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Vol. 2, Part 3A

Evaluation of Potential Severe Accidents During Low Power and Shutdown Operations at Surry, Unit 1

Analysis of Core Damage Frequency from Internal Events During Mid-Loop Operations

Appendix E (Sections E.1–E.8)

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Prepared by
T. L. Chu, Z. Musicki, P. Kohut, D. Bley[1], J. Yang, B. Holmes[2],
G. Bozoki, C. J. Hsu, D. J. Diamond, D. Johnson[1], J. Lin[1],
R. F. Su[3], V. Dang[3], D. Ilberg[4], S. M. Wong, N. Siu[3]

Brookhaven National Laboratory
Upton, NY 11973

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[1]PLG Inc., 4590 MacArthur Boulevard, Newport Beach, CA 92660-2027
[2]AEA Technology, Winfrith, Dorchester, Dorset, England, DT2 8DH
[3]MIT, Cambridge, MA 02139 (N. Siu currently at EG&G, Idaho Falls, ID 83415)
[4]Soreq Nuclear Research Center, Yavne 70600, Israel

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ABSTRACT

Traditionally, probabilistic risk assessments (PRA) of severe accidents in nuclear power plants have considered initiating events potentially occurring only during full power operation. Some previous screening analyses that were performed for other modes of operation suggested that risks during those modes were small relative to full power operation. However, more recent studies and operational experience have implied that accidents during low power and shutdown could be significant contributors to risk.

During 1989, the Nuclear Regulatory Commission (NRC) initiated an extensive program to carefully examine the potential risks during low power and shutdown operations. The program includes two parallel projects being performed by Brookhaven National Laboratory (BNL) and Sandia National Laboratories (SNL). Two plants, Surry (pressurized water reactor) and Grand Gulf (boiling water reactor), were selected as the plants to be studied.

The objectives of the program are to assess the risks of severe accidents initiated during plant operational states other than full power operation and to compare the estimated core damage frequencies, important accident sequences and other qualitative and quantitative results with those accidents initiated during full power operation as assessed in NUREG-1150. The scope of the program includes that of a level-3 PRA.

The objective of this volume of the report is to document the approach utilized in the level-1 internal events PRA for the Surry plant, and discuss the results obtained. A phased approach was used in the level-1 program. In phase 1, which was completed in Fall 1991, a coarse screening analysis examining accidents initiated by internal events (including internal fire and flood) was performed for all plant operational states (POSs). The objective of the phase 1 study was to identify potential vulnerable plant configurations, to characterize (on a high, medium, or low basis) the potential core damage accident scenarios, and to provide a foundation for a detailed phase 2 analysis.

In phase 2, mid-loop operation was selected as the plant configuration to be analyzed based on the results of the phase 1 study. The objective of the phase 2 study is to perform a detailed analysis of the potential accident scenarios that may occur during mid-loop operation, and compare the results with those of NUREG-1150. The scope of the level-1 study includes plant damage state analysis, and uncertainty analysis. Volume 1 summarizes the results of the study. Internal events analysis is documented in Volume 2. It also contains an appendix that documents the part of the phase 1 study that has to do with POSs other than mid-loop operation. Internal fire and internal flood analyses are documented in Volumes 3 and 4. A separate study on seismic analysis, documented in Volume 5, was performed for the NRC by Future Resources Associates, Inc. Volume 6 documents the accident progression, source terms, and consequences analysis.

In the phase 2 study, system models applicable for shutdown conditions were developed and supporting thermal hydraulic analysis were performed to determine both the timing of the accidents and success criteria for systems. Initiating events that may occur during mid-loop operations were identified and accident sequence event trees were developed and quantified. In the preliminary quantification of the mid-loop accident sequences, it was found that the decay heat at which the accident initiating event occurs is an important parameter that determines both the success criteria for the mitigating functions and the time available for operator actions. In order to better account for the decay heat, a "time window" approach was

developed. In this approach, time windows after shutdown were defined based on the success criteria established for the various methods that can be used to mitigate the accident. Within each time window, the decay heat and accident sequence timing are more accurately defined and new event trees developed and quantified accordingly. Statistical analysis of the past outage data was performed to determine the time at which a mid-loop condition is reached, and the duration of the mid-loop operation. Past outage data were used to determine the probability that an accident initiating event occurs in each of the time windows. This probability is used in the quantification of the accident sequences.

The mean core damage frequency of the Surry plant due to internal events that may take place during mid-loop operations is 5E-06 per year, and the 5th and 95th percentiles are 5E-07 and 2E-05 per year, respectively. This can be compared with the mean core damage frequency from internal events of 4E-05 per year estimated in the NUREG-1150 study for full power operations.

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Appendix E Event Trees and Their Associated High Level Fault Trees

FOREWORD

(NUREG/CR-6143 and 6144)
Low Power and Shutdown Probabilistic Risk Assessment Program

Traditionally, probabilistic risk assessments (PRA) of severe accidents in nuclear power plants have considered initiating events potentially occurring only during full power operation. Some previous screening analysis that were performed for other modes of operation suggested that risks during those modes were small relative to full power operation. However, more recent studies and operational experience have implied that accidents during low power and shutdown could be significant contributors to risk.

During 1989, the Nuclear Regulatory Commission (NRC) initiated an extensive program to carefully examine the potential risks during low power and shutdown operations. The program includes two parallel projects performed by Brookhaven National Laboratory(BNL) and Sandia National Laboratories(SNL), with the seismic analysis performed by Future Resources Associates. Two plants, Surry (pressurized water reactor) and Grand Gulf (boiling water reactor), were selected as the plants to be studied.

The objectives of the program are to assess the risks of severe accidents due to internal events, internal fires, internal floods, and seismic events initiated during plant operational states other than full power operation and to compare the estimated core damage frequencies, important accident sequences and other qualitative and quantitative results with those accidents initiated during full power operation as assessed in NUREG-1150. The scope of the program includes that of a level-3 PRA.

The results of the program are documented in two reports, NUREG/CR-6143 and 6144. The reports are organized as follows:

For Grand Gulf:

NUREG/CR-6143 - Evaluation of Potential Severe Accidents during Low Power and Shutdown Operations at Grand Gulf, Unit 1

Volume 1: Summary of Results
Volume 2: Analysis of Core Damage Frequency from Internal Events for Operational State 5 During a Refueling Outage
- Part 1: Main Report
  - Part 1A: Sections 1 - 9
  - Part 1B: Section 10
  - Part 1C: Sections 11 - 14
- Part 2: Internal Events Appendices A to H
- Part 3: Internal Events Appendices I and J
- Part 4: Internal Events Appendices K to M

Volume 3: Analysis of Core Damage Frequency from Internal Fire Events for Plant Operational State 5 During a Refueling Outage
Volume 4: Analysis of Core Damage Frequency from Internal Flooding Events for Plant Operational State 5 During a Refueling Outage
Volume 5: Analysis of Core Damage Frequency from Seismic Events for Plant Operational State 5 During a Refueling Outage

Foreword (continued)

Volume 6: Evaluation of Severe Accident Risks for Plant Operational State 5 During a Refueling Outage
- Part 1: Main Report
- Part 2: Supporting MELCOR Calculations

For Surry:

NUREG/CR-6144- Evaluation of Potential Severe Accidents during Low Power and Shutdown Operations at Surry Unit-1

Volume 1: Summary of Results

Volume 2: Analysis of Core Damage Frequency from Internal Events during Mid-loop Operations
- Part 1: Main Report
  - Part 1A: Chapters 1 - 6
  - Part 1B: Chapters 7 - 12
- Part 2: Internal Events Appendices A to D
- Part 3: Internal Events Appendix E
  - Part 3A: Sections E.1 - E.8
  - Part 3B: Sections E.9 - E.16
- Part 4: Internal Events Appendices F to H
- Part 5: Internal Events Appendix I

Volume 3: Analysis of Core Damage Frequency from Internal Fires during Mid-loop Operations
- Part 1: Main Report
- Part 2: Appendices

Volume 4: Analysis of Core Damage Frequency from Internal Floods during Mid-loop Operations

Volume 5: Analysis of Core Damage Frequency from Seismic Events during Mid-loop Operations

Volume 6: Evaluation of Severe Accident Risks during Mid-loop Operations
- Part 1: Main Report
- Part 2: Appendices

APPENDIX E

EVENT TREES AND THEIR ASSOCIATED HIGH LEVEL FAULT TREES

APPENDIX E

EVENT TREES AND THEIR ASSOCIATED HIGH LEVEL FAULT TREES

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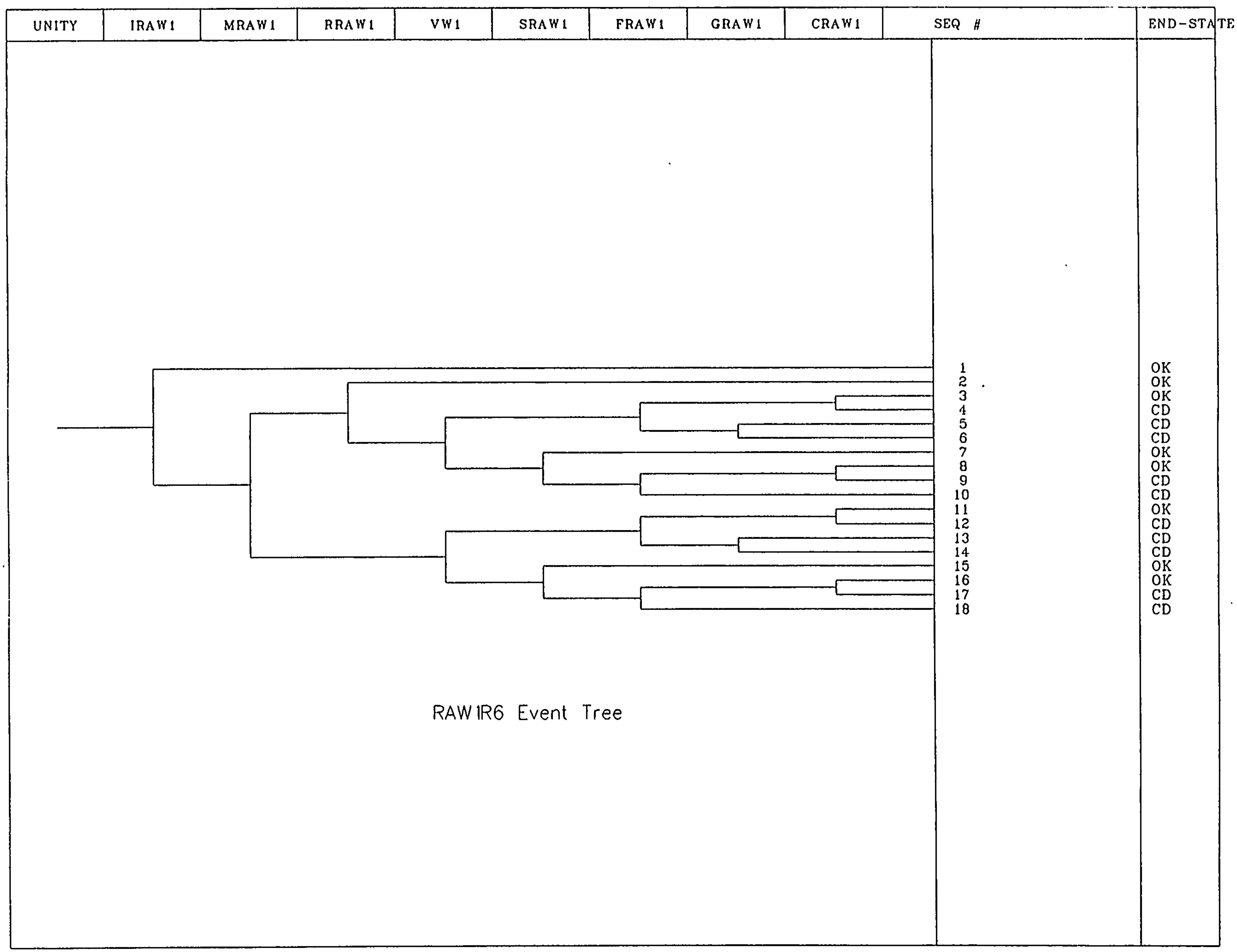
Appendix E.1 Event Trees and High Level Fault trees for Over Draining to Mid-loop(RHR2A)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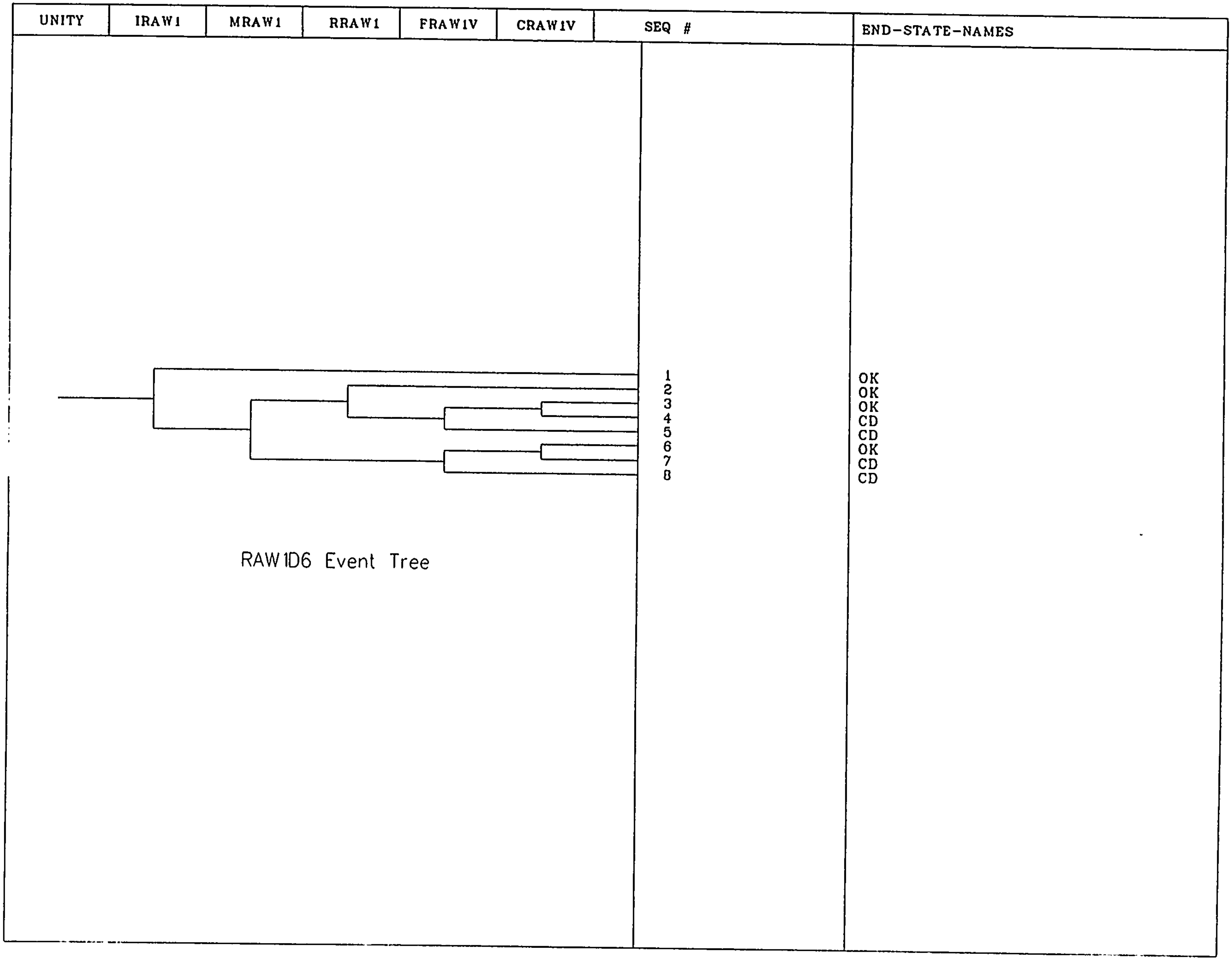
RAW1R6 Event Tree



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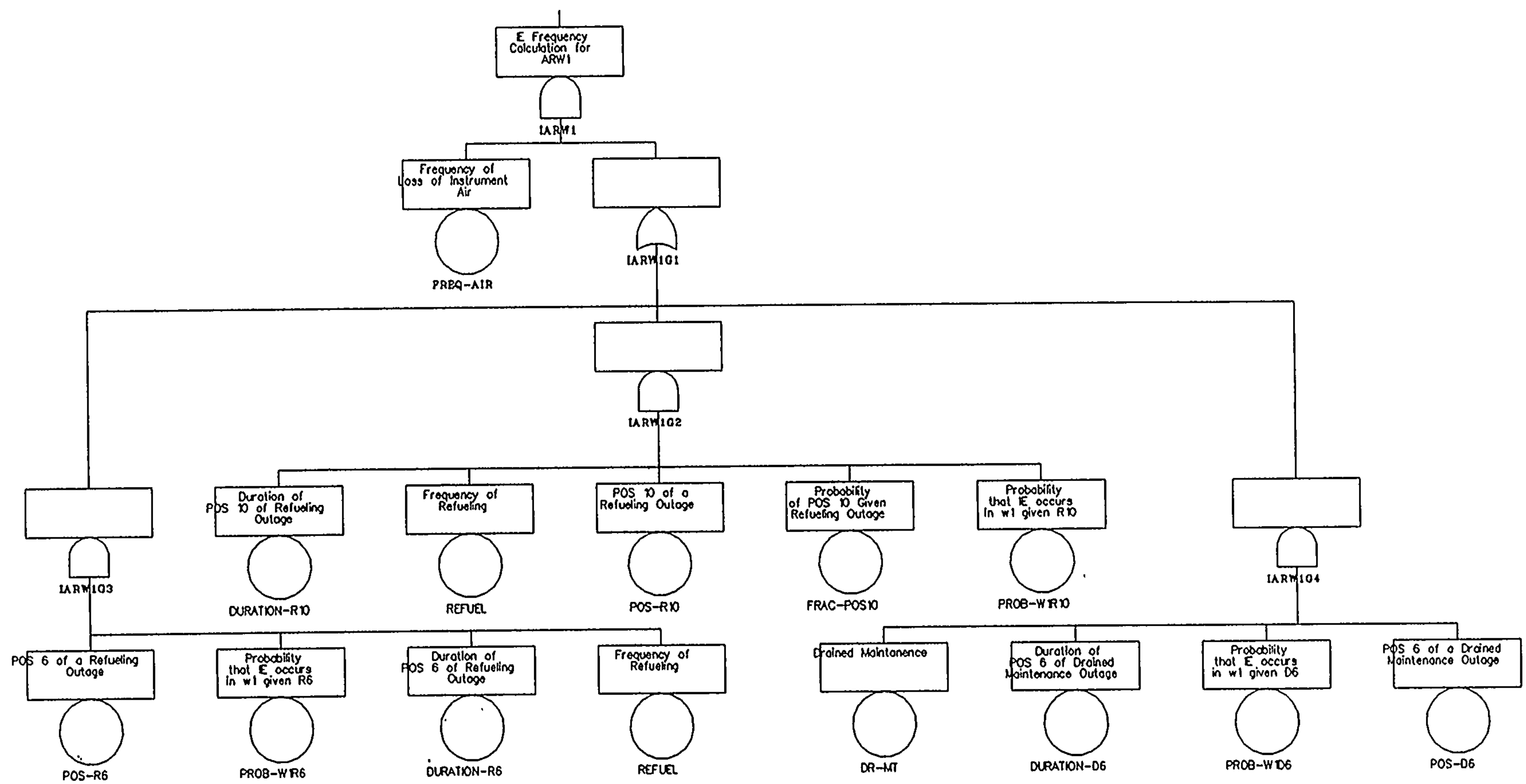
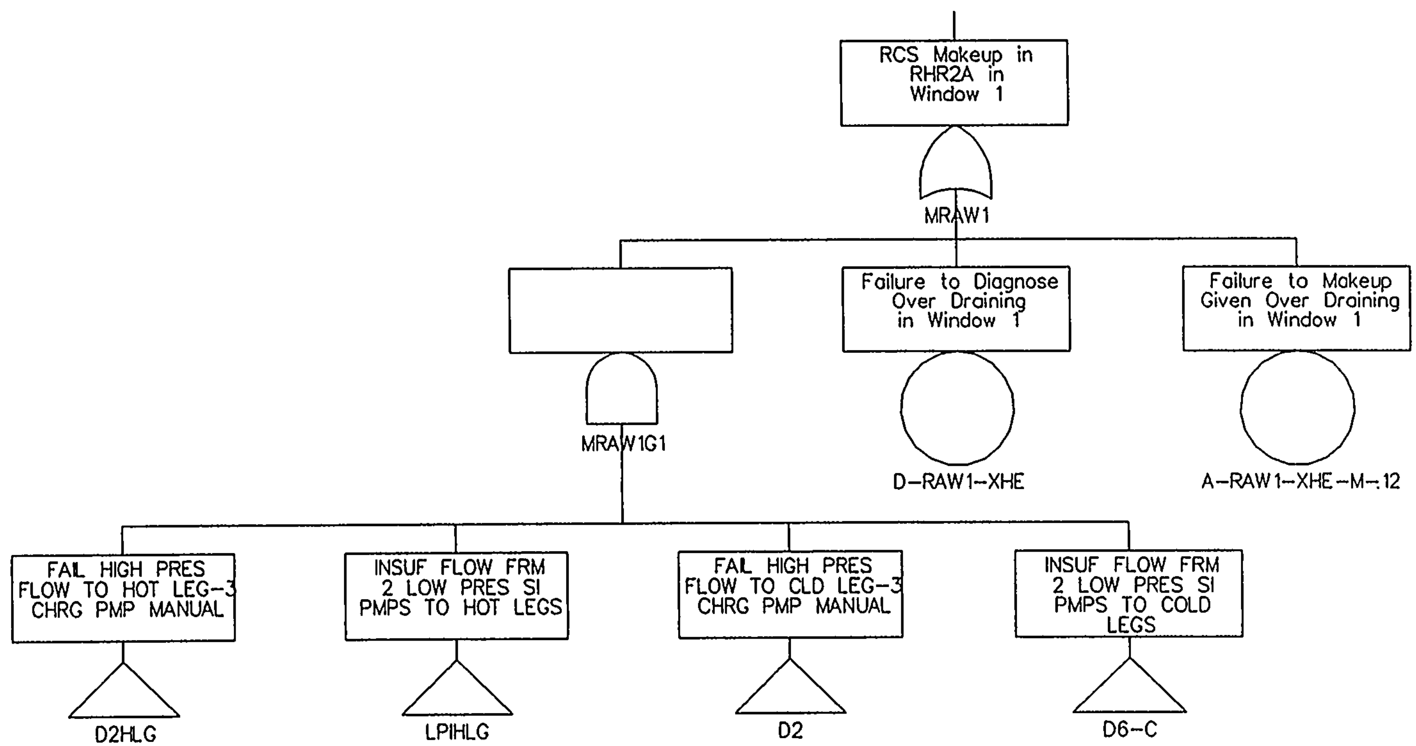
RAW1D6 Event Tree

