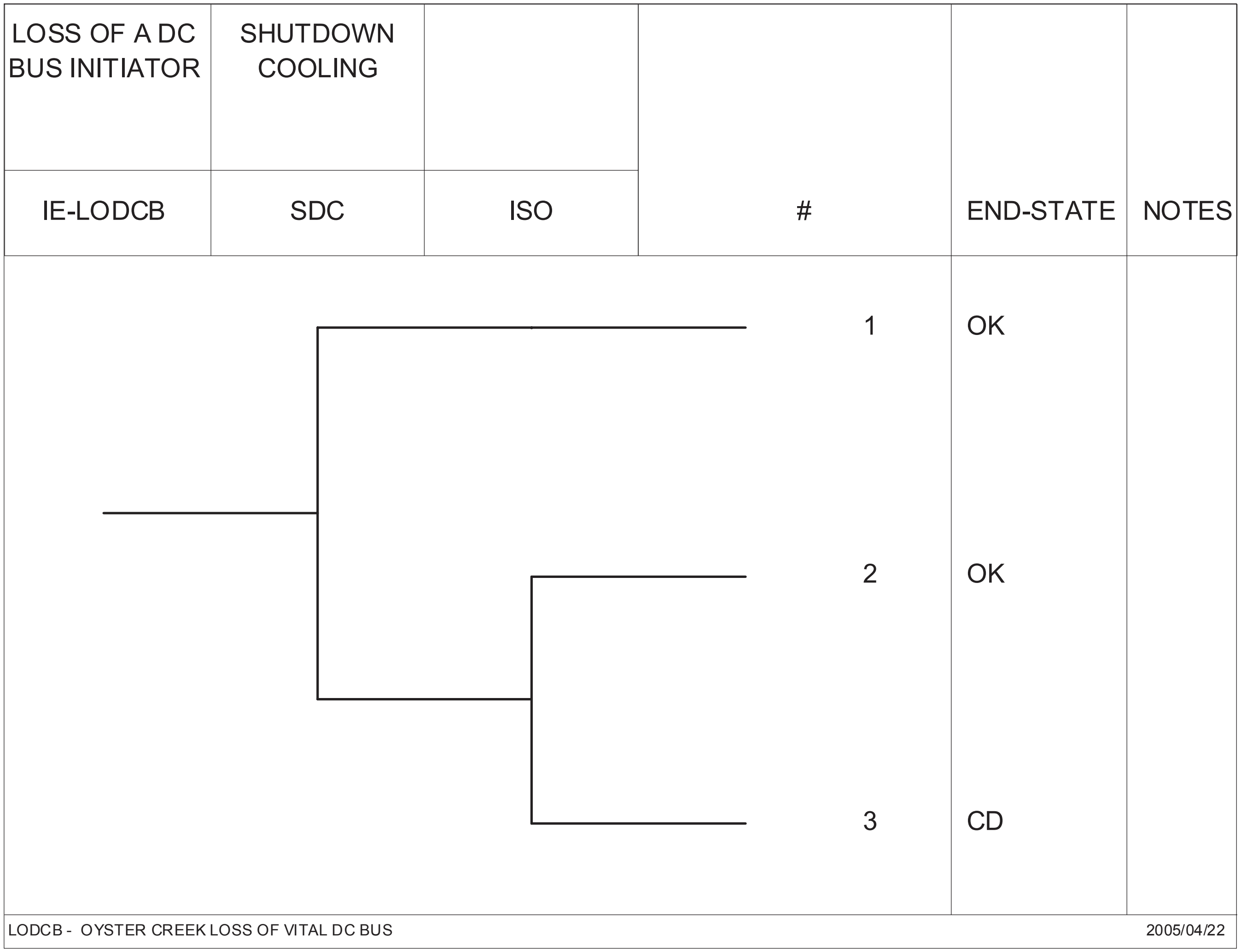


Figure A-8 SDC Fault Tree

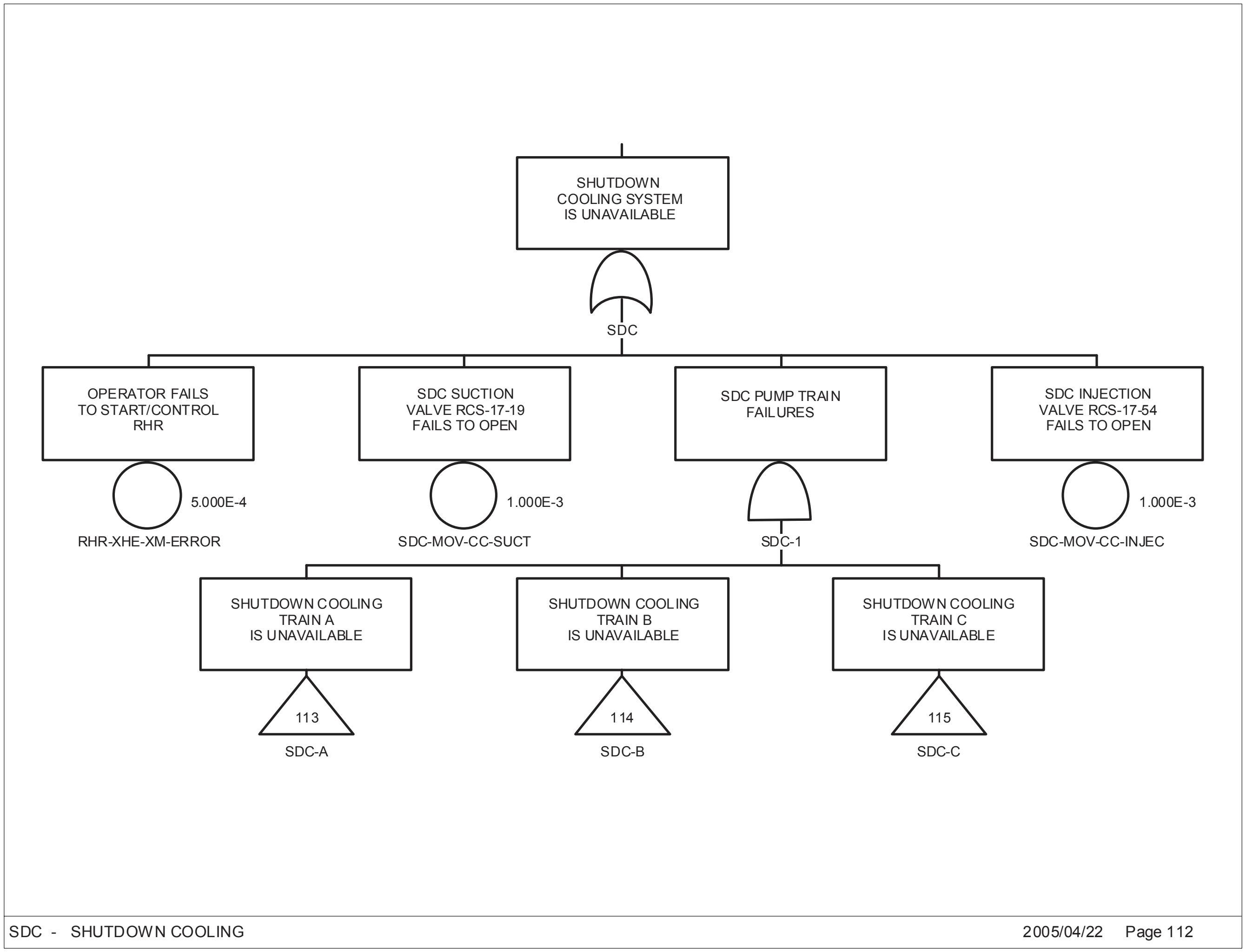


Figure A-9 SDC-A Fault Tree

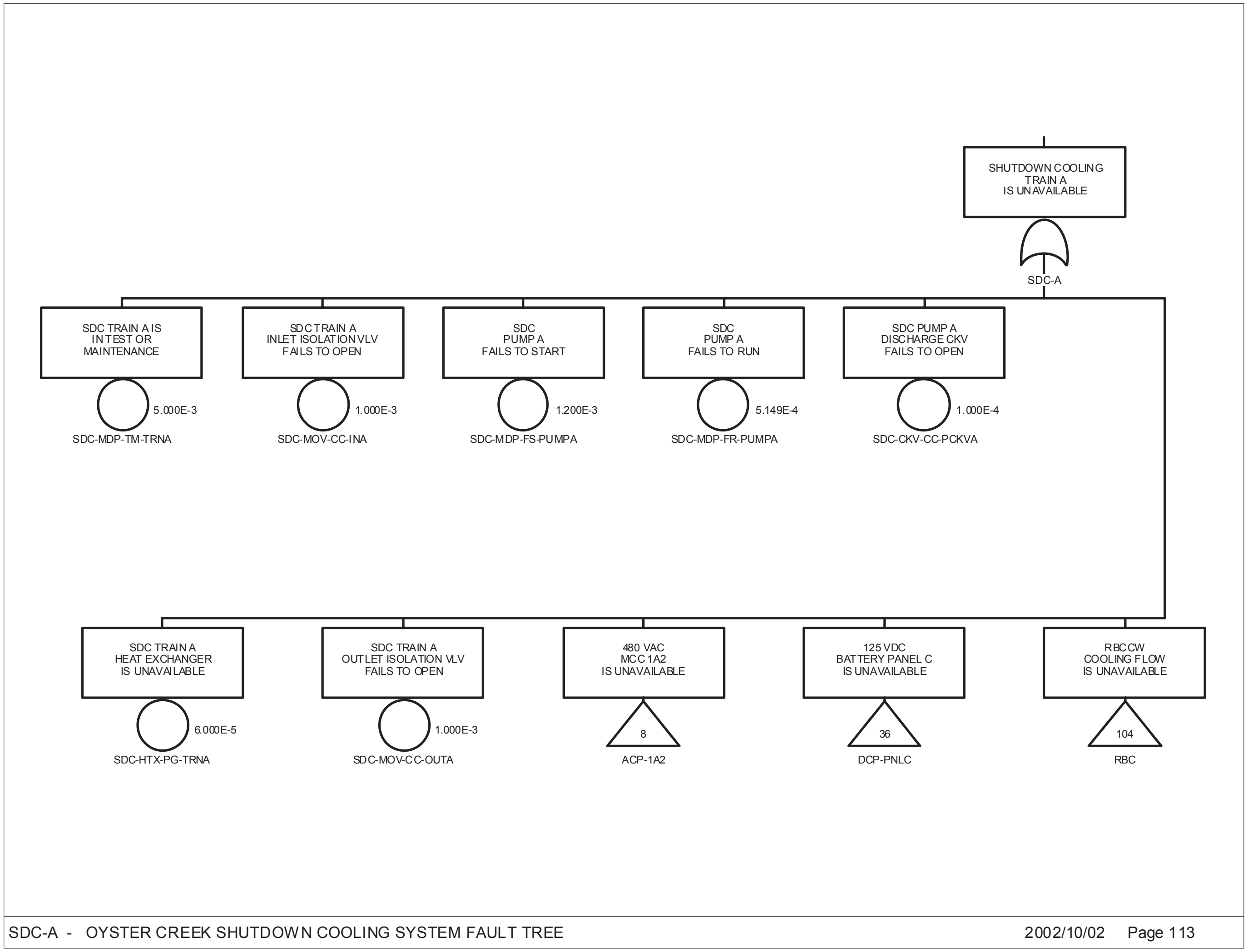