I Top Event for Loss of Instrument Air in Window 1



RCS Makeup in Window 1



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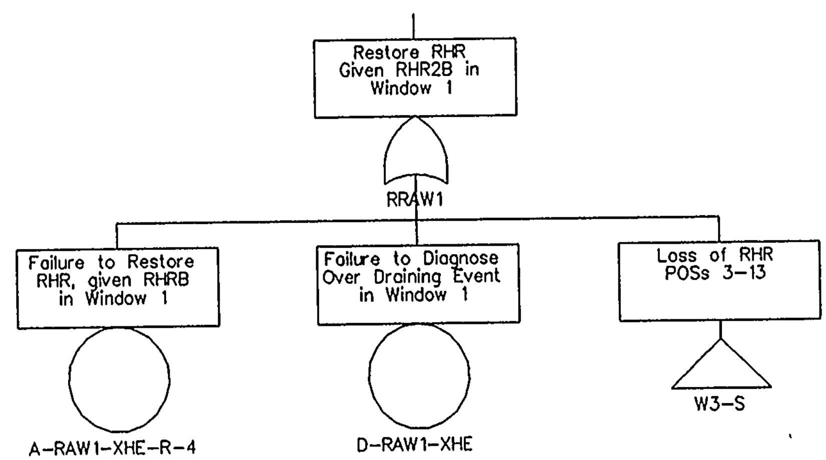

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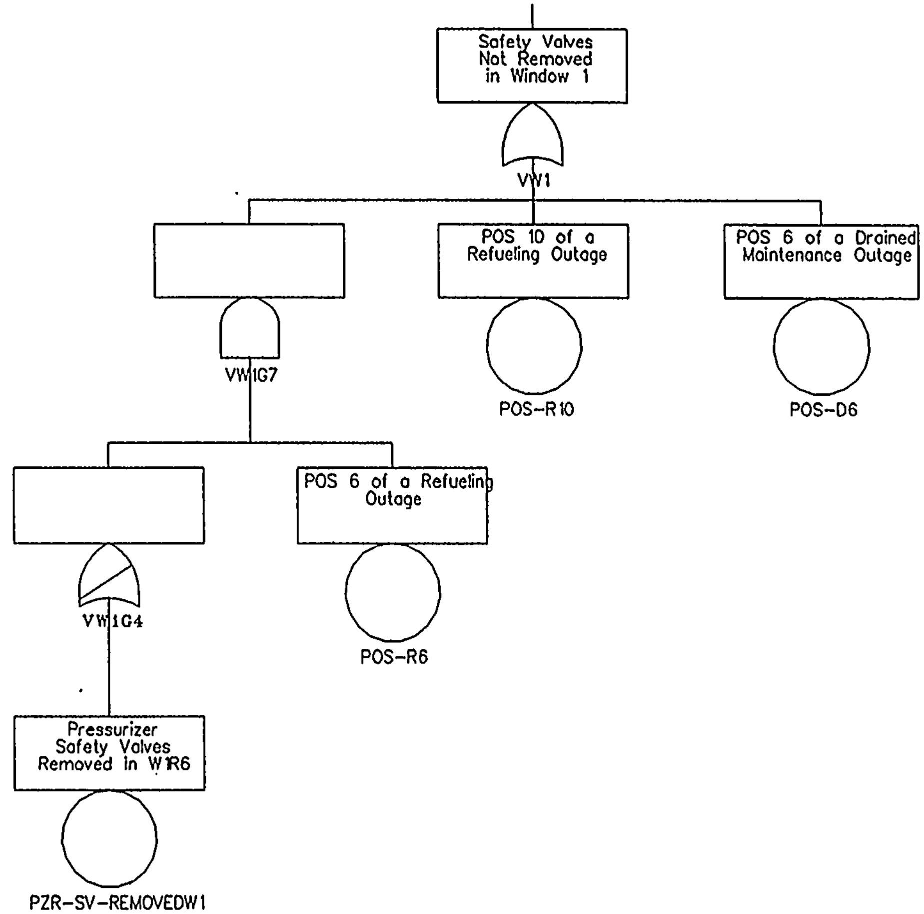
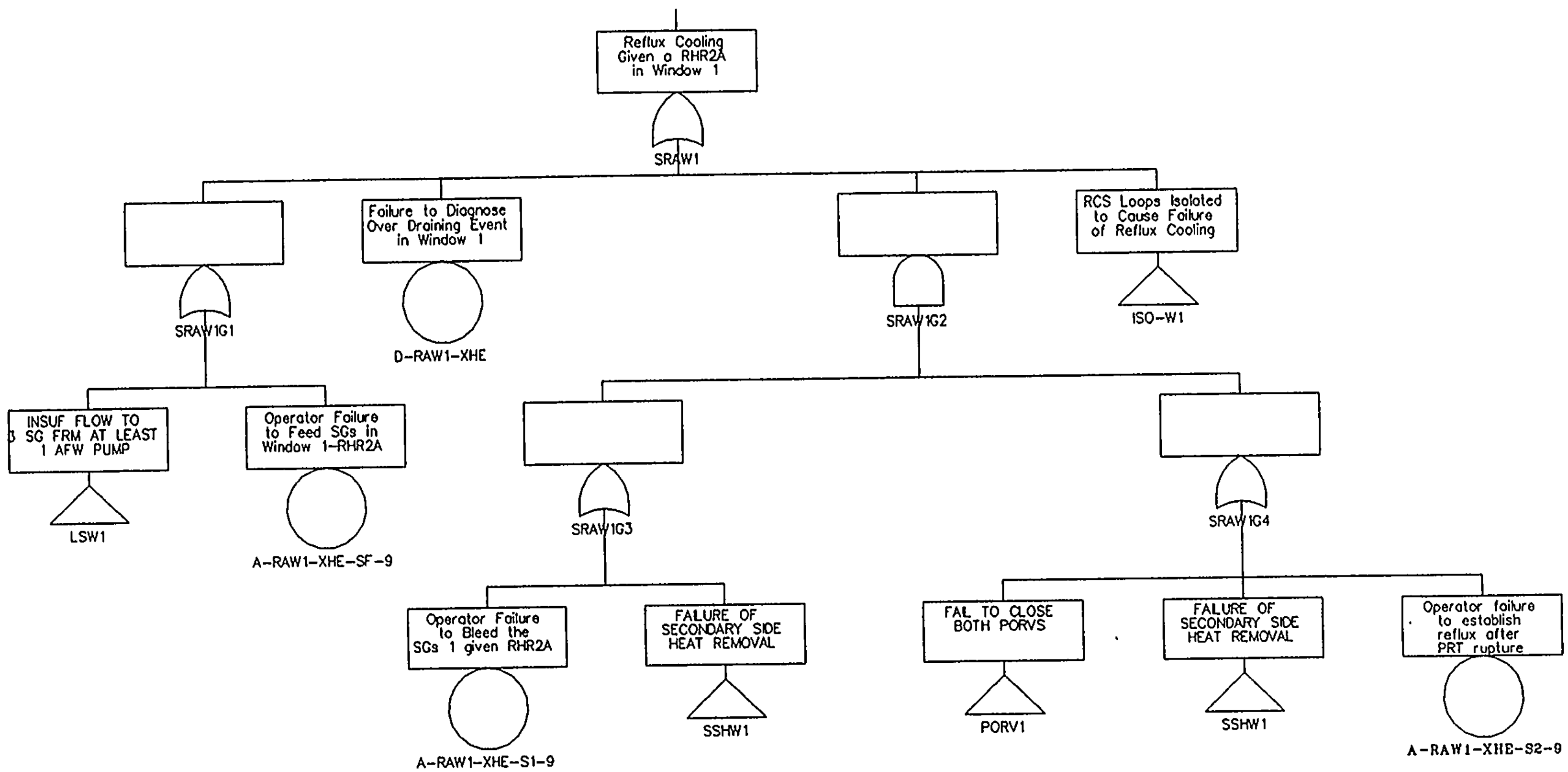
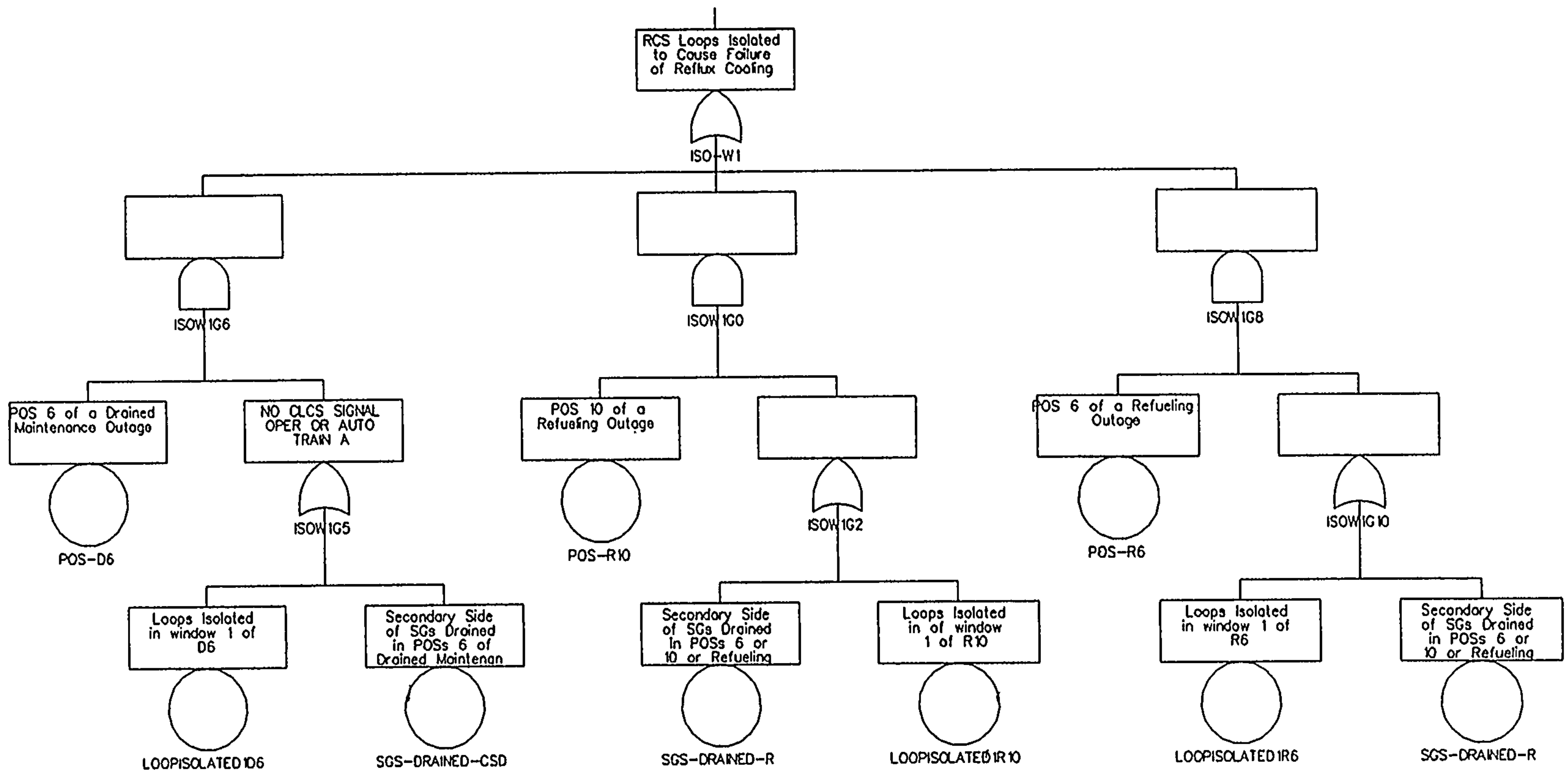


Reflux Cooling in Window 1



RCS Loops Isolated to Cause Failure of Reflux in Window 1



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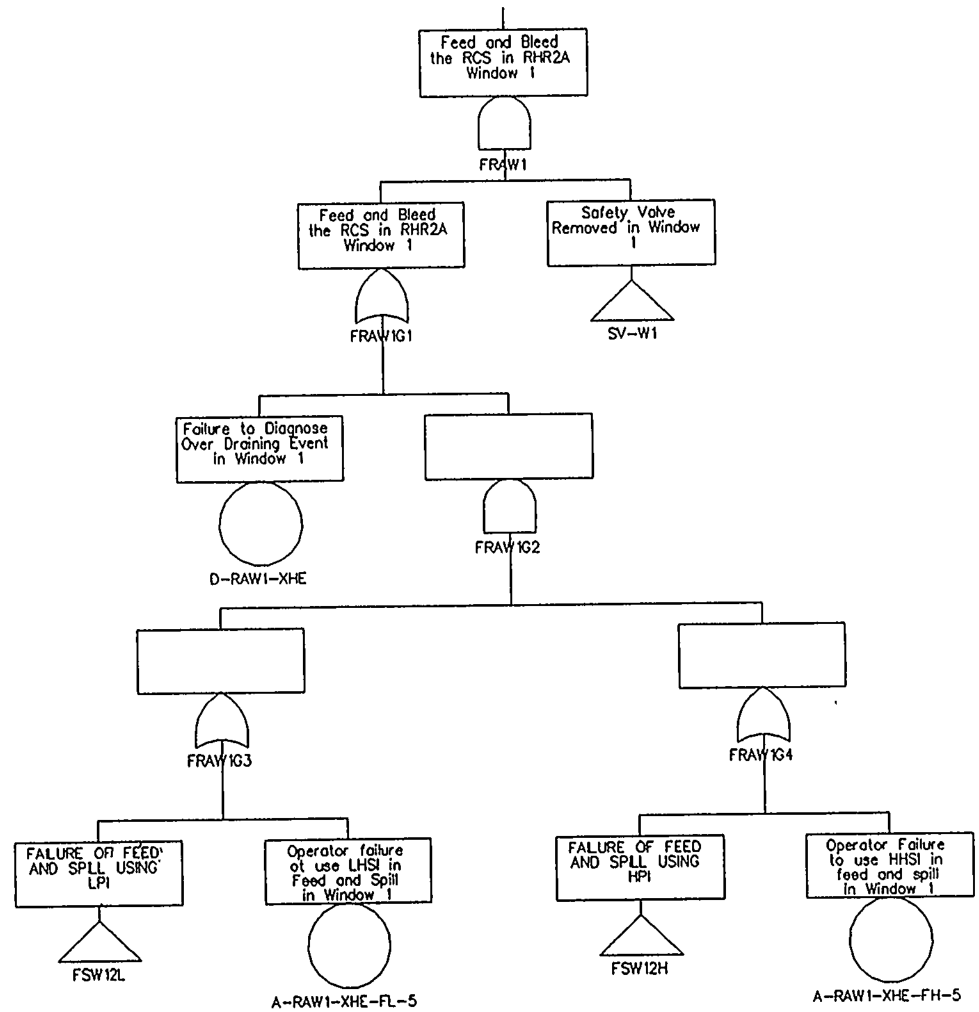

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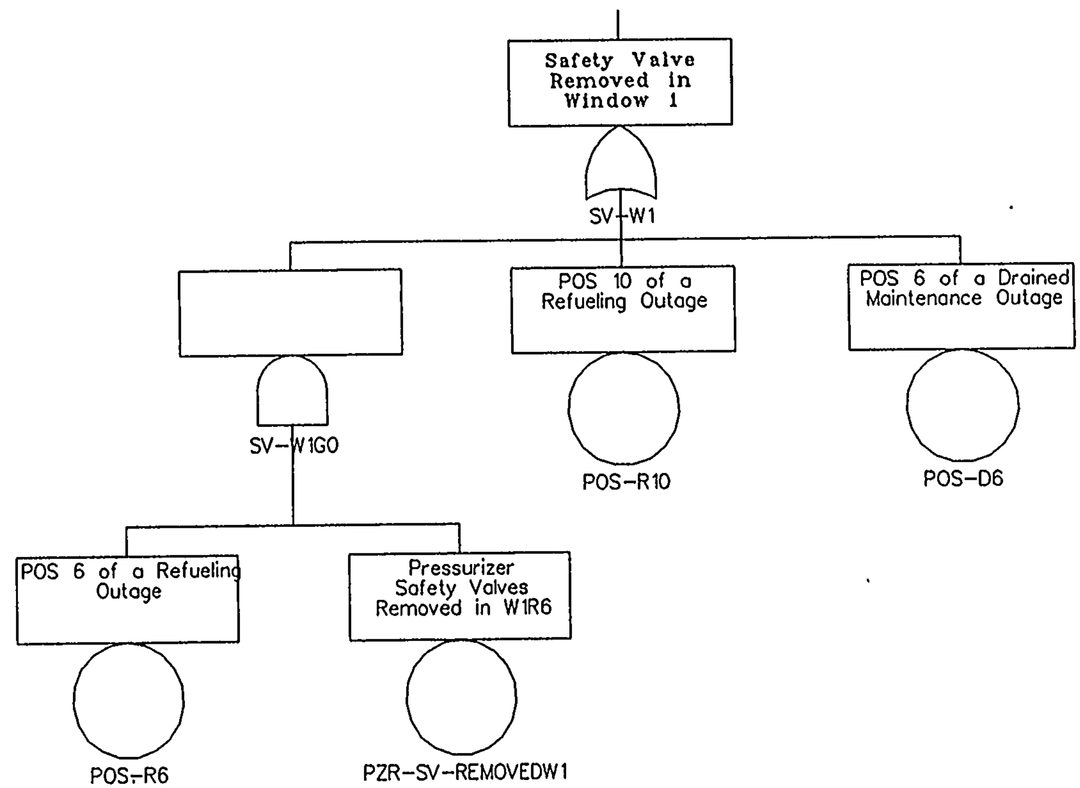

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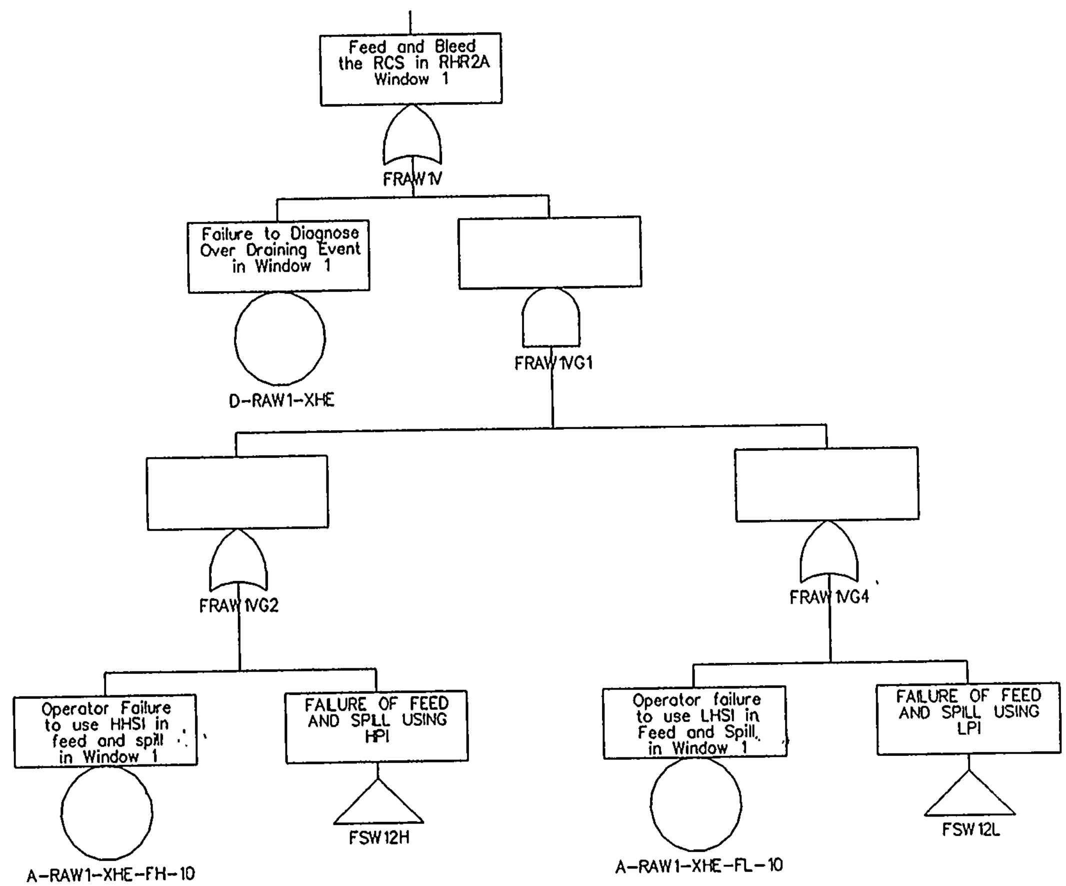