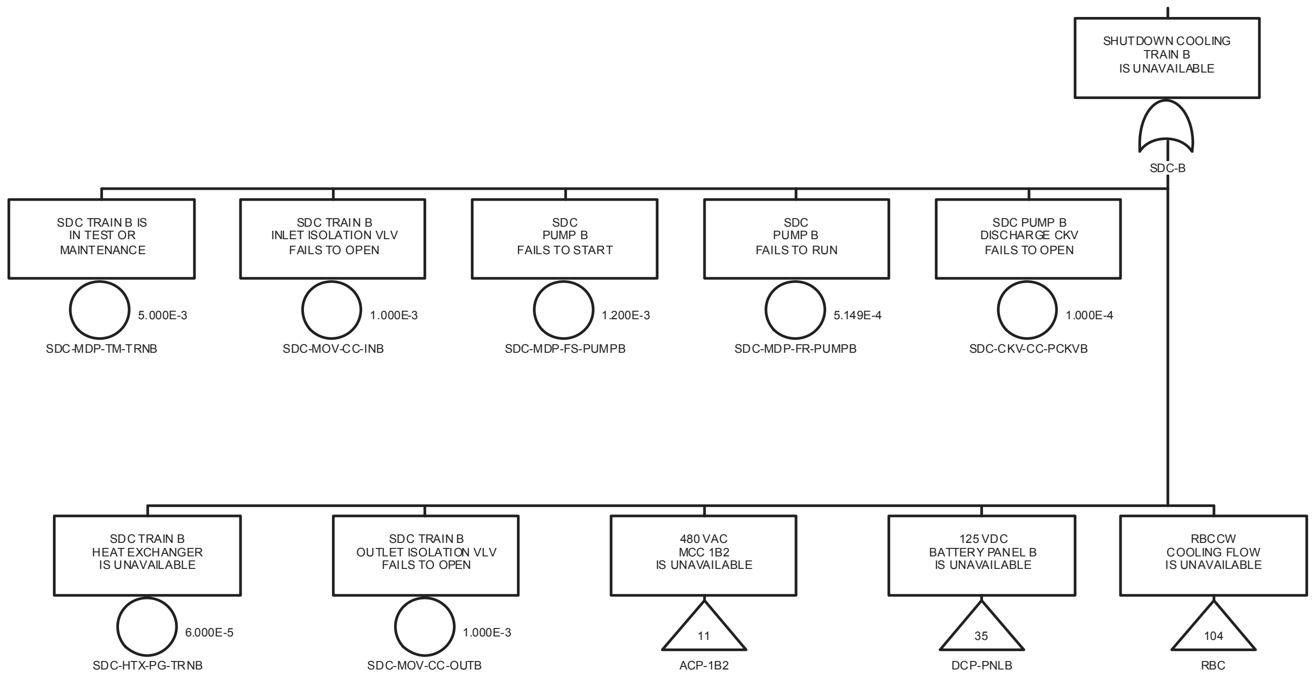
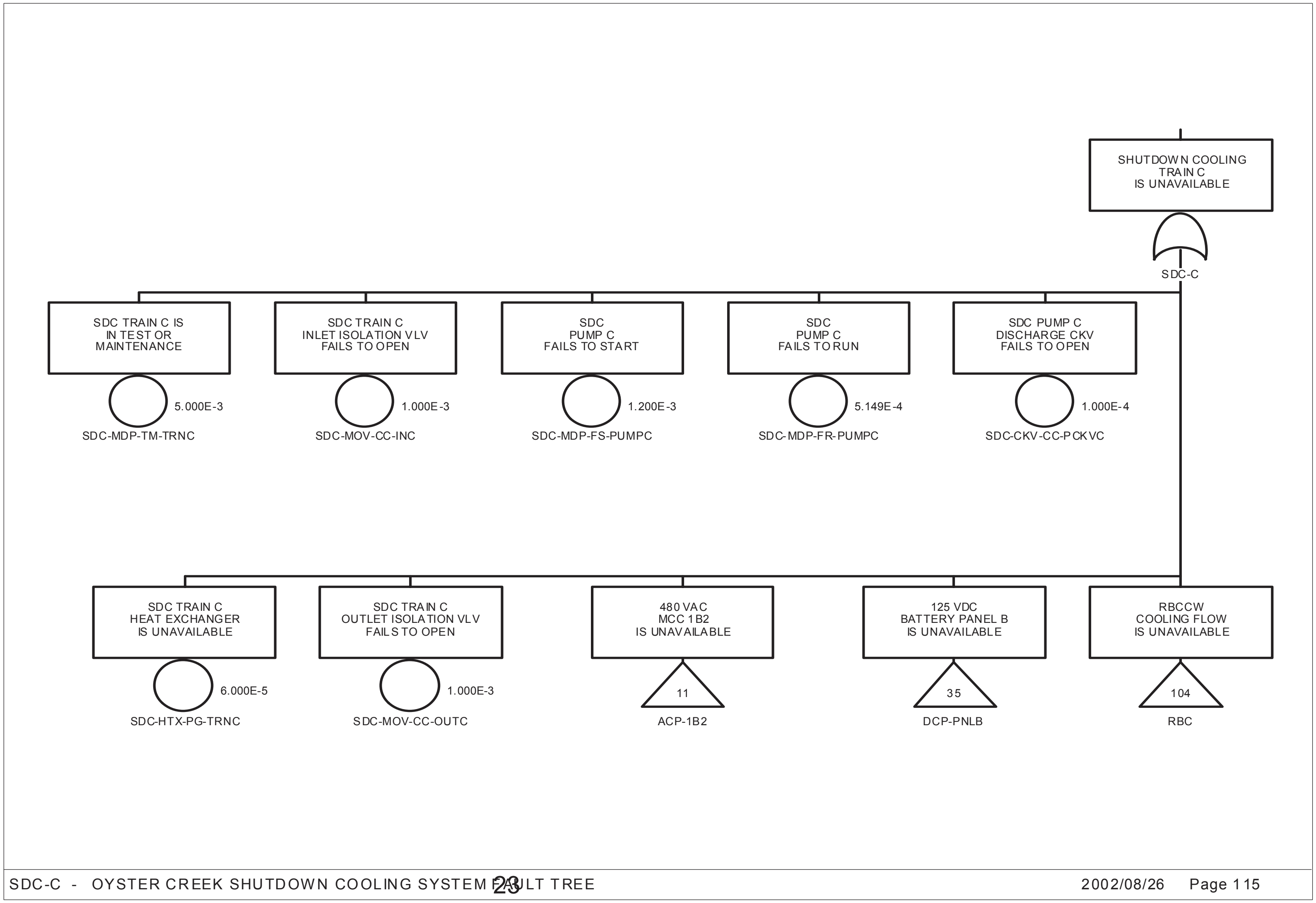


Figure A-10 SDC-B Fault Tree



SDC-B - OYSTER CREEK SHUTDOWN COOLING SYSTEM FAULT TREE 2002/08/26 Page 114

Figure A-11 SDC-C Fault Tree



Attachment B   Human Error Analysis

An operator recovery action represented by the basic event ISO-XHE-MOV-REC has been introduced, if the initiating event of loss of DC Bus B occurs, in addition to the plant condition. In that case, the DC bus A is also assumed depleted by the condition. However, the operators have the proceduralized recovery action (Reference 4) of opening the isolation condenser MOV EC-14-34 to start decay heat removal via the isolation condenser (ISO event tree node) upon failure of DC bus B.

The diagnosis part of this HEP is assigned moderately complex diagnosis and high stress due to loss of DC bus B event coupled with the condition. The action is also assigned high stress, but is of nominal complexity. The other PSFs are nominal.

The HEP of the basic event ISO-XHE-MOV-REC is calculated as the sum of diagnosis (4E-02) plus action (2E-03)phases:

HEP = 4.2E-02.

Table C-1: Table C-2

Attachment C Ou

Output for the TRANS4 event

LER 219/03-002

C O N D I T I O N   A S S E S S M E N T

Code Version: 7:25	Model Version : 2004/12/22
Project : OYST_3	Duration (hrs) : 3.4E+001
User Name : INEEL	Total CCDP : 5.6E-007
Event ID : 34-HOURS	Total CDP : 1.4E-008
	Importance : 5.5E-007

Description : Condition Assessment for 34-hour condition

BASIC EVENT CHANGES

Event Name	Description	Base Prob	Curr Prob	Type
ACP-BAC-LP-1C	4160 VAC BUS 1C IS UNAVAILAB	4.8E-006	1.0E+000	TRUE
EPS-DGN-TM-DG1	DG1 IS UNAVAILABLE DUE TO TE	9.0E-003	1.0E+000	TRUE
ISO-XHE-MOV-REC	Operator opens MOV EC-14-34	+0.0E+000	4.2E-002	

SEQUENCE PROBABILITIES

Truncation : Cummulative : 100.0% Individual : 1.0%

Event Tree Name	Sequence Name	CCDP	CDP	Importance
LODCB	29	4.5E-007	2.6E-010	4.5E-007
LOOP	14-24	6.2E-008	3.1E-009	5.9E-008
LOOP	14-03	1.6E-008	7.8E-010	1.5E-008
LODCB	32-20	1.3E-008	3.3E-013	1.3E-008
LOOP	14-26	5.8E-009	2.9E-010	5.5E-009

NOTE: Percent contribution to total Importance.