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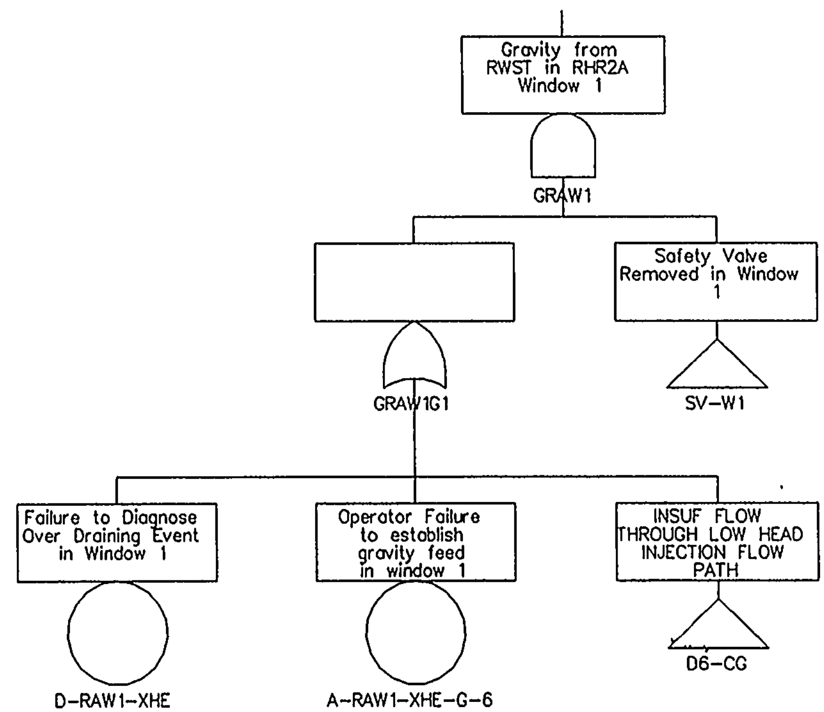
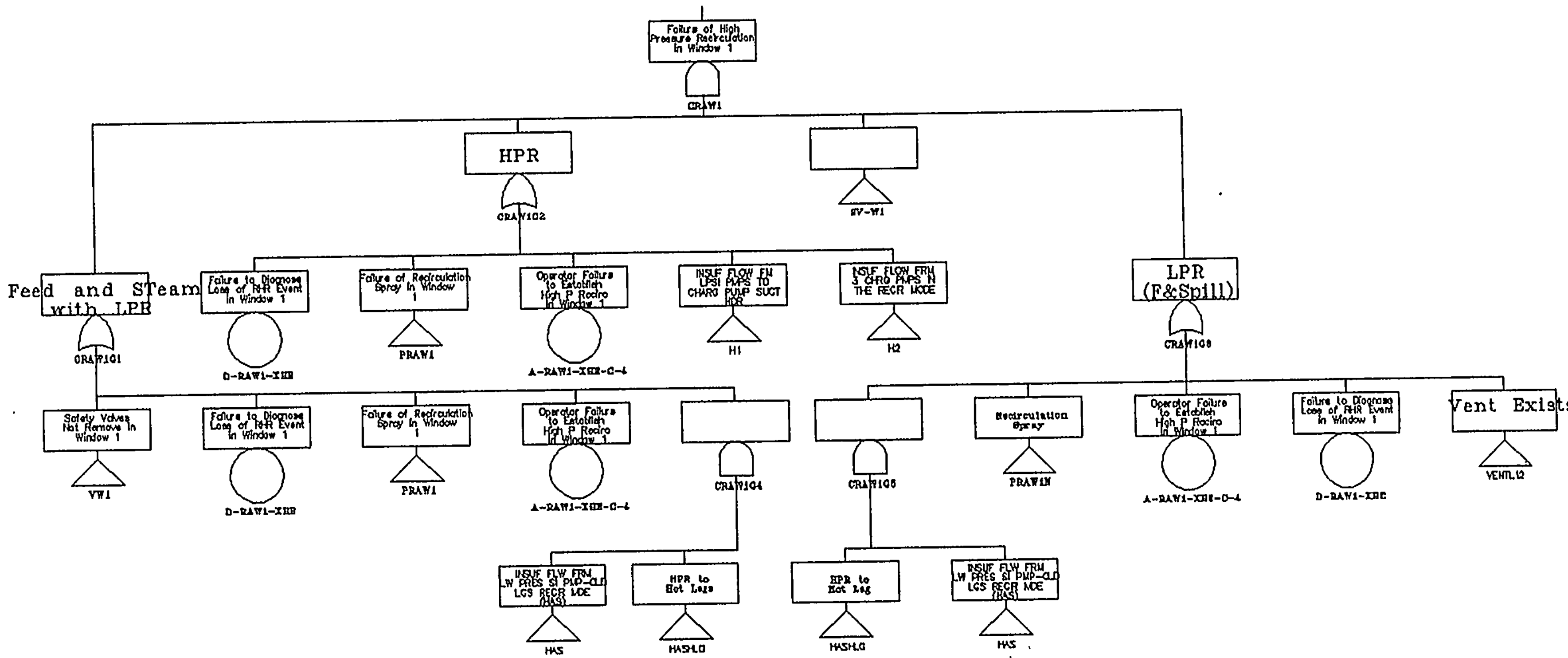
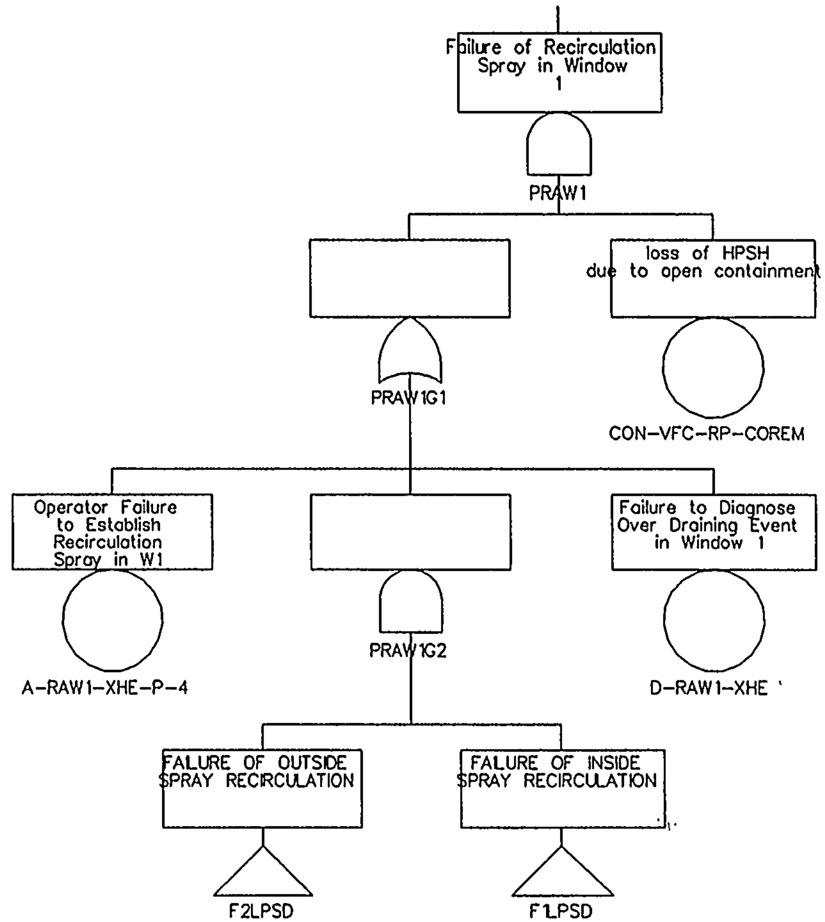


Failure of High Pressure Recirculation in Window 1



Failure of Recirculation Spray in Window 1—cause HPR failure



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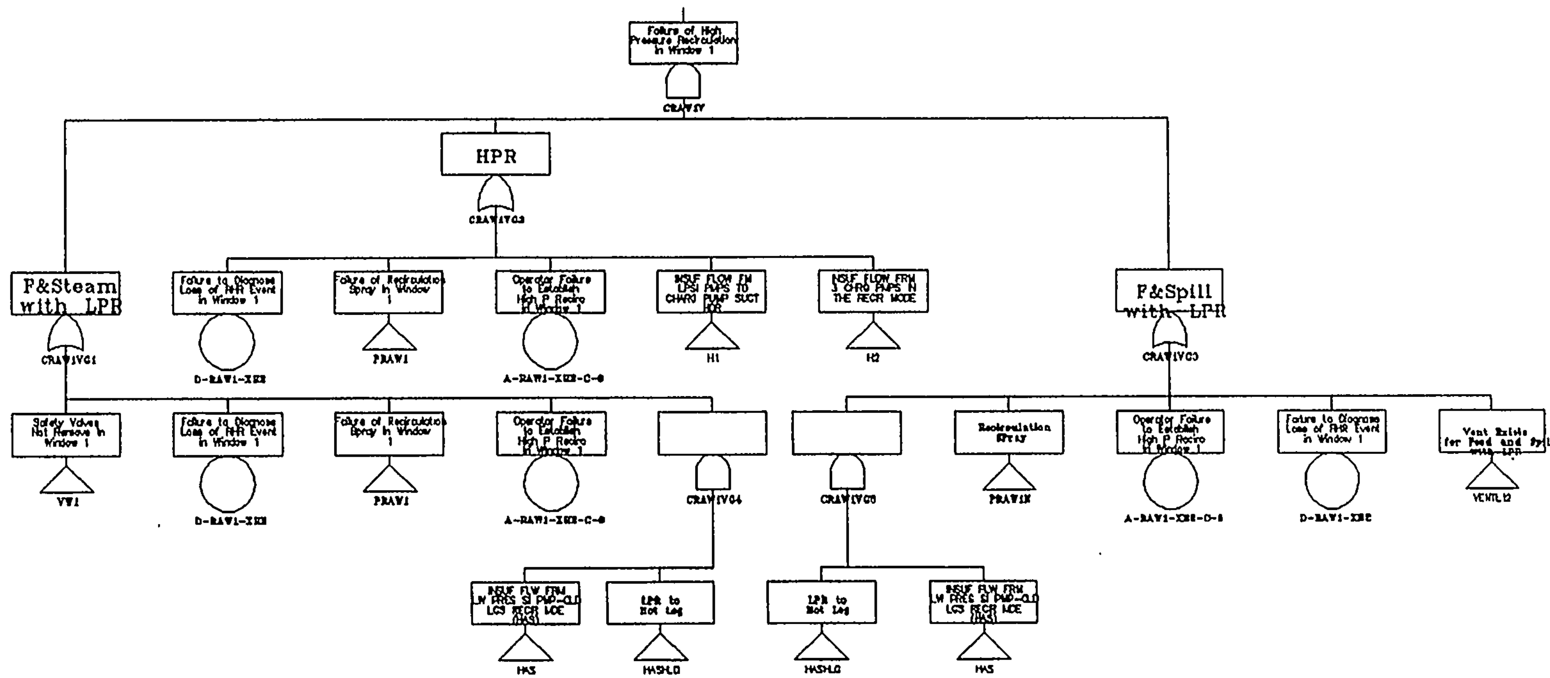

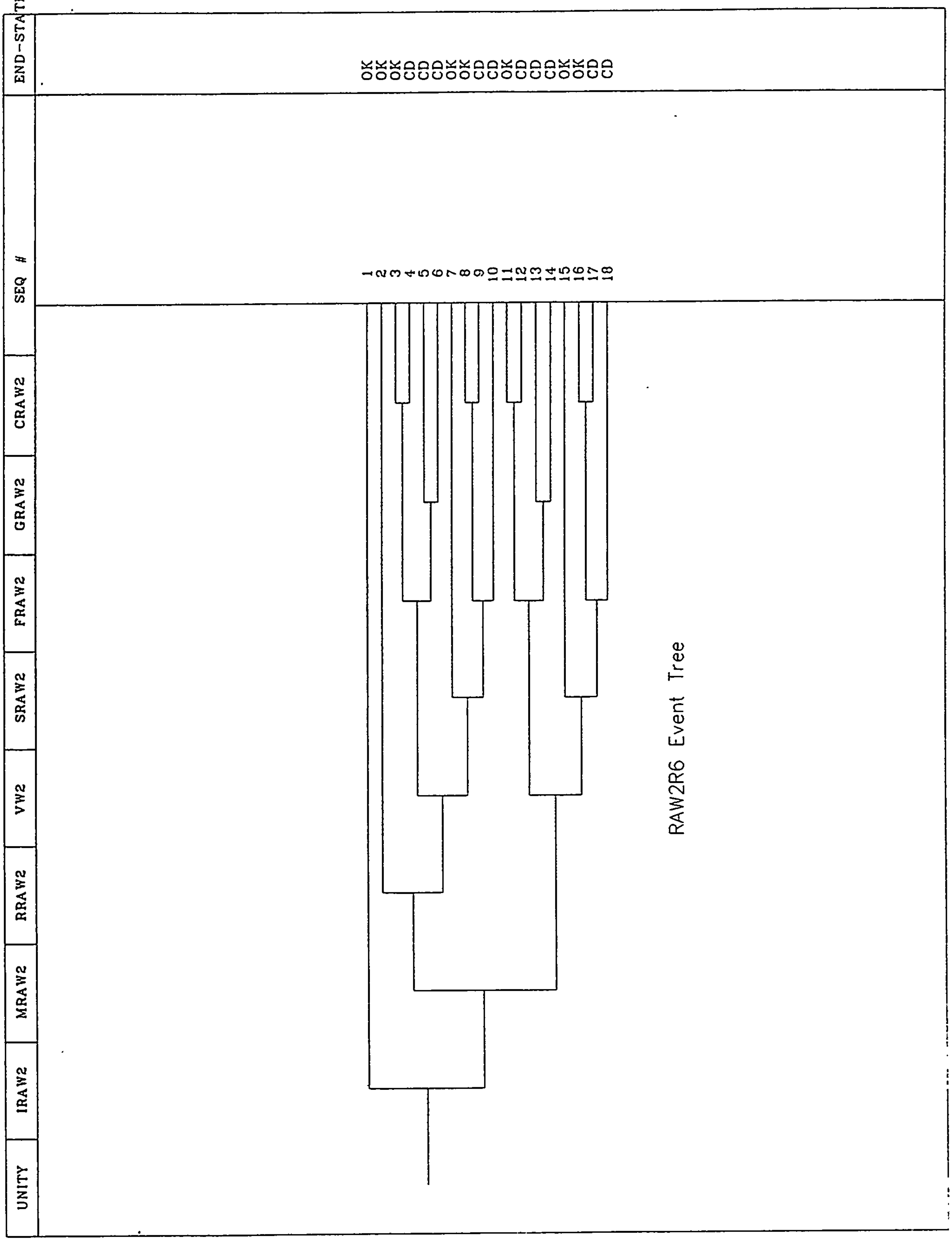

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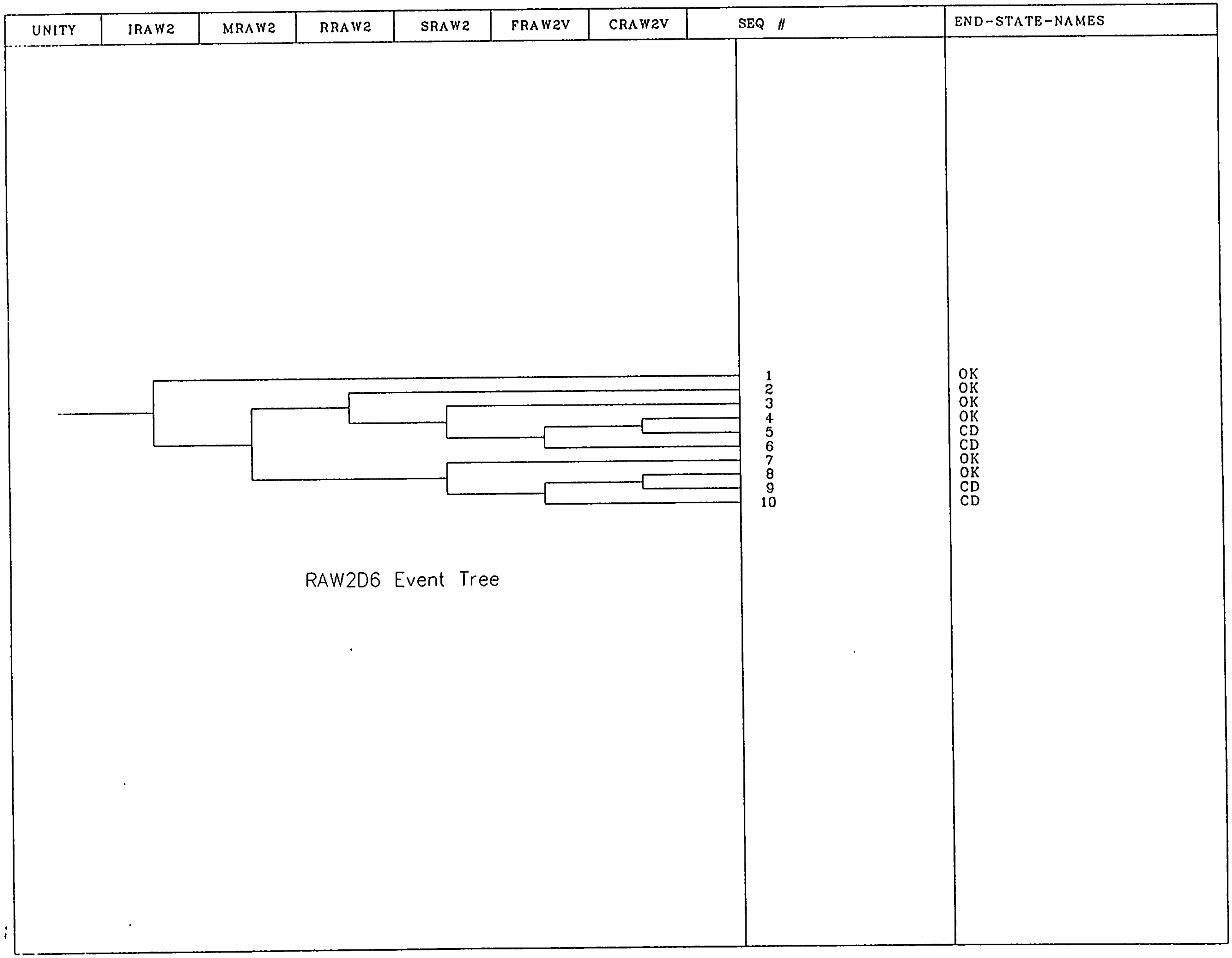
RAW2R6 Event Tree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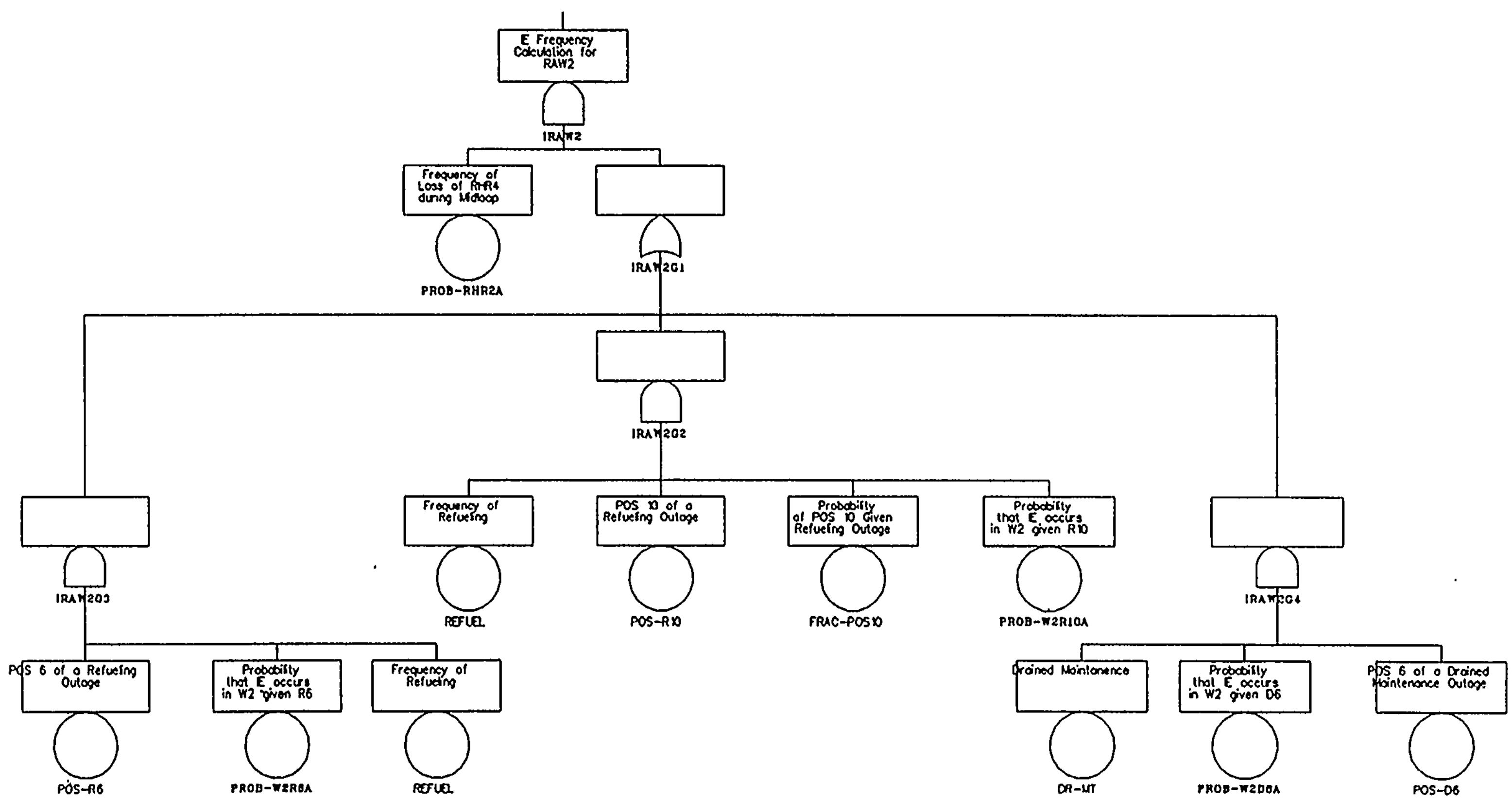
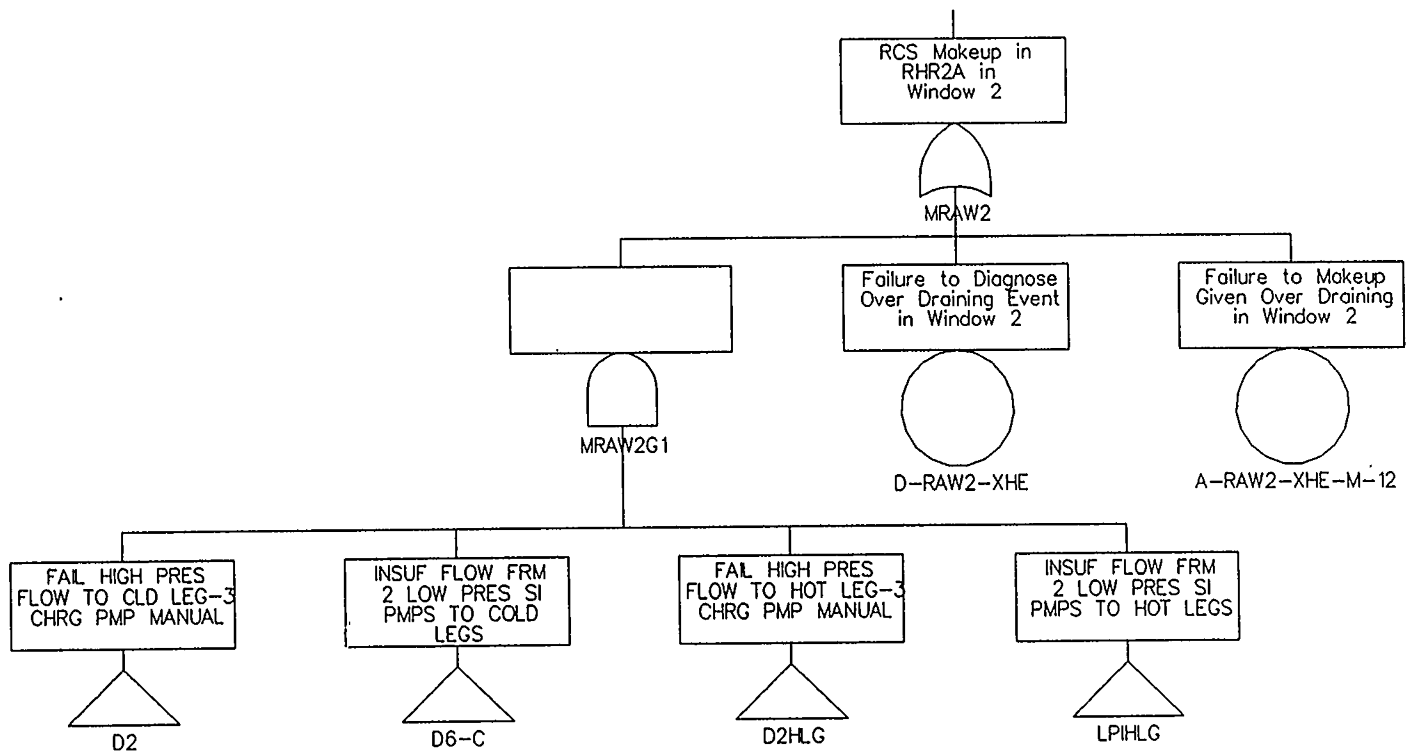
RAW2D6 Event Tree