SEQUENCE LOGIC

Event Tree	Sequence Name	Logic	
LODCB	29	/RPS	/SRV
		PCS	ISO
		MFW	/DEP
		CDS	LCS
LOOP	14-24	/RPS	EPS
		P1	/ISO1
		AC-1HR	
LOOP	14-03	/RPS	EPS
		/SRV	/ISO1
		CTG	/SEALS
		/DCL	AC-8HR
LODCB	32-20	/RPS	P2

		PCS /DEP LCS	MFW CDS
LOOP	14-26	/RPS P2	EPS

Fault Tree Name	Description
AC-1HR	OYSTER CREEK AC POWER RECOVERY IN 1 HOUR
AC-8HR	OYSTER CREEK AC POWER RECOVERY IN 8 HOURS
CDS	CONDENSATE
CTG	OYSTER CREEK AC FORKED RIVER COMBUSTION TURBINES
DCL	OYSTER CREEK AC OPERATOR SHEDS DC LOADS
DEP	MANUAL REACTOR DEPRESS
EPS	OYSTER CREEK AC TRANSFER BRANCH SBO
ISO	ISOLATION CONDENSER
ISO1	OYSTER CREEK ISOLATION CONDENSER
LCS	CORE SPRAY
MFW	FEEDWATER
P1	OYSTER CREEK PRESSURE RELIEF SYSTEM FAULT TREE
P2	OYSTER CREEK PRESSURE RELIEF SYSTEM FAULT TREE
PCS	POWER CONVERSION SYSTEM
RPS	REACTOR PROTECTION SYSTEM
SEALS	OYSTER CREEK RECIRC PUMP SEAL FAULT TREE
SRV	SRVs ARE CLOSED

SEQUENCE CUT SETS

Truncation: Cummulative: 100.0% Individual: 1.0%

Event Tree: LODCB CCDF: 1.2E-004
Sequence: 29

CCDF	% Cut Set	Cut Set Events
1.1E-004	91.53	ISO-XHE-MOV-REC
2.5E-006	2.18	ISO-XHE-XE-LCTRL
2.5E-006	2.18	ISO-MOV-CC-V1434
2.5E-006	2.18	ISO-XHE-XE-ERROR
2.3E-006	1.96	ISO-AOV-CC-V1136

Event Tree: LOOP CCDF: 1.6E-005
Sequence: 14-24

CCDF	% Cut Set	Cut Set Events	
9.7E-006	60.74	EPS-XHE-XL-NR01H	PPR-SRV-OO-1VLV
		EPS-DGN-FR-DG2	OEP-XHE-XL-NR01H

4.1E-006	25.82	EPS-XHE-XL-NR01H	PPR-SRV-OO-1VLV
		EPS-DGN-TM-DG2	OEP-XHE-XL-NR01H
1.8E-006	11.48	EPS-XHE-XL-NR01H	PPR-SRV-OO-1VLV
		EPS-DGN-FS-DG2	OEP-XHE-XL-NR01H
2.7E-007	1.68	EPS-XHE-XL-NR01H	PPR-SRV-OO-1VLV
		OEP-XHE-XL-NR01H	EPS-DGN-CF-RUN

Event Tree: LOOP   CCDF: 4.0E-006
Sequence: 14-03

CCDF	% Cut Set	Cut Set Events	
2.1E-006	53.48	EPS-XHE-XM-CTG	EPS-XHE-XL-NR08H
		EPS-DGN-FR-DG2	OEP-XHE-XL-NR08H
9.1E-007	22.73	EPS-XHE-XM-CTG	EPS-XHE-XL-NR08H
		EPS-DGN-TM-DG2	OEP-XHE-XL-NR08H
4.0E-007	10.10	EPS-XHE-XM-CTG	EPS-XHE-XL-NR08H
		EPS-DGN-FS-DG2	OEP-XHE-XL-NR08H
5.9E-008	1.48	EPS-XHE-XM-CTG	EPS-XHE-XL-NR08H
		EPS-DGN-CF-RUN	OEP-XHE-XL-NR08H
5.3E-008	1.34	EPS-CTG-TM-#1	EPS-CTG-TM-#2
		EPS-XHE-XL-NR08H	EPS-DGN-FR-DG2
		OEP-XHE-XL-NR08H	
4.3E-008	1.07	EPS-CTG-FS-#1	EPS-CTG-TM-#2
		EPS-XHE-XL-NR08H	EPS-DGN-FR-DG2
		OEP-XHE-XL-NR08H	
4.3E-008	1.07	EPS-CTG-FS-#2	EPS-CTG-TM-#1
		EPS-XHE-XL-NR08H	EPS-DGN-FR-DG2
		OEP-XHE-XL-NR08H	