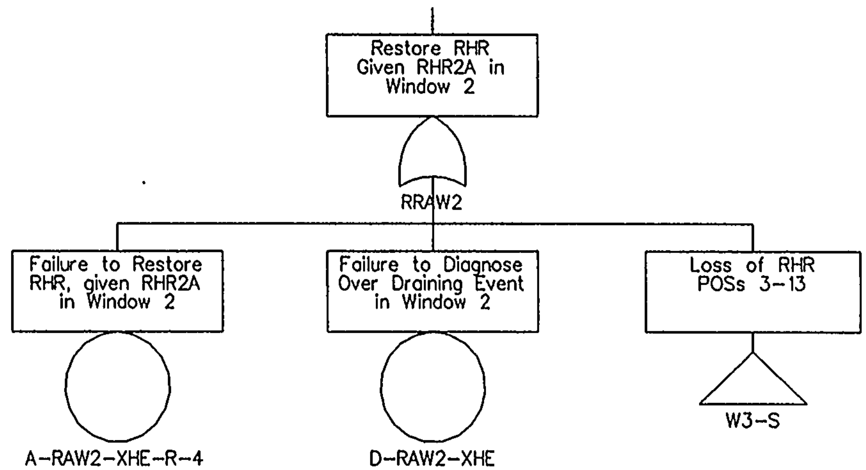
I Top Event for Over Draining Window 2



RCS Makeup in Window 2



Restore RHR given RHR2A in Window 2



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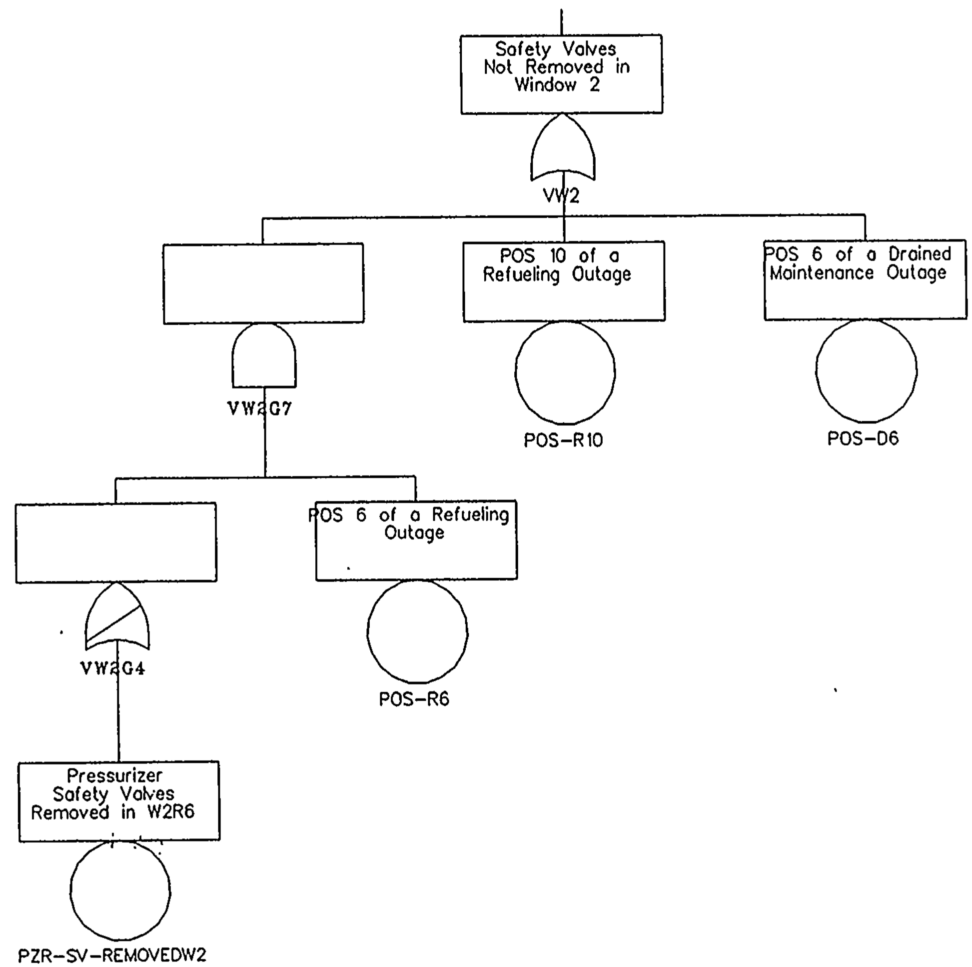
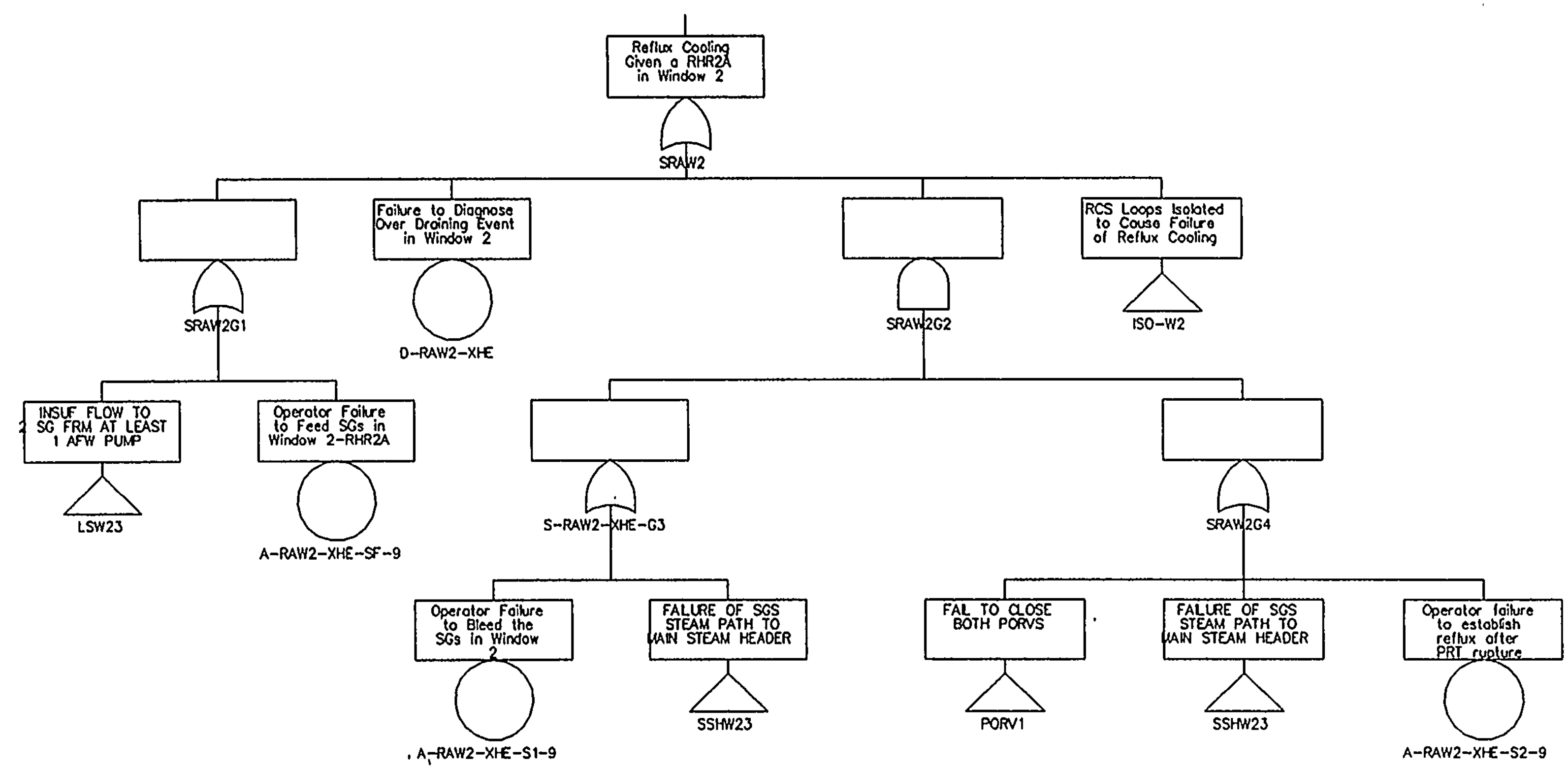
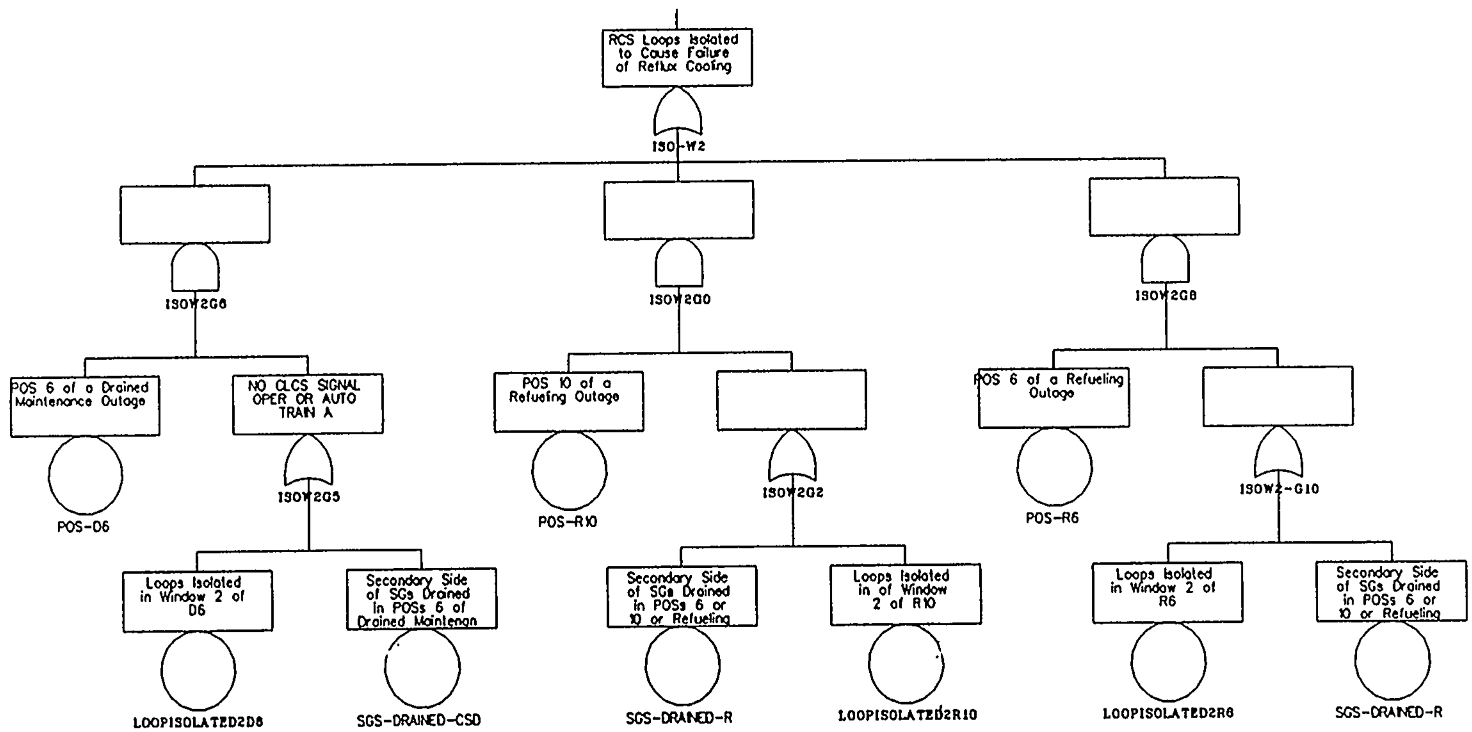


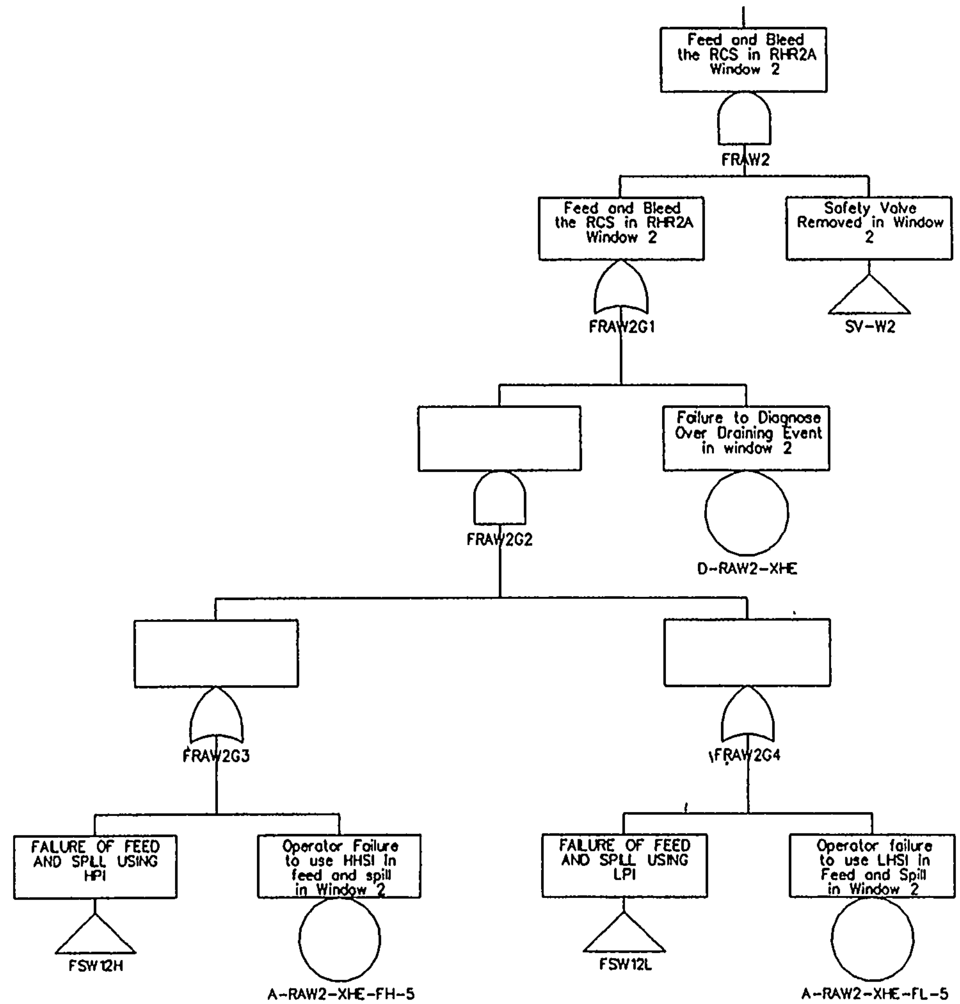
Reflux Cooling in Window 2



RCS Loops Isolated to Cause Failure of Reflux in Window 2



Feed and Bleed the RCS in RHR2A, Window 2



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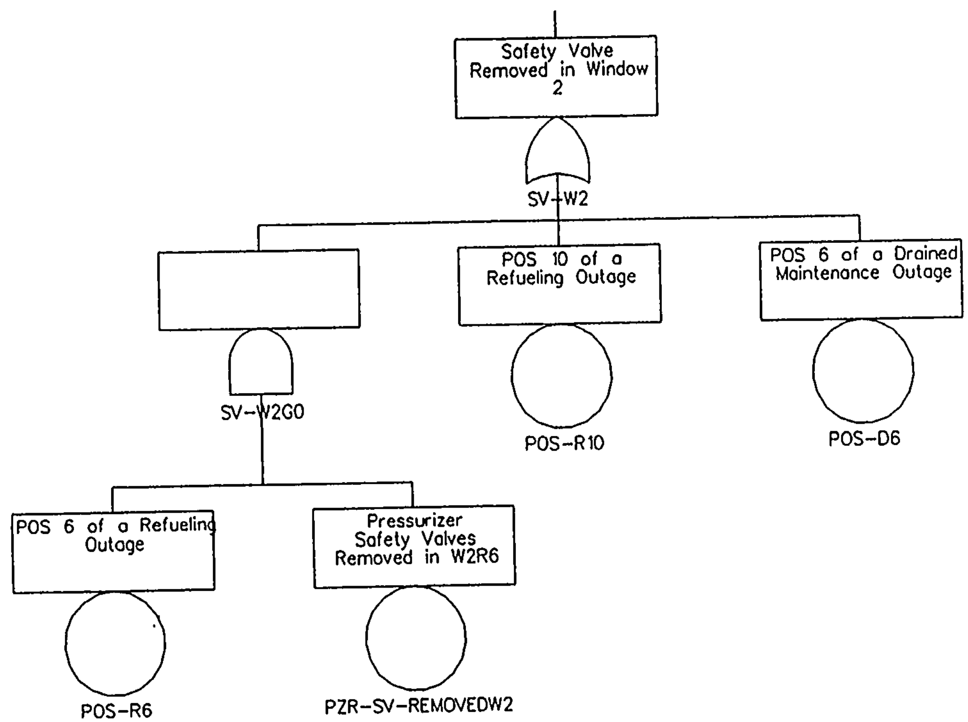

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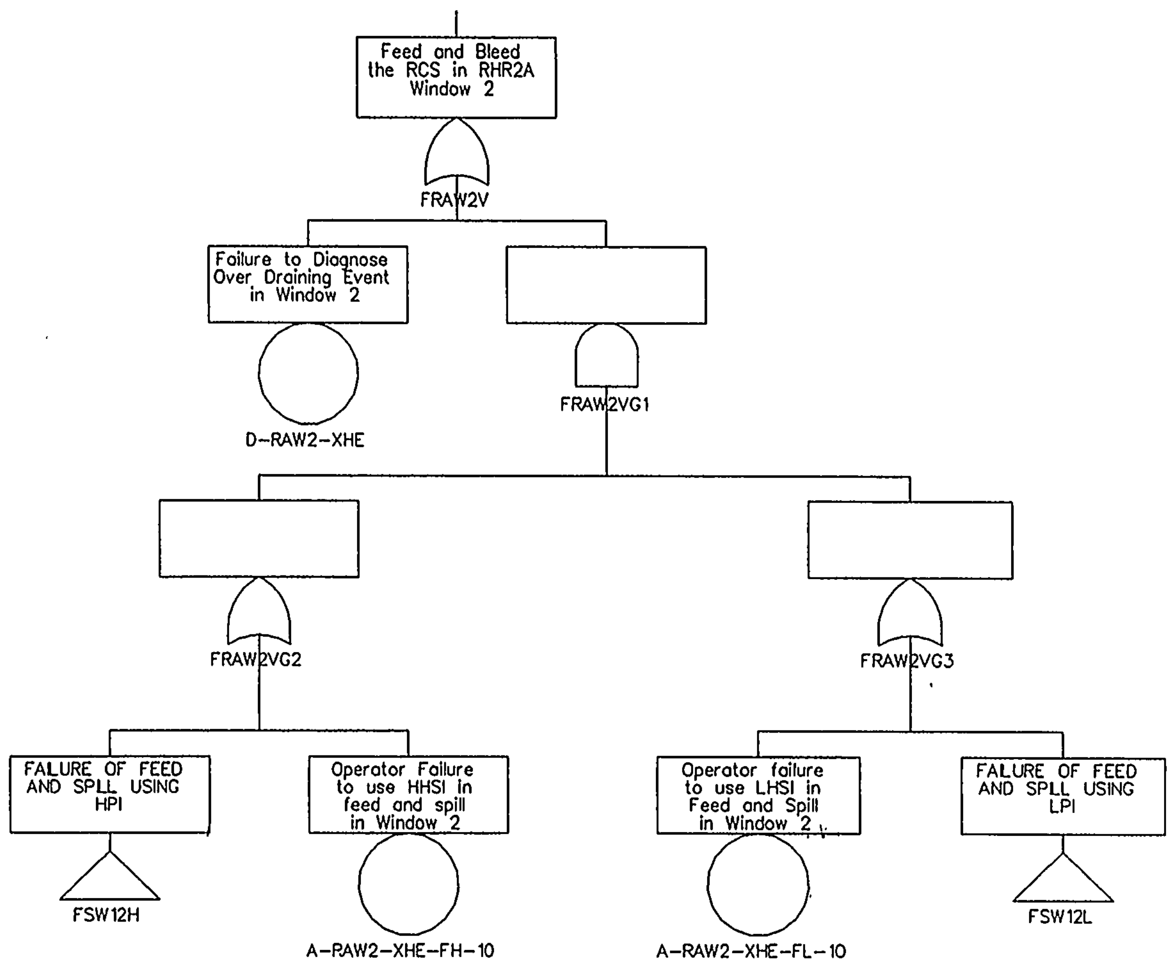
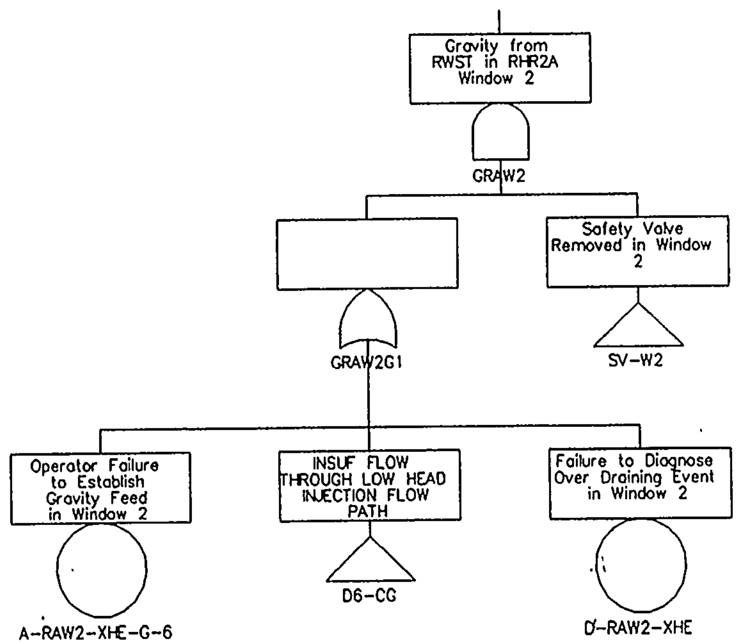
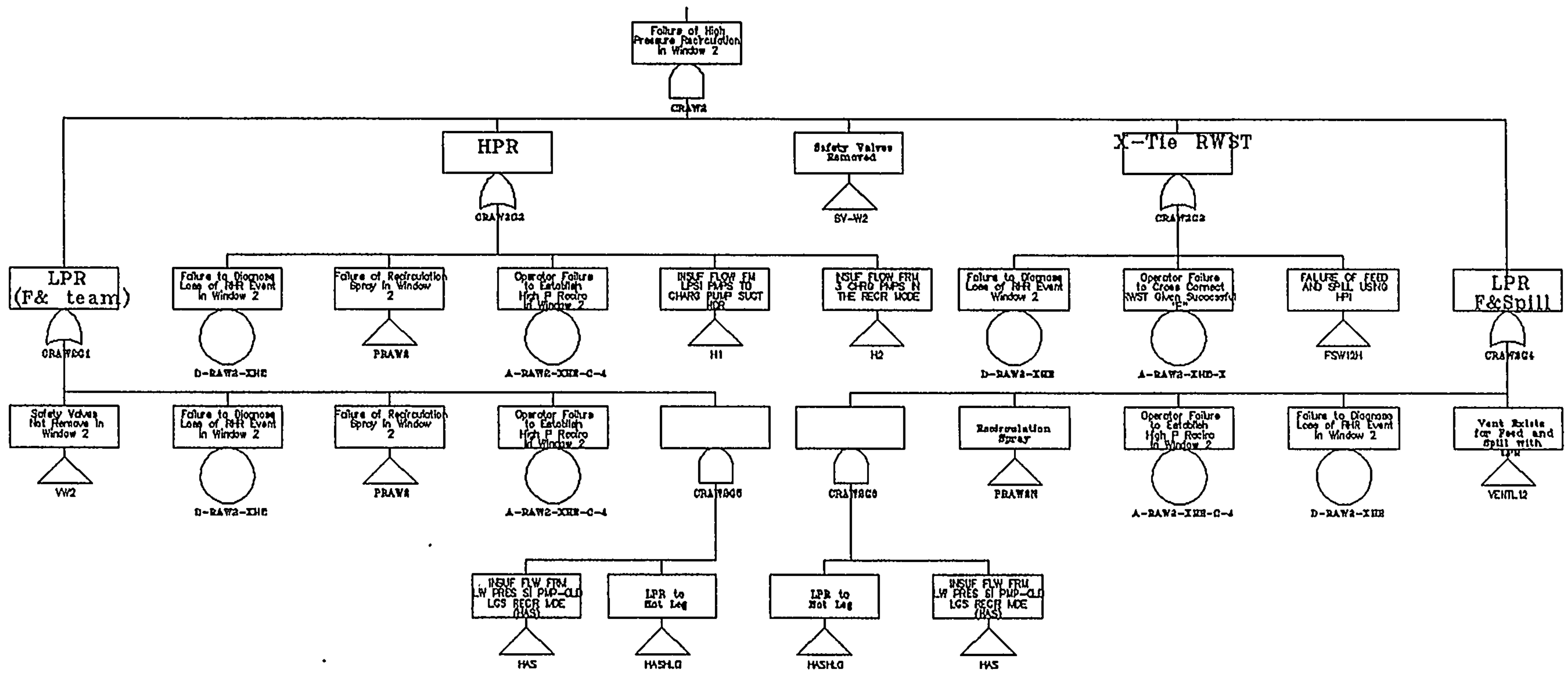