Event Tree: LODCB   CCDF: 3.3E-006
Sequence: 32-20

CCDF	% Cut Set	Cut Set Events
3.3E-006	100.00	PPR-SRV-OO-2VLVS

Event Tree: LOOP   CCDF: 1.5E-006
Sequence: 14-26

CCDF	% Cut Set	Cut Set Events	
9.1E-007	60.73	PPR-SRV-OO-2VLVS	EPS-DGN-FR-DG2
3.9E-007	25.82	PPR-SRV-OO-2VLVS	EPS-DGN-TM-DG2
1.7E-007	11.47	PPR-SRV-OO-2VLVS	EPS-DGN-FS-DG2
2.5E-008	1.68	PPR-SRV-OO-2VLVS	EPS-DGN-CF-RUN

BASIC EVENTS (Cut Sets Only)

Event Name	Description	Curr Prob

Event Name	Description	Curr Prob
EPS-CTG-FS-#1	FORKED RIVER COMBUSTION TURBINE #1 FAILS TO S	4.0E-002
EPS-CTG-FS-#2	FORKED RIVER COMBUSTION TURBINE #2 FAILS TO S	4.0E-002
EPS-CTG-TM-#1	FORKED RIVER COMBUSTION TURBINE #1 IS IN TEST	5.0E-002
EPS-CTG-TM-#2	FORKED RIVER COMBUSTION TURBINE #2 IS IN TEST	5.0E-002
EPS-DGN-CF-RUN	DIESEL FAIL FROM COMMON CAUSE TO RUN	5.9E-004
EPS-DGN-FR-DG2	DIESEL GENERATOR DG2 FAILS TO RUN	2.1E-002
EPS-DGN-FS-DG2	DIESEL GENERATOR DG2 FAILS TO START	4.0E-003
EPS-DGN-TM-DG2	DG2 IS UNAVAILABLE DUE TO TEST OR MAINTENANCE	9.0E-003
EPS-XHE-XL-NR01H	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN	8.4E-001
EPS-XHE-XL-NR08H	OPERATOR FAILS TO RECOVER EMERGENCY DIESEL IN	2.5E-001
EPS-XHE-XM-CTG	FAILURE TO ALIGN FORKED RIVER COMBUSTION TURB	1.0E-001
ISO-AOV-CC-V1136	MAKEUP ISOLATION VALVE V-11-36 TO EC-A FAILS	9.0E-004
ISO-MOV-CC-V1434	TRAIN A INJECTION VALVE EC-14-34 FAILS TO OPE	1.0E-003
ISO-XHE-MOV-REC	OPERATOR OPENS MOV EC-14-34 WHEN 125VDC BUS I	4.2E-002
ISO-XHE-XE-ERROR	OPERATOR FAILS TO START/CONTROL EMERGENCY CON	1.0E-003
ISO-XHE-XE-LCTRL	OPERATOR FAILS TO CONTROL REACTOR WATER LEVEL	1.0E-003
OEP-XHE-XL-NR01H	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 1	5.3E-001
OEP-XHE-XL-NR08H	OPERATOR FAILS TO RECOVER OFFSITE POWER IN 8	1.2E-001
PPR-SRV-OO-1VLV	ONE SRV FAILS TO CLOSE	3.1E-002
PPR-SRV-OO-2VLVS	TWO SRVS STICK OPEN	1.3E-003

I N I T I A T I N G   E V E N T   A S S E S S M E N T

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                                          Code  Ver : 7:25
Fam  : OYST_3                             Model Ver : 2004/12/22
User : INEEL                              Init Event: IE-TRANS
Ev ID: TRANS-IEV                          Total CCDP:  3.6E-007
Desc : Initiating Event Assessment
```

BASIC EVENT CHANGES

Event Name	Description	Base Prob	Curr Prob	Type
ACP-BAC-LP-1C	4160 VAC BUS 1C IS UNAVAILAB	4.8E-006	1.0E+000	TRUE
EPS-DGN-TM-DG1	DG1 IS UNAVAILABLE DUE TO TE	9.0E-003	1.0E+000	TRUE
IE-IORV	INADVERTENT OPEN RELIEF VALV	1.5E-002	+0.0E+000	
IE-LCS-V-A	ISLOCA OCCURS WITH REACTOR A	8.8E+003	+0.0E+000	
IE-LCS-V-B	ISLOCA OCCURS WITH REACTOR A	8.8E+003	+0.0E+000	
IE-LLOCA	LARGE LOSS OF COOLANT ACCIDE	3.0E-005	+0.0E+000	
IE-LOCHS	LOSS OF CONDENSER HEAT SINK	2.0E-001	+0.0E+000	
IE-LOCW	LOSS OF CIRCULATING WATER	4.0E-004	+0.0E+000	
IE-LODCB	LOSS OF A DC BUS INITIATOR	2.5E-003	+0.0E+000	
IE-LOIS	LOSS OF INTAKE STRUCTURE (PS	7.5E-003	+0.0E+000	
IE-LOMFW	LOSS OF FEEDWATER TRANSIENT	1.0E-001	+0.0E+000	
IE-LOOP	LOSS OF OFFSITE POWER	3.3E-002	+0.0E+000	
IE-LOSWS	LOSS OF SERVICE WATER INITIA	4.0E-004	+0.0E+000	
IE-SLOCA	SMALL LOCA INITIATING EVENT	4.0E-004	+0.0E+000	
IE-TRANS	GENERAL TRANSIENT	8.0E-001	1.0E+000	
ISO-XHE-MOV-REC	Operator opens MOV EC-14-34	+0.0E+000	4.2E-002	

SEQUENCE PROBABILITIES

Truncation : Cummulative : 100.0% Individual :   1.0%

Event Tree Name	Sequence Name	CCDP	%Cont
TRANS	33-6	2.7E-007	
TRANS	34-6	5.0E-008	
TRANS	34-5	2.1E-008	
TRANS	34-7	1.9E-008	

SEQUENCE LOGIC

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Event Tree     Sequence Name                        Logic
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TRANS          33-6          /RPS                        P3
                              LCS

TRANS          34-6           RPS                       /PPR
                             /RRS                        PCS

TRANS          34-5           RPS                       /PPR
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		/RRS	/PCS
		SLC	
TRANS	34-7	RPS	/PPR
		RRS	

Fault Tree Name	Description
LCS	CORE SPRAY
P3	OYSTER CREEK PRESSURE RELIEF SYSTEM FAULT TREE
PCS	POWER CONVERSION SYSTEM
PPR	OYSTER CREEK PRESSURE RELIEF SYSTEM FAULT TREE
RPS	REACTOR PROTECTION SYSTEM
RRS	OYSTER CREEK RECIRCULATION PUMP TRIP FAULT TREE
SLC	OYSTER CREEK STANDBY LIQUID CONTROL SYSTEM FAULT TREE

SEQUENCE CUT SETS

Truncation: Cummulative: 100.0% Individual: 1.0%

Event Tree: TRANS CCDP: 2.7E-007
Sequence: 33-6

CCDP	% Cut Set	Cut Set Events	
2.0E-007	75.04	PPR-SRV-OO-3VLVS	LCS-XHE-XM-ERROR
5.0E-009	1.88	PPR-SRV-OO-3VLVS	LCS-MDP-TM-P1C
		LCS-MDP-TM-P3B	
5.0E-009	1.88	PPR-SRV-OO-3VLVS	LCS-MDP-TM-P1B
		LCS-MDP-TM-P3C	
5.0E-009	1.88	PPR-SRV-OO-3VLVS	LCS-MDP-TM-P3B
		LCS-MDP-TM-P3C	
5.0E-009	1.88	PPR-SRV-OO-3VLVS	LCS-MDP-TM-P1B
		LCS-MDP-TM-P1C	

Event Tree: TRANS CCDP: 5.0E-008
Sequence: 34-6

CCDP	% Cut Set	Cut Set Events	
1.9E-008	37.74	MSS-TBV-CC-BYPS1	RPS-SYS-FC-PSOVS
8.5E-009	17.15	RPS-SYS-FC-PSOVS	TBC-MDP-TM-P55
4.2E-009	8.44	MSS-TBV-CC-BYPS1	RPS-SYS-FC-RELAY
2.8E-009	5.55	MSS-TBV-CC-BYPS1	RPS-SYS-FC-CRD
2.6E-009	5.15	RPS-SYS-FC-PSOVS	TBC-MDP-FS-P55
1.9E-009	3.83	RPS-SYS-FC-RELAY	TBC-MDP-TM-P55
1.7E-009	3.43	RPS-SYS-FC-PSOVS	TBC-XHE-XR-P55