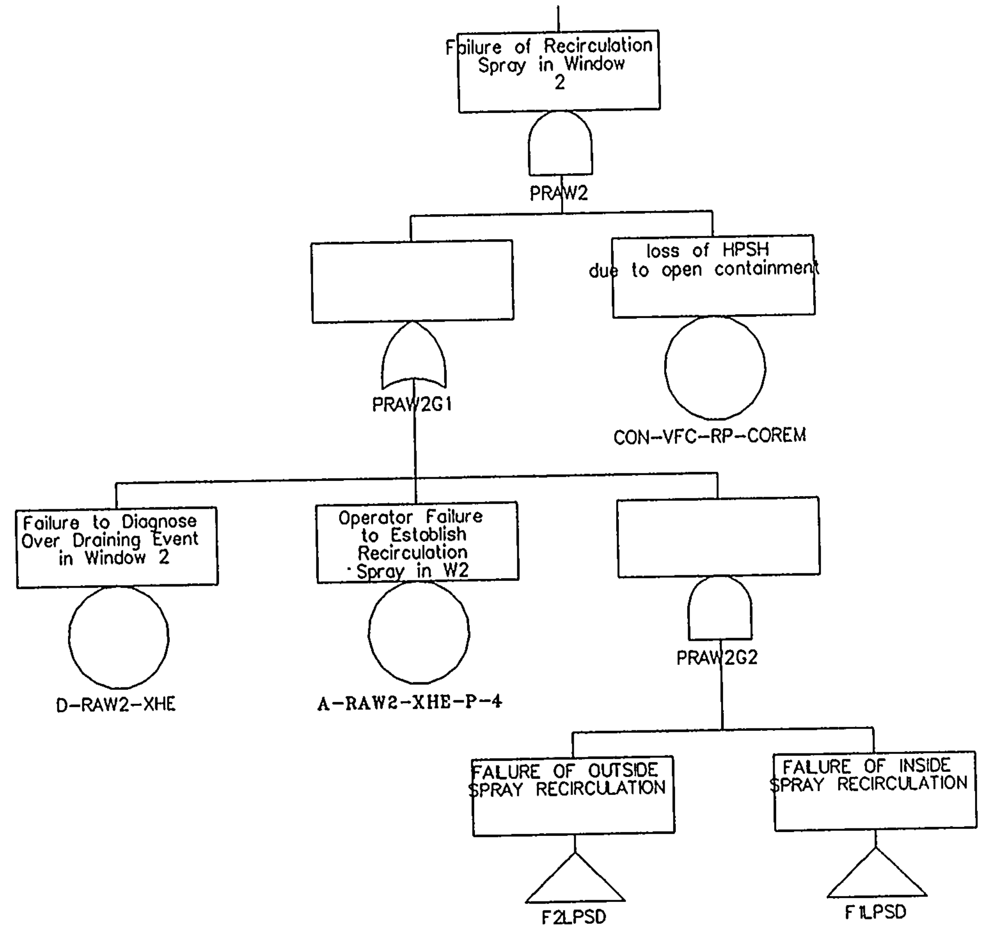
Gravity from RWST in RHR2A, Window 2



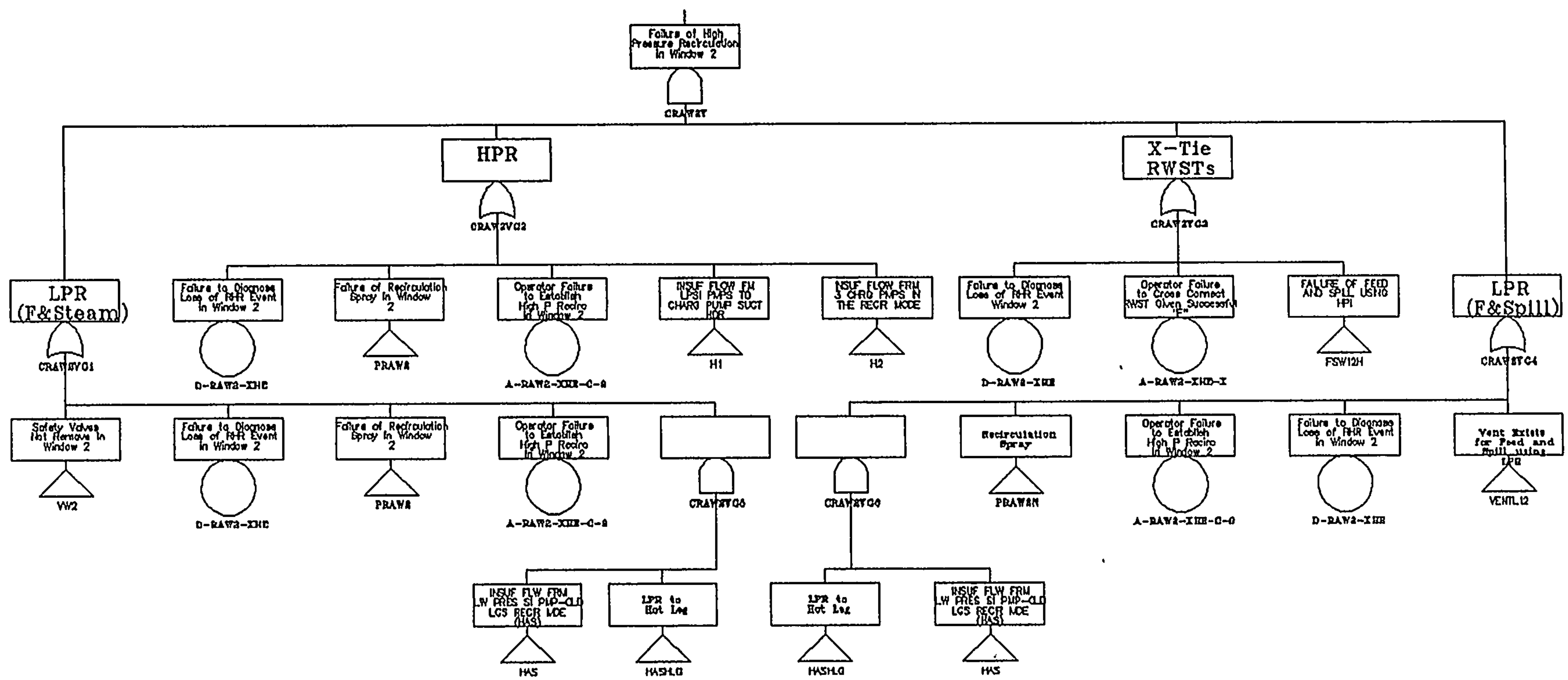
Failure of High Pressure Recirculation in Window 2

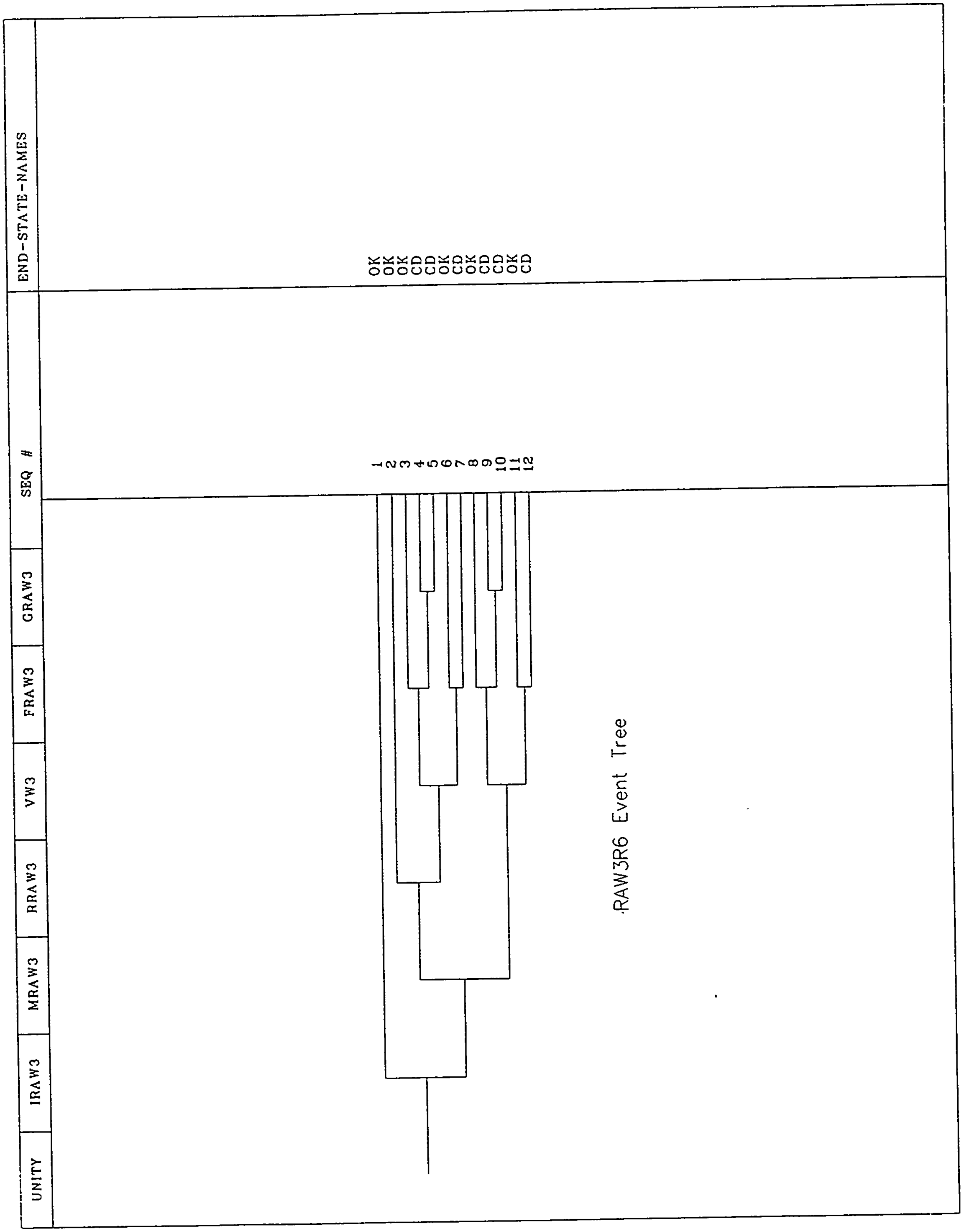


Failure of Recirculation Spray in Window 2-cause HPR failure



Failure of High Pressure Recirculation in Window 2

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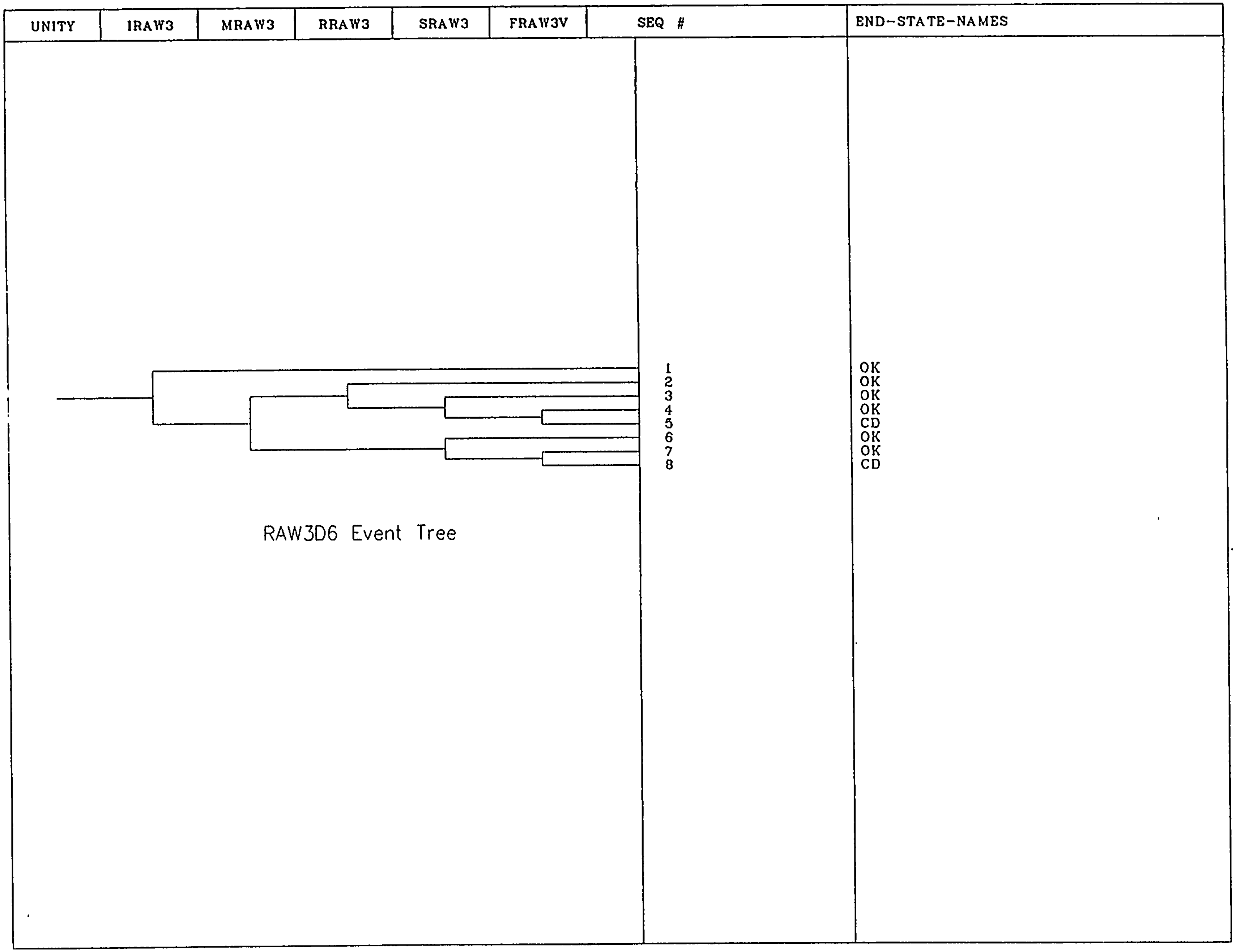
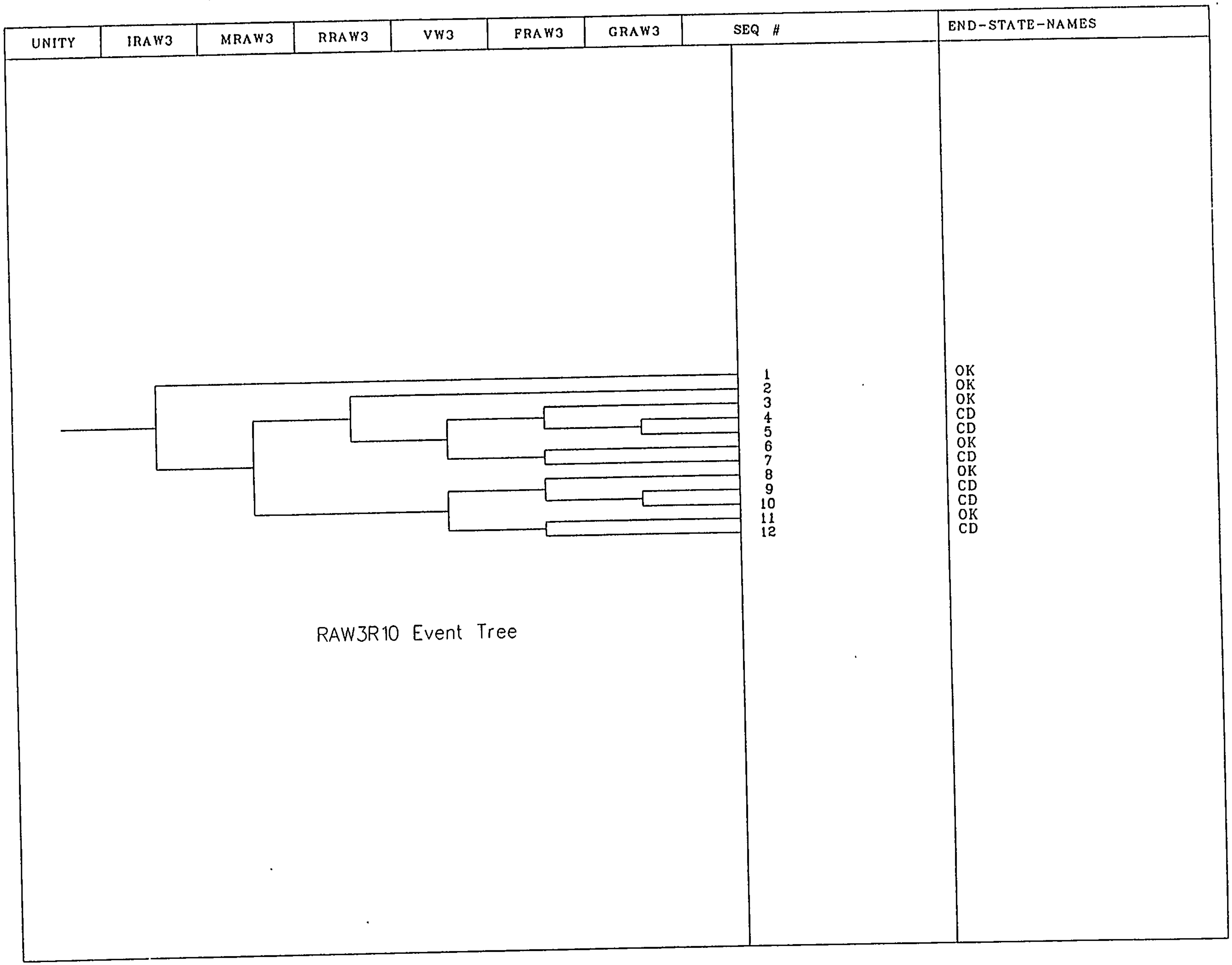
RAW3R6 Event Tree

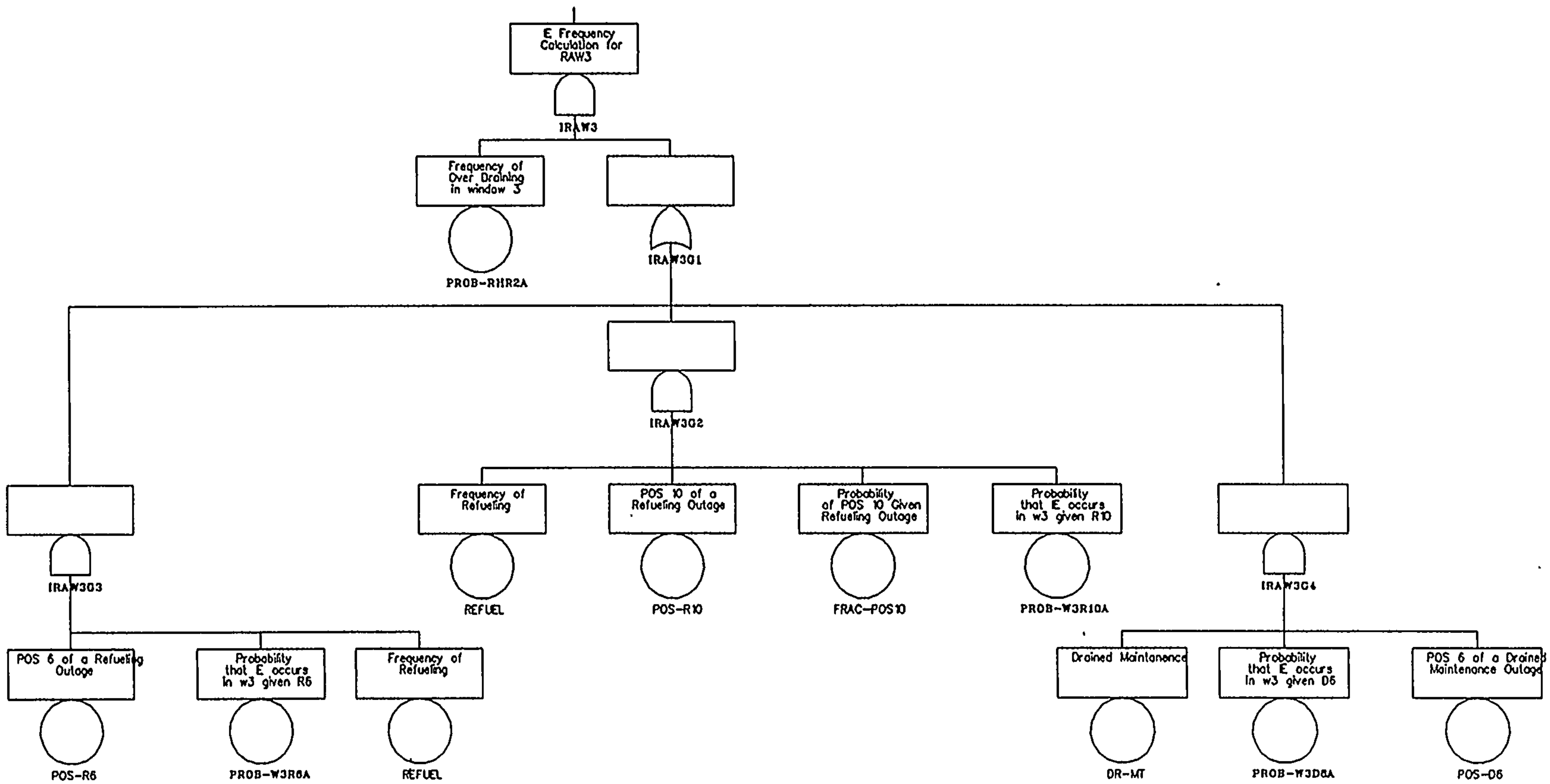


RAW3D6 Event Tree

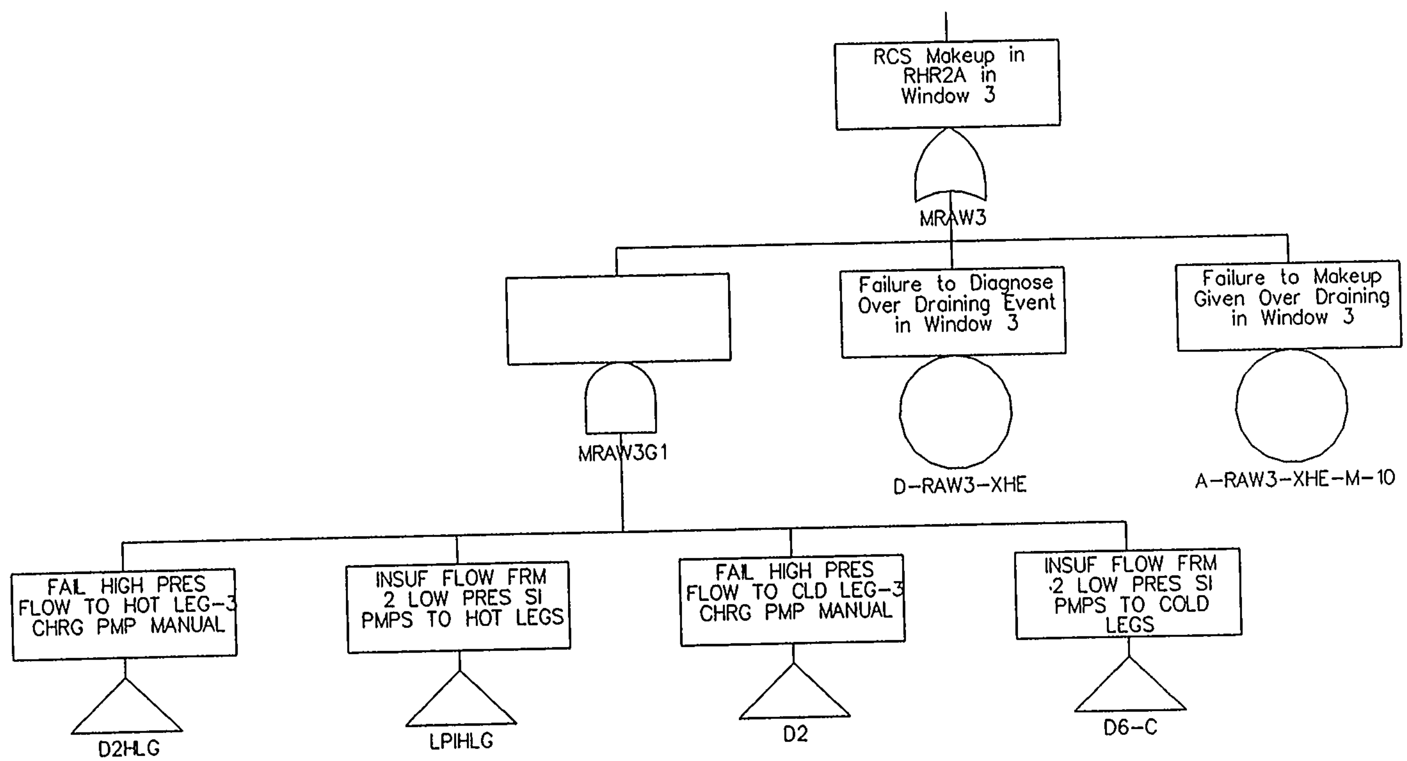


RAW3R10 Event Tree

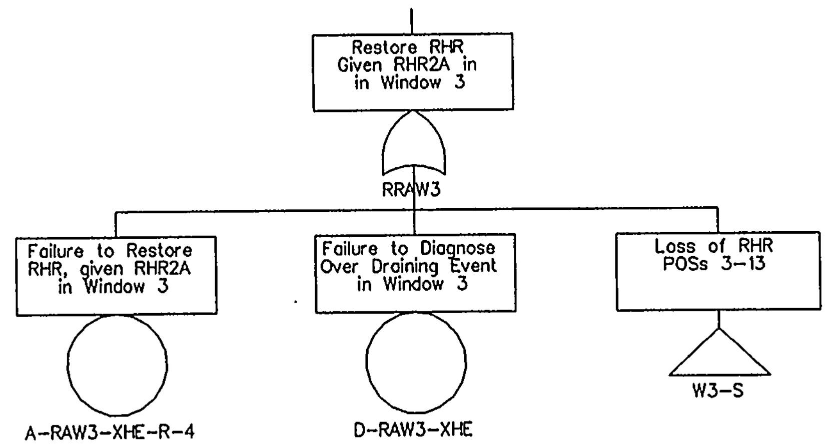
I top event for Over Draining in window 3



RCS Makeup in Window 3



Restore RHR given RHR2A in Window 3



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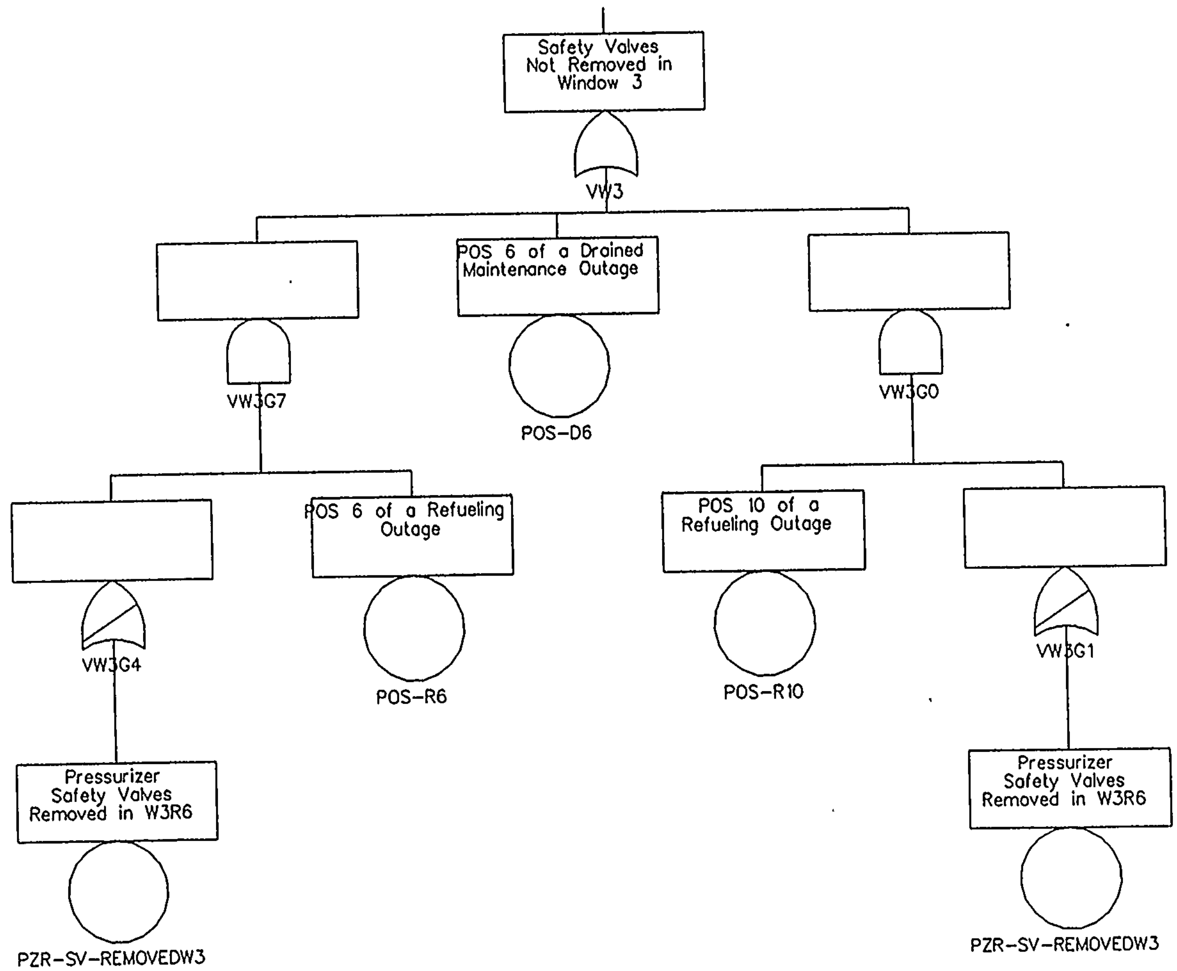

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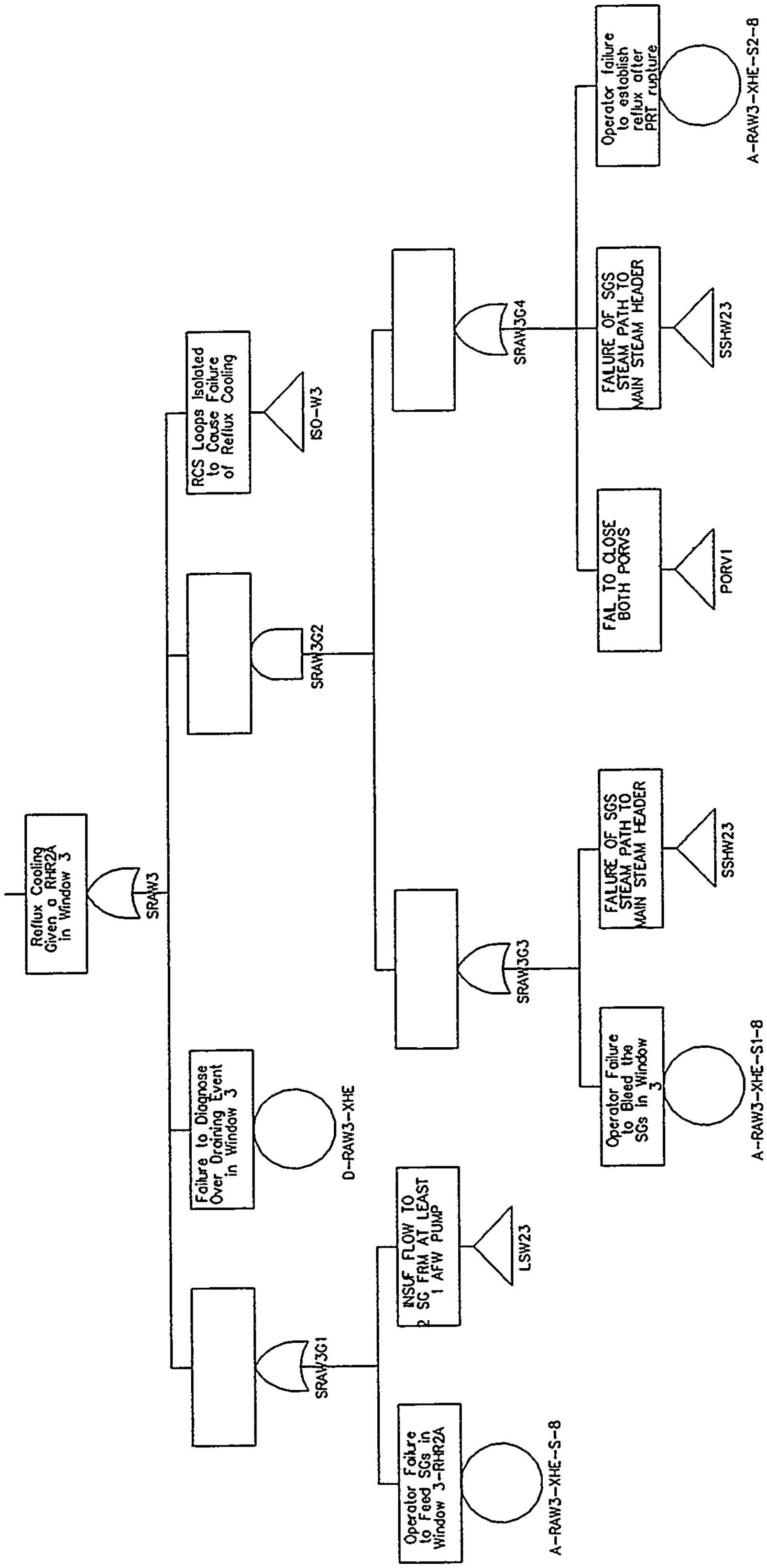
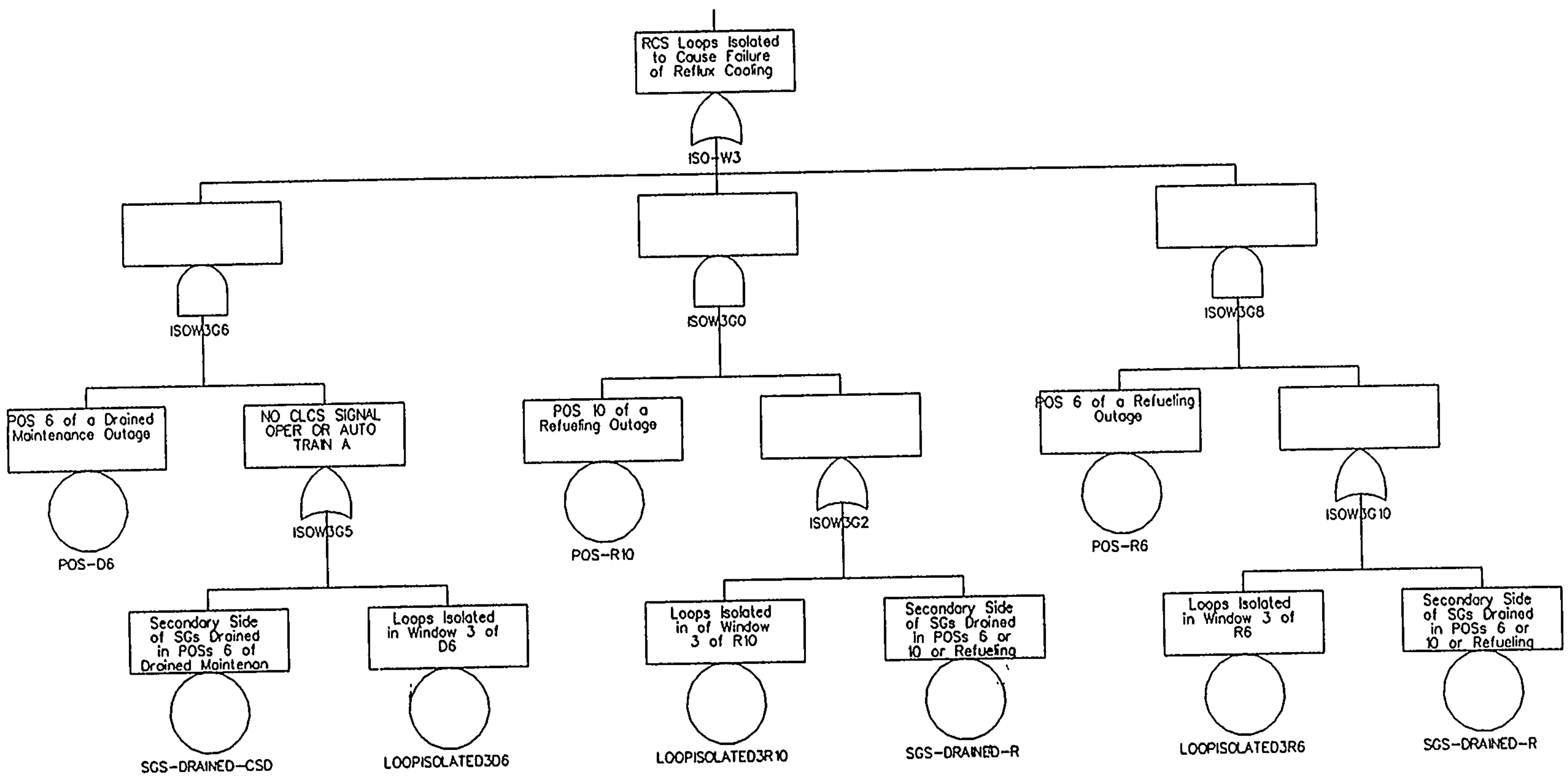
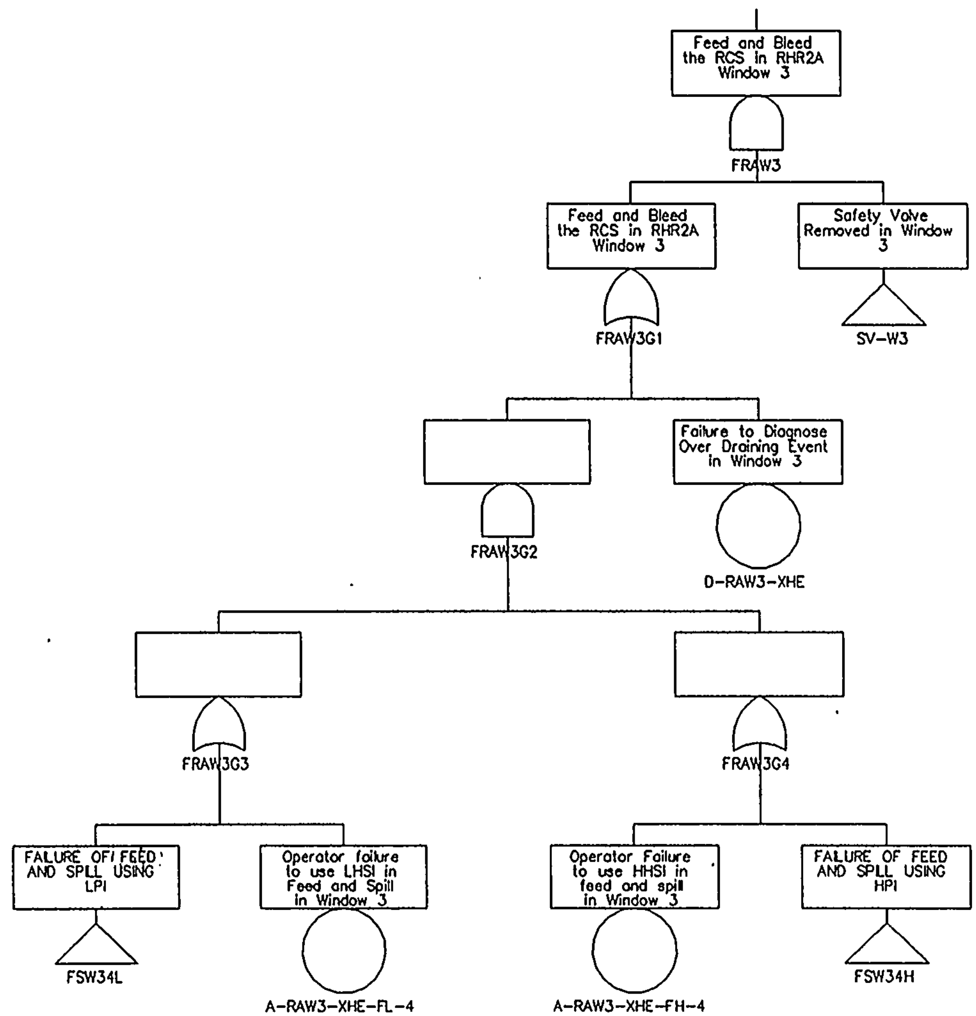