1.7E-009	3.43	MFW-XHE-XO-ERROR	RPS-SYS-FC-PSOVS
1.3E-009	2.52	RPS-SYS-FC-CRD	TBC-MDP-TM-P55

1.2E-009	2.44	MSS-TBV-CC-BYPS1	RPS-SYS-FC-HCU
5.7E-010	1.15	RPS-SYS-FC-RELAY	TBC-MDP-FS-P55
5.5E-010	1.11	RPS-SYS-FC-HCU	TBC-MDP-TM-P55

Event Tree: TRANS　　CCDP: 2.1E-008
Sequence: 34-5

CCDP	% Cut Set	Cut Set Events	
8.5E-009	40.64	SLC-MDP-TM-P12	RPS-SYS-FC-PSOVS
2.0E-009	9.75	SLC-MDP-FS-P12	RPS-SYS-FC-PSOVS
1.9E-009	9.09	SLC-MDP-TM-P12	RPS-SYS-FC-RELAY
1.7E-009	8.13	SLC-XHE-XR-P12	RPS-SYS-FC-PSOVS
1.7E-009	8.13	RPS-SYS-FC-PSOVS	SLC-XHE-XM-ERROR
1.3E-009	5.98	SLC-MDP-TM-P12	RPS-SYS-FC-CRD
5.5E-010	2.63	SLC-MDP-TM-P12	RPS-SYS-FC-HCU
4.6E-010	2.18	SLC-MDP-FS-P12	RPS-SYS-FC-RELAY
3.8E-010	1.82	SLC-XHE-XR-P12	RPS-SYS-FC-RELAY
3.8E-010	1.82	RPS-SYS-FC-RELAY	SLC-XHE-XM-ERROR
3.0E-010	1.43	SLC-MDP-FS-P12	RPS-SYS-FC-CRD
2.5E-010	1.20	RPS-SYS-FC-CRD	SLC-XHE-XM-ERROR
2.5E-010	1.20	SLC-XHE-XR-P12	RPS-SYS-FC-CRD

Event Tree: TRANS　　CCDP: 1.9E-008
Sequence: 34-7

CCDP	% Cut Set	Cut Set Events	
2.6E-009	13.72	RRS-CRB-CC-PUMP2	RPS-SYS-FC-PSOVS
2.6E-009	13.72	RRS-CRB-CC-PUMP1	RPS-SYS-FC-PSOVS
2.6E-009	13.72	RRS-CRB-CC-PUMP3	RPS-SYS-FC-PSOVS
2.6E-009	13.72	RRS-CRB-CC-PUMP4	RPS-SYS-FC-PSOVS
2.6E-009	13.72	RRS-CRB-CC-PUMP5	RPS-SYS-FC-PSOVS
5.7E-010	3.07	RRS-CRB-CC-PUMP2	RPS-SYS-FC-RELAY
5.7E-010	3.07	RRS-CRB-CC-PUMP1	RPS-SYS-FC-RELAY
5.7E-010	3.07	RRS-CRB-CC-PUMP3	RPS-SYS-FC-RELAY
5.7E-010	3.07	RRS-CRB-CC-PUMP4	RPS-SYS-FC-RELAY
5.7E-010	3.07	RRS-CRB-CC-PUMP5	RPS-SYS-FC-RELAY
3.8E-010	2.02	RRS-CRB-CC-PUMP2	RPS-SYS-FC-CRD
3.8E-010	2.02	RRS-CRB-CC-PUMP1	RPS-SYS-FC-CRD
3.8E-010	2.02	RRS-CRB-CC-PUMP3	RPS-SYS-FC-CRD
3.8E-010	2.02	RRS-CRB-CC-PUMP4	RPS-SYS-FC-CRD
3.8E-010	2.02	RRS-CRB-CC-PUMP5	RPS-SYS-FC-CRD

BASIC EVENTS (Cut Sets Only)

Event Name	Description	Curr Prob
LCS-MDP-TM-P1B	PUMP CRS-1B IS IN TEST OR MAINTENANCE	5.0E-003
LCS-MDP-TM-P1C	PUMP CRS-1C IS IN TEST OR MAINTENANCE	5.0E-003
LCS-MDP-TM-P3B	PUMP CRS-3B IS IN TEST OR MAINTENANCE	5.0E-003

Event Name	Description	Curr Prob
LCS-MDP-TM-P3C	PUMP CRS-3C IS IN TEST OR MAINTENANCE	5.0E-003
LCS-XHE-XM-ERROR	OPERATOR FAILS TO START/CONTROL CORE SPRAY	1.0E-003
MFW-XHE-XO-ERROR	OPERATOR FAILS TO MAINTAIN FEEDWATER INJECTIO	1.0E-003
MSS-TBV-CC-BYPS1	TURBINE BYPASS VALVES FAIL TO OPEN	1.1E-002
PPR-SRV-OO-3VLVS	THREE OR MORE SRVS STICK OPEN	2.0E-004
RPS-SYS-FC-CRD	CONTROL ROD DRIVE MECHANICAL FAILURE	2.5E-007
RPS-SYS-FC-HCU	HCU COMPONENTS FAIL	1.1E-007
RPS-SYS-FC-PSOVS	HCU SCRAM PILOT SOVS FAIL	1.7E-006
RPS-SYS-FC-RELAY	TRIP SYSTEM RELAYS FAIL	3.8E-007
RRS-CRB-CC-PUMP1	RECIRC PUMP 1 FIELD BREAKER FAILS TO OPEN	1.5E-003
RRS-CRB-CC-PUMP2	RECIRC PUMP 2 FIELD BREAKER FAILS TO OPEN	1.5E-003
RRS-CRB-CC-PUMP3	RECIRC PUMP 3 FIELD BREAKER FAILS TO OPEN	1.5E-003
RRS-CRB-CC-PUMP4	RECIRC PUMP 4 FIELD BREAKER FAILS TO OPEN	1.5E-003
RRS-CRB-CC-PUMP5	RECIRC PUMP 5 FIELD BREAKER FAILS TO OPEN	1.5E-003
SLC-MDP-FS-P12	SLC PUMP 1-2 FAILS TO START	1.2E-003
SLC-MDP-TM-P12	SLC PUMP 1-2 IS IN TEST OR MAINTENANCE	5.0E-003
SLC-XHE-XM-ERROR	OPERATOR FAILS START/CONTROL SLC	1.0E-003
SLC-XHE-XR-P12	OPERATOR FAILS TO RESTORE PUMP AFTER TEST OR	1.0E-003
TBC-MDP-FS-P55	TBCCW PUMP P-5-005 FAILS TO START	1.5E-003
TBC-MDP-TM-P55	TBCCW PUMP P-5-005 IS UNAVAILABLE BECAUSE OF	5.0E-003
TBC-XHE-XR-P55	TBCCW PUMP P-5-005 NOT RESTORED AFTER MAINTEN	1.0E-003