RCS Loops Isolated to Cause Failure of Reflux in Window 3



Feed and Bleed the RCS in RHR2A, Window 3



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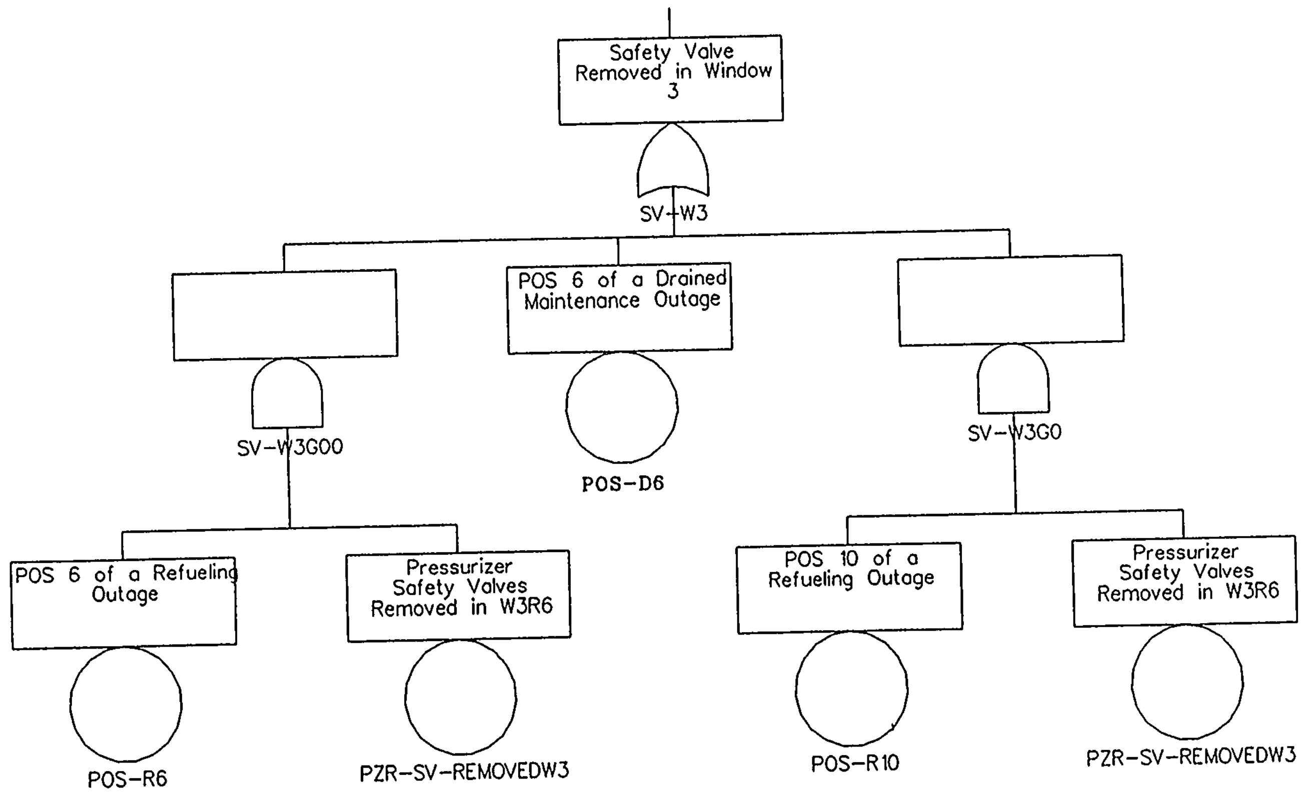
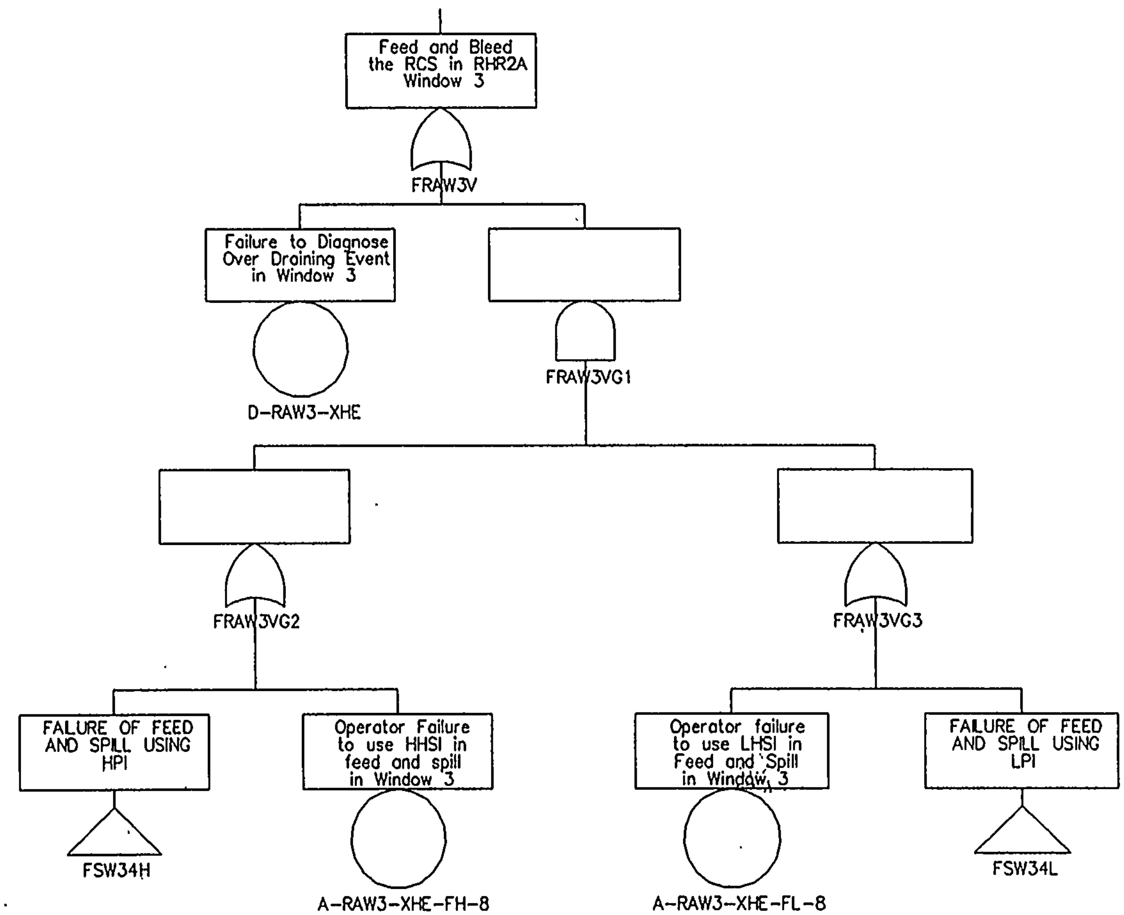
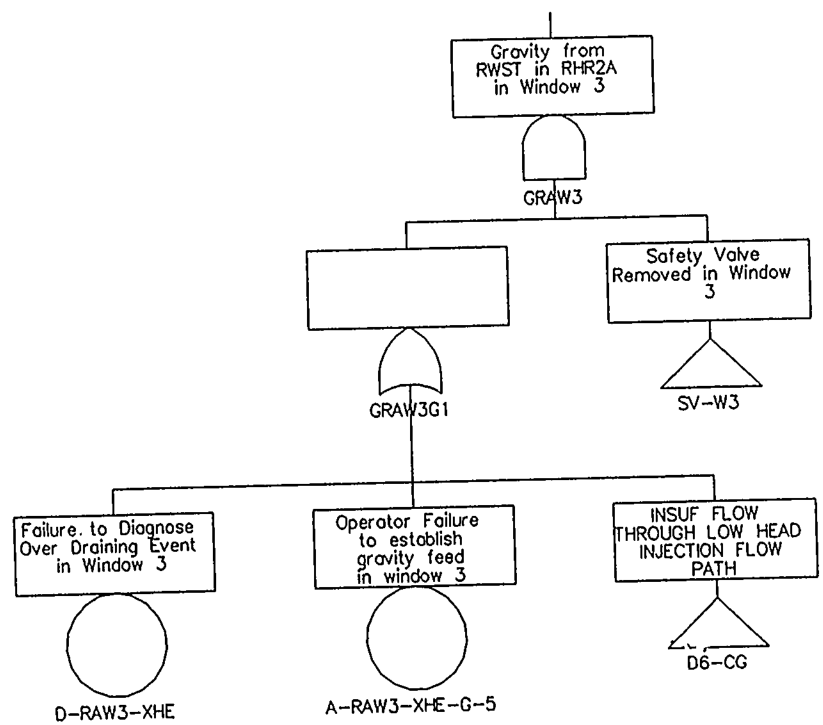
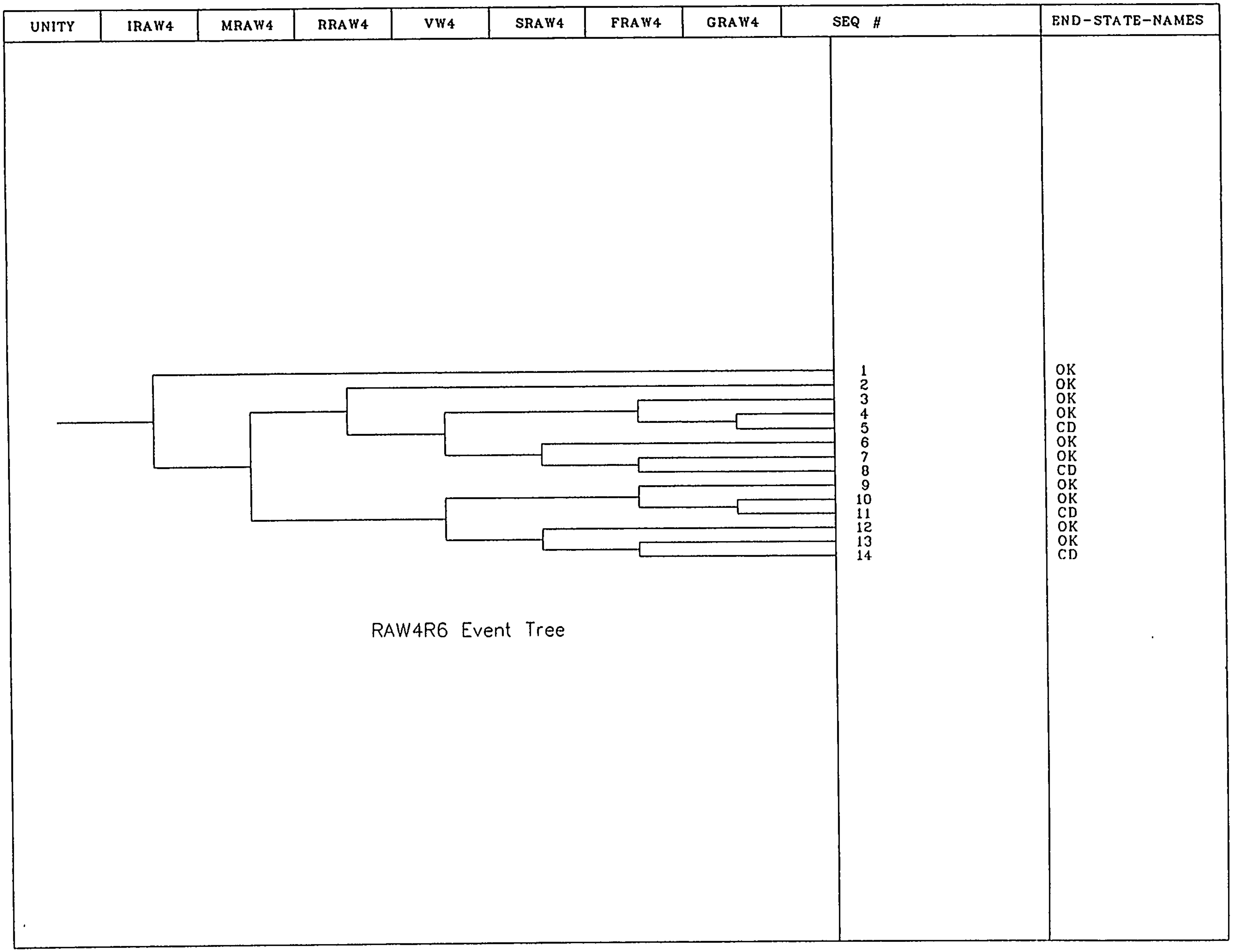


Feed and Bleed the RCS with V failed in RHR2A, Window 3



Gravity from RWST in RHR2A, Window 3

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IRAW4
MRAW4
RRAW4
VW4
SRAW4
FRAW4
GRAW4
SEQ #
END-STATE-NAMES
1 OK
2 OK
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6 OK
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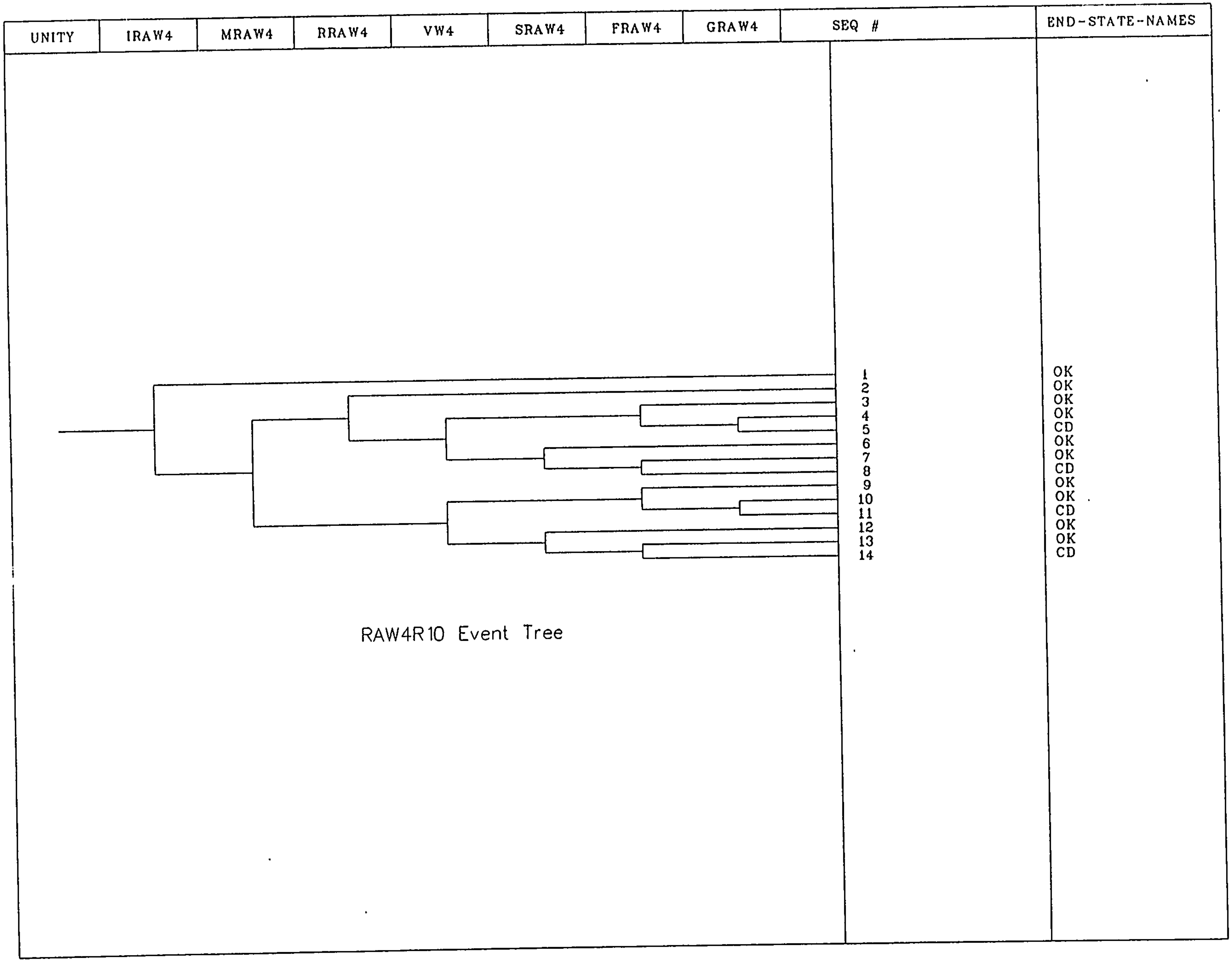
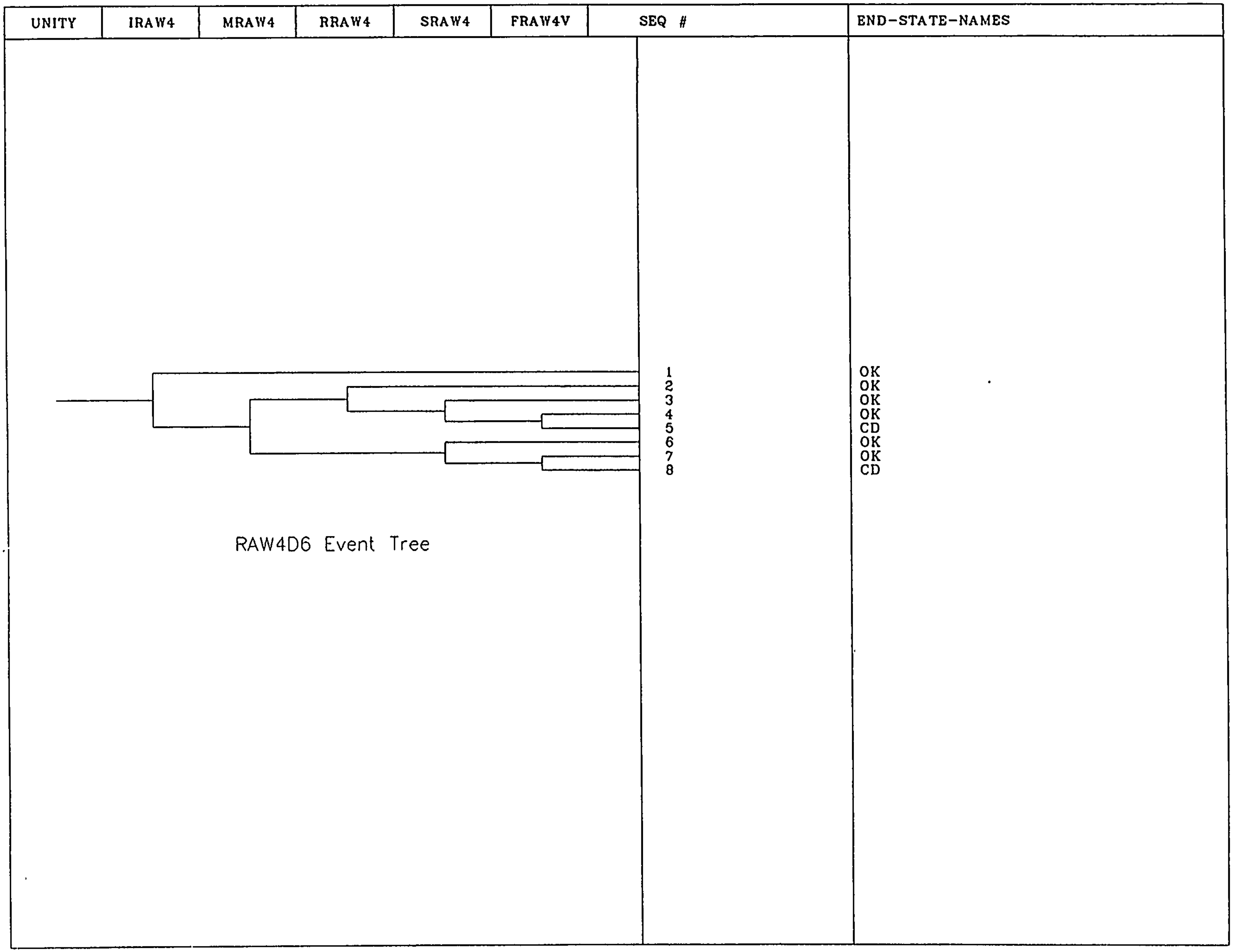
11 CD
12 OK
13 OK
14 CD
RAW4R6 Event Tree



RAW4R10 Event Tree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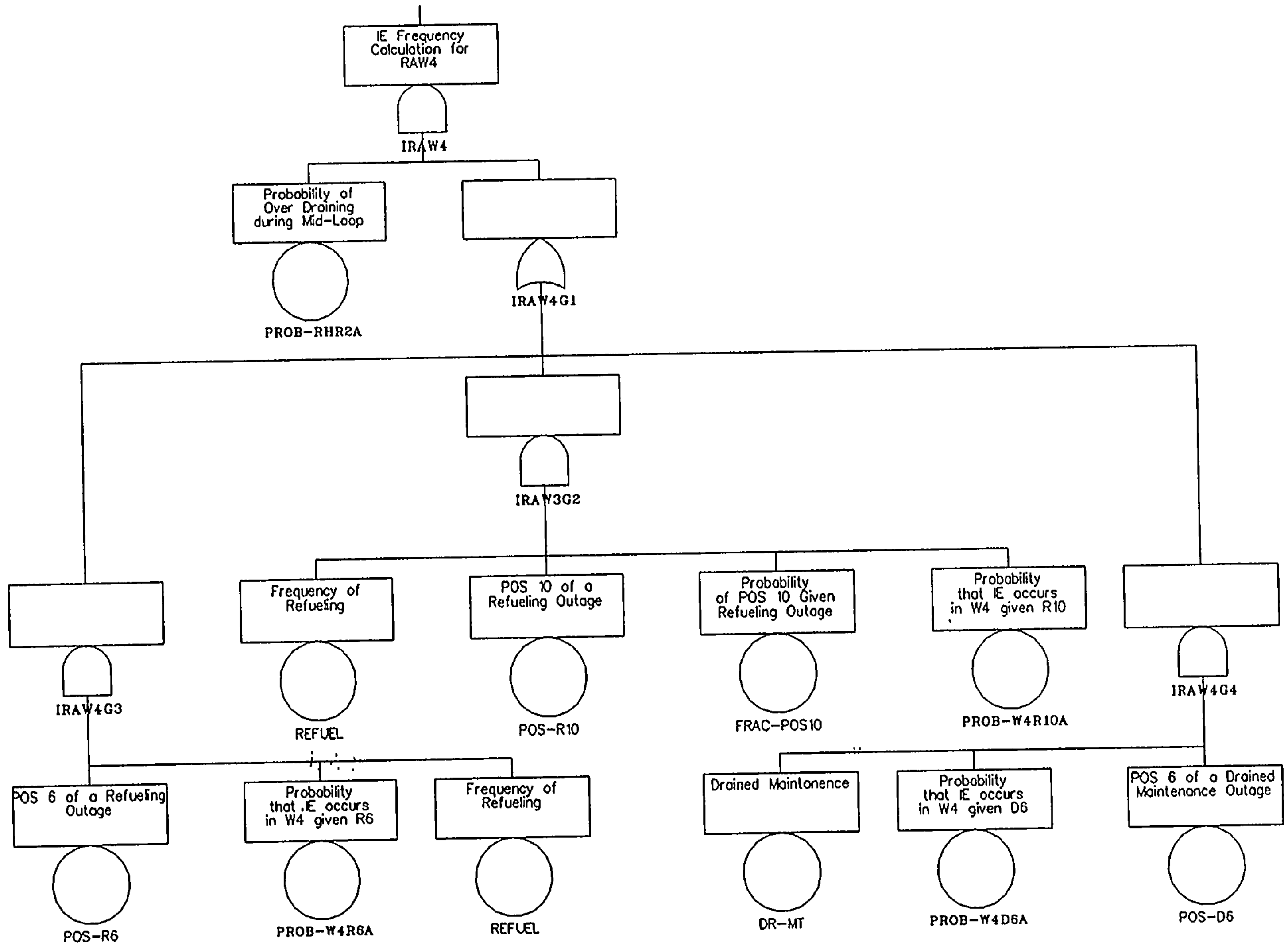
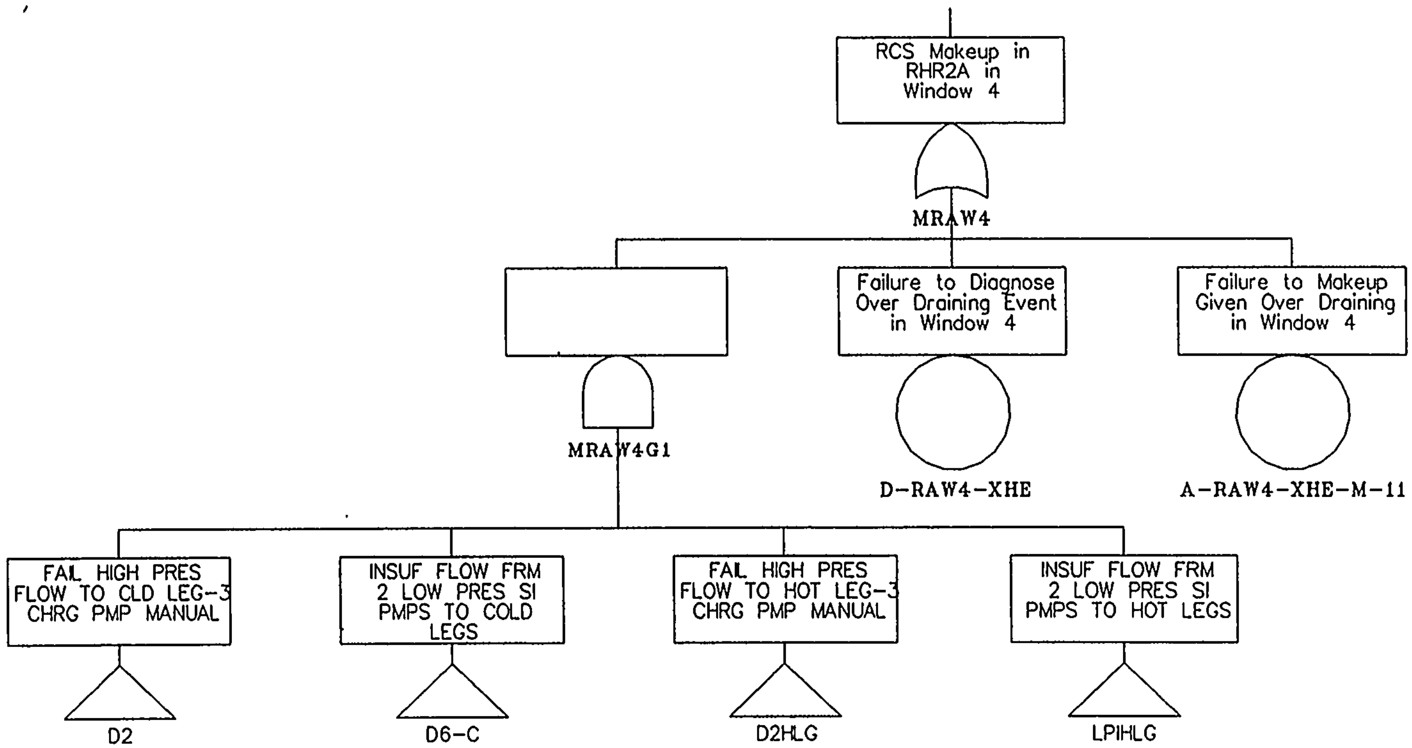
IRAW4
MRAW4
RRAW4
SRAW4
FRAW4V
SEQ #
END-STATE-NAMES
1 OK
2 OK
3 OK
4 OK
5 CD
6 OK
7 OK
8 CD
RAW4D6 Event Tree

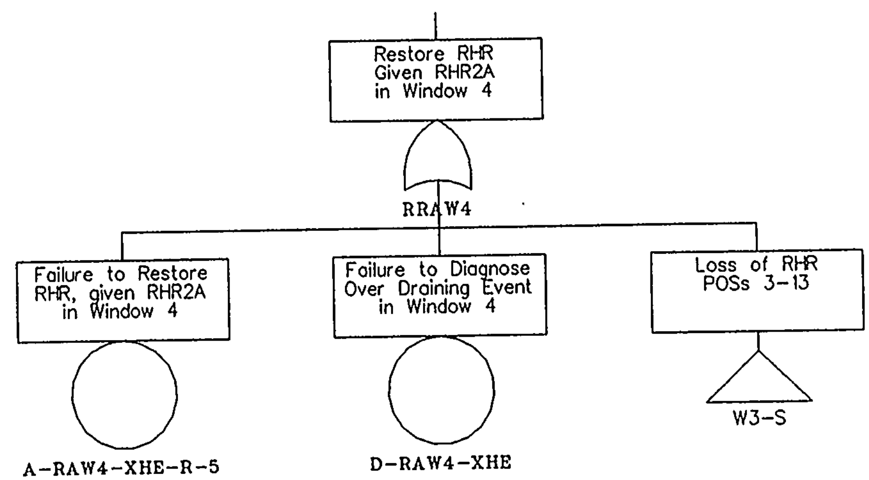
I top event for over Draining in window 4



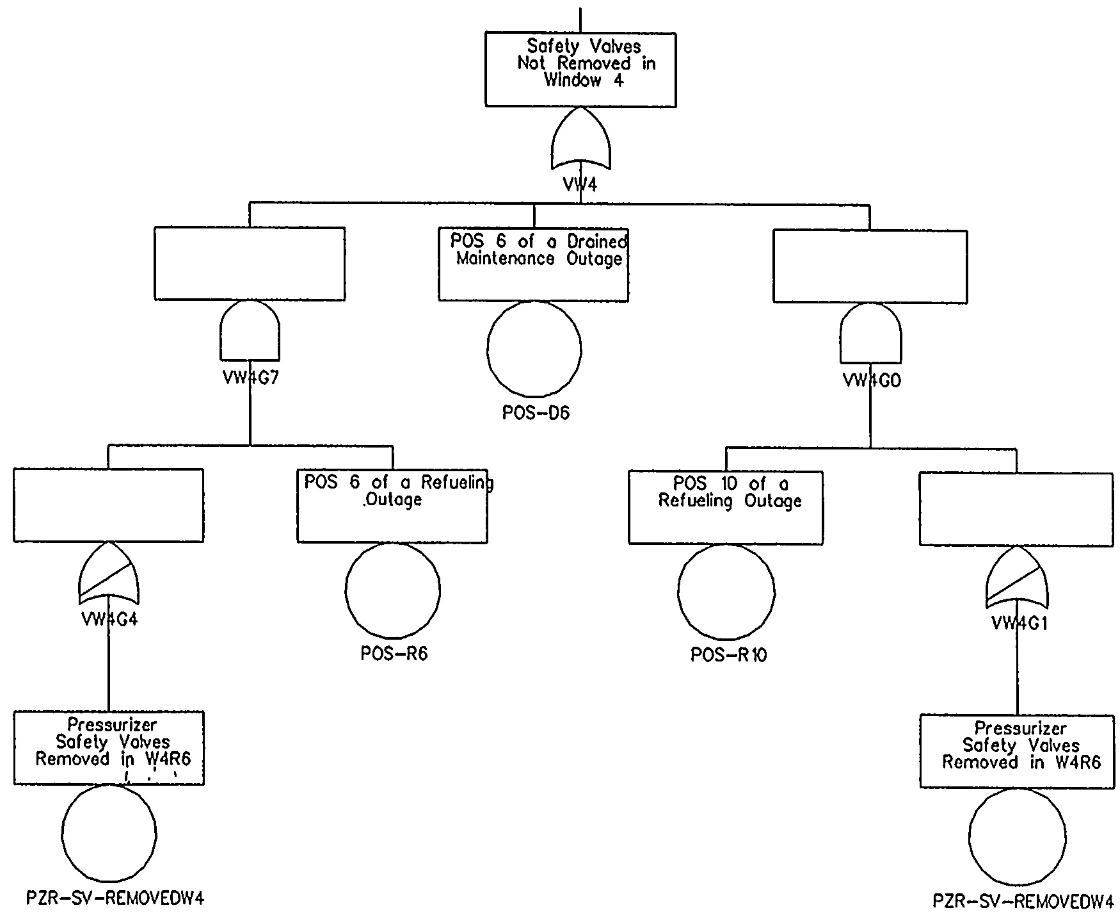
RCS Makeup in Window 4



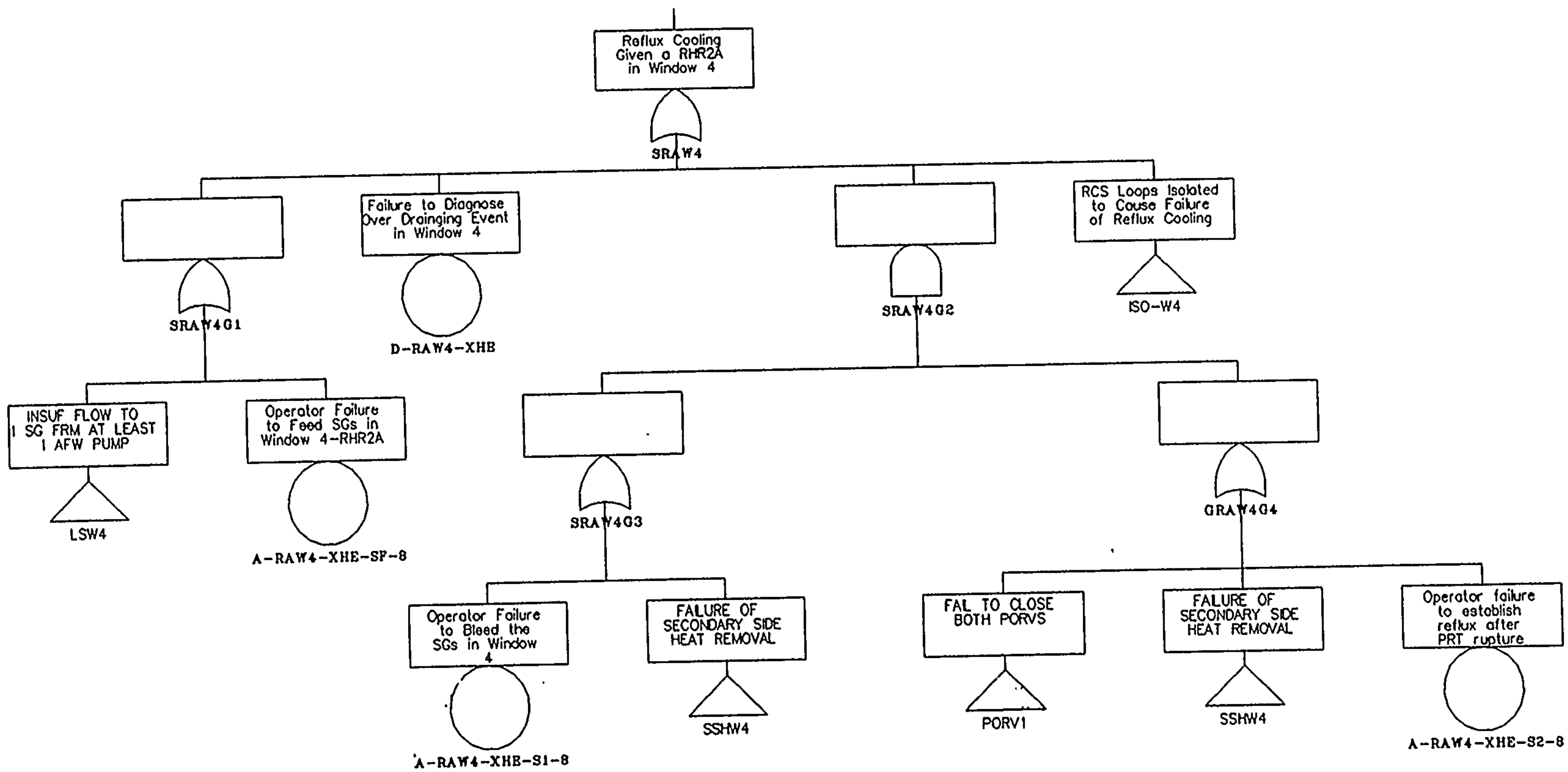
Restore RHR given RHR2A in Window 4



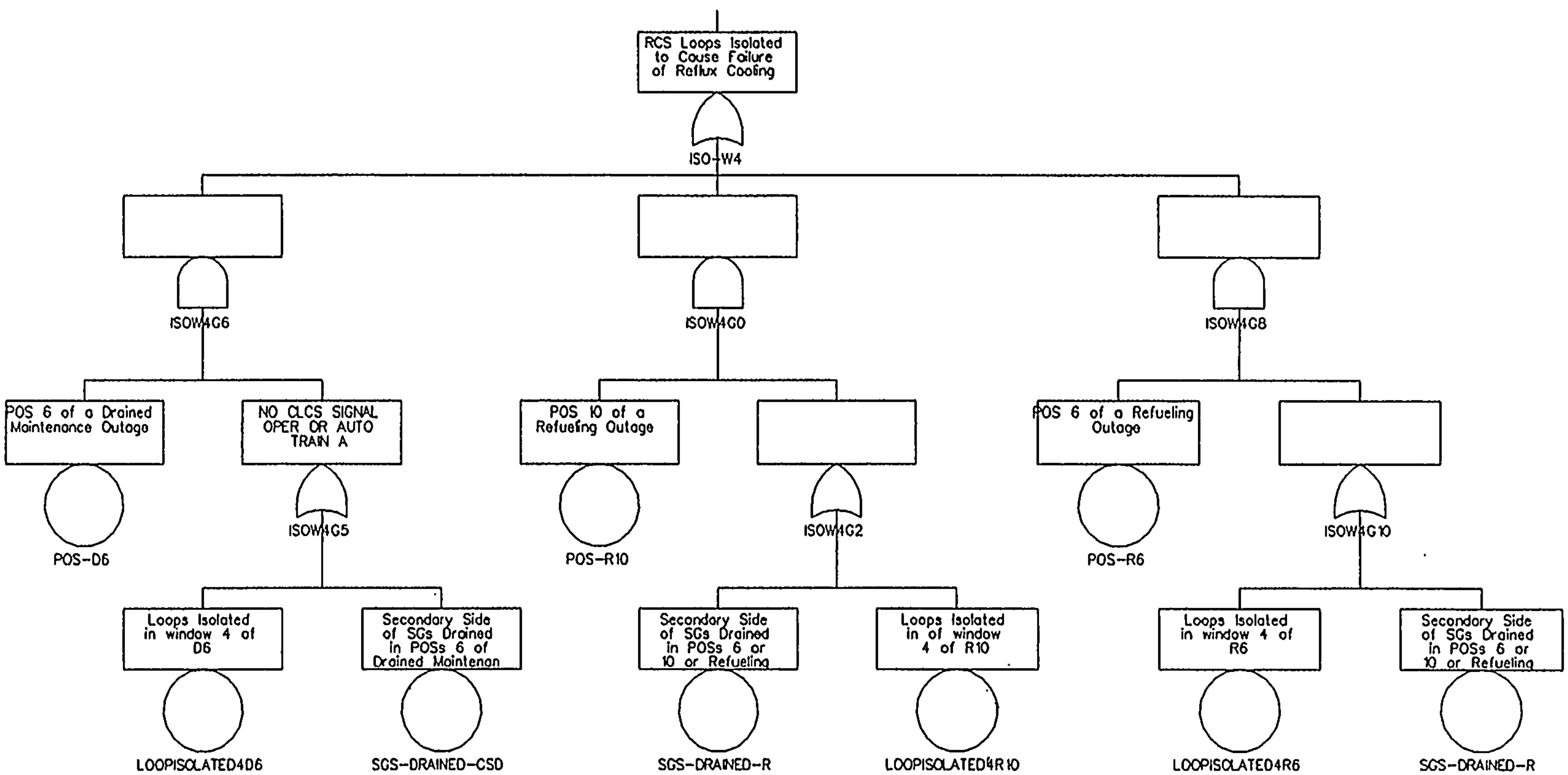
Safety Valves Not Removed in Window 4



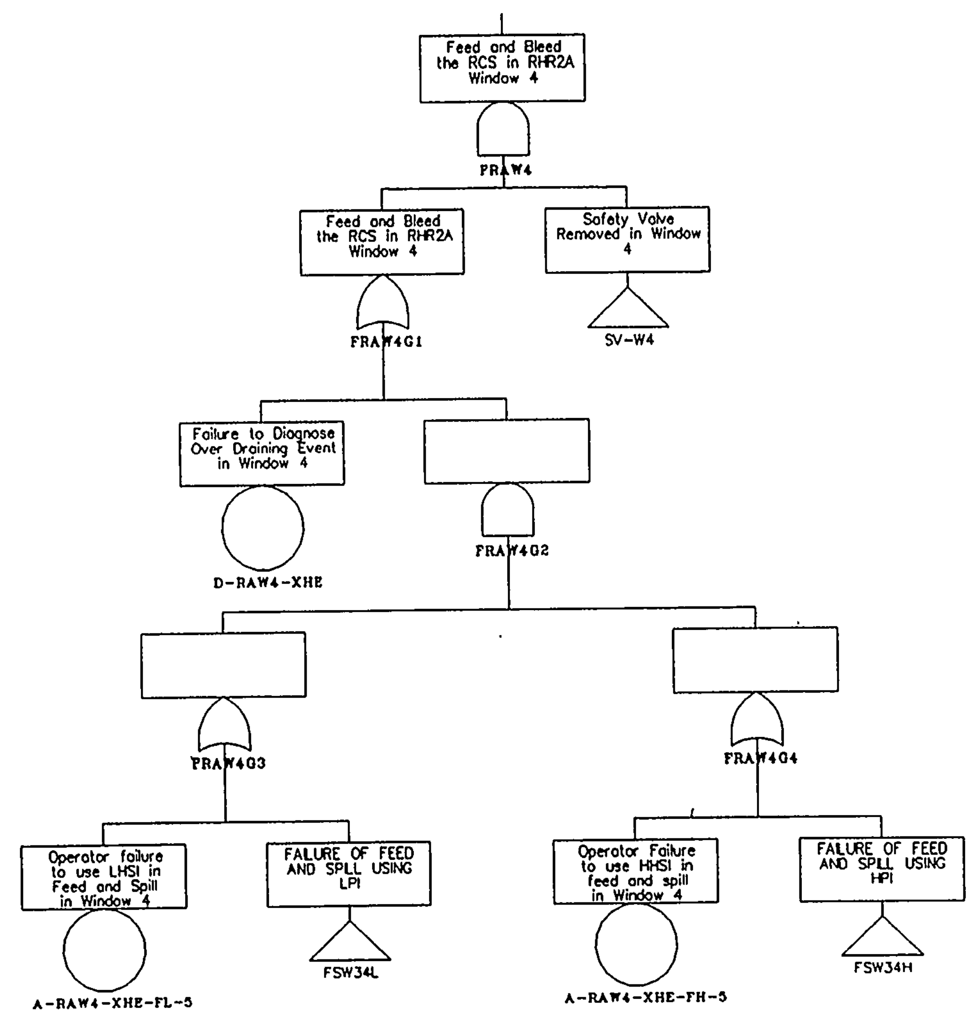
Reflux Cooling in Window 4



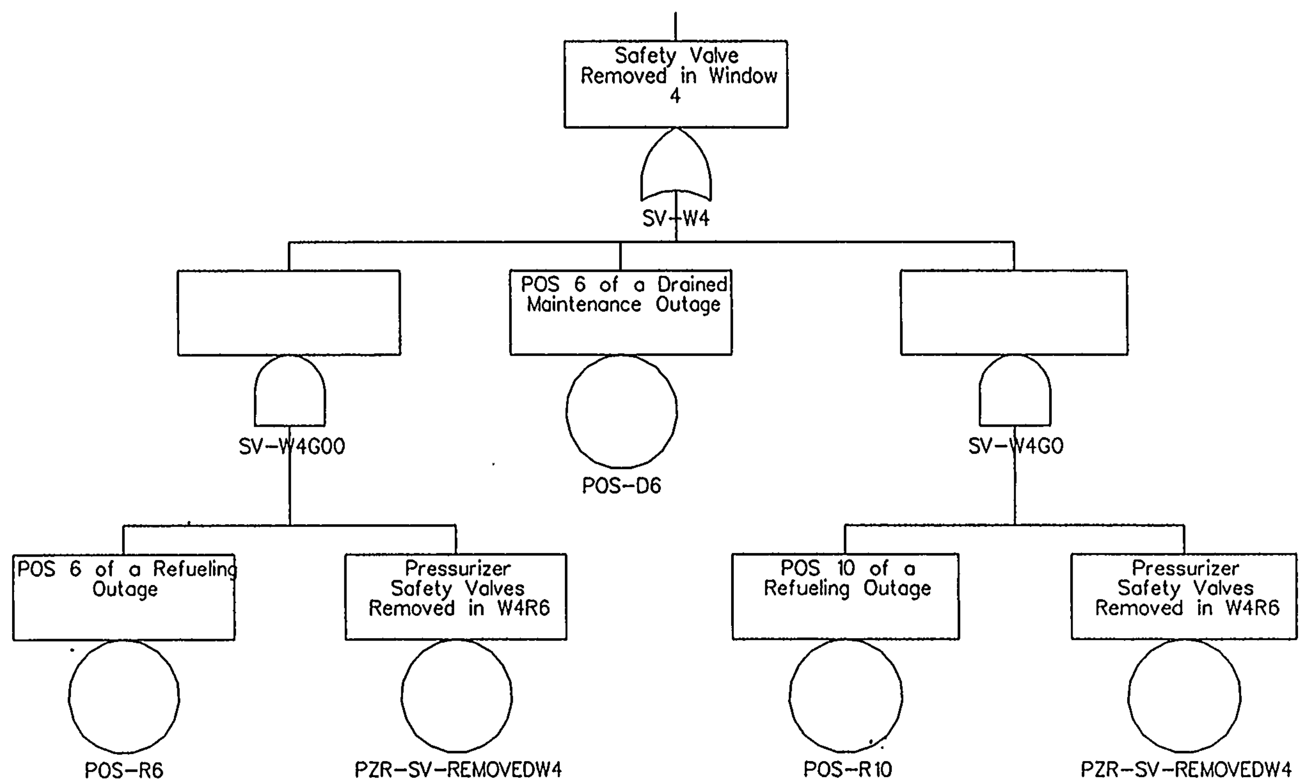
RCS Loops Isolated to Cause Failure of Reflux in Window 4



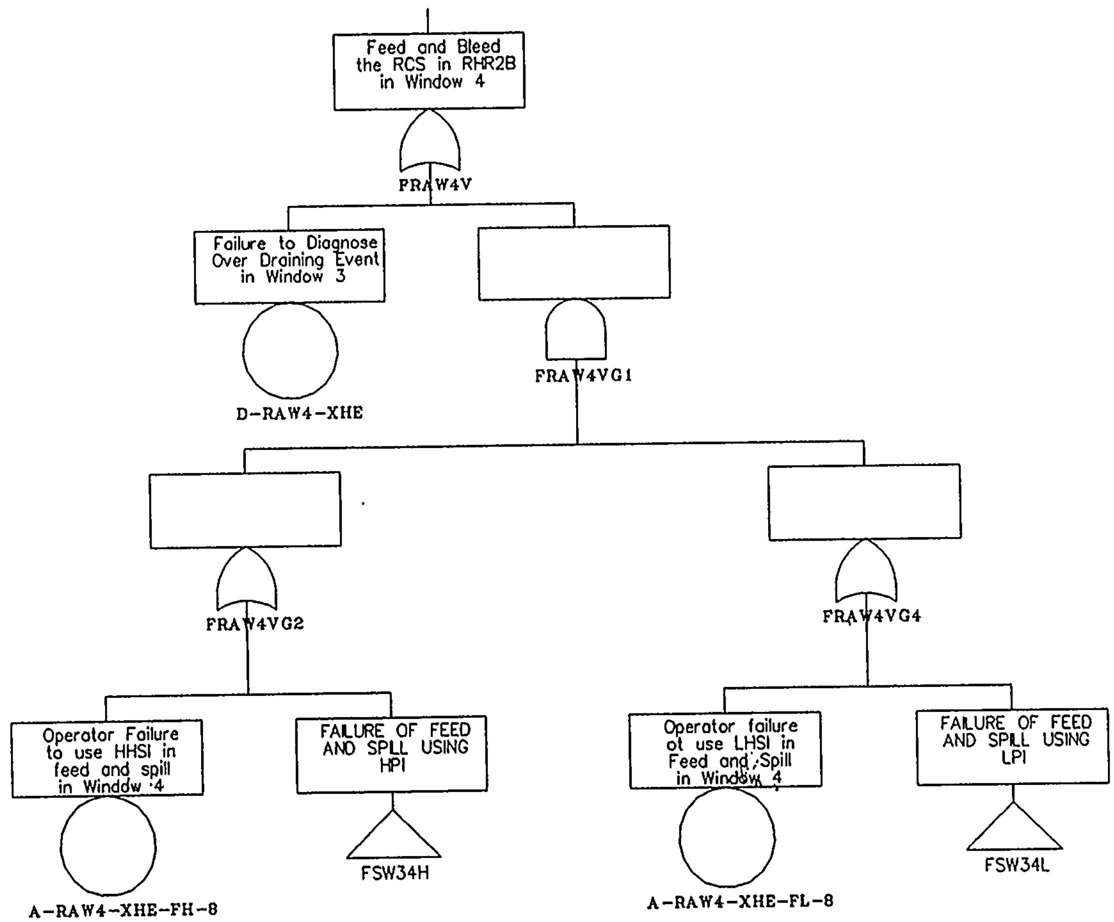
Feed and Bleed the RCS in RHR2A Window 4



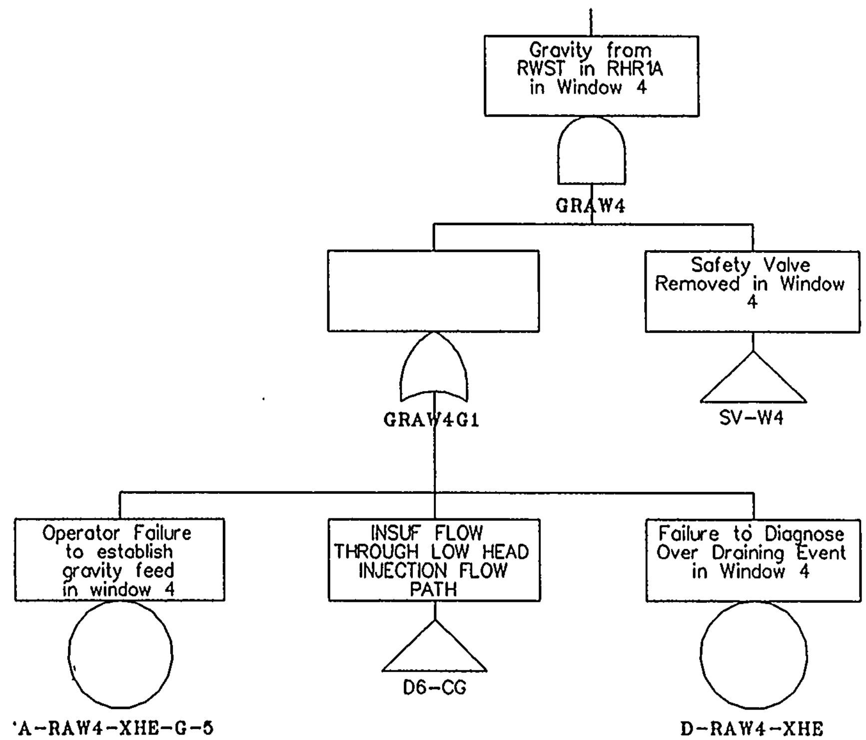
Safety Valves Removed in Window 4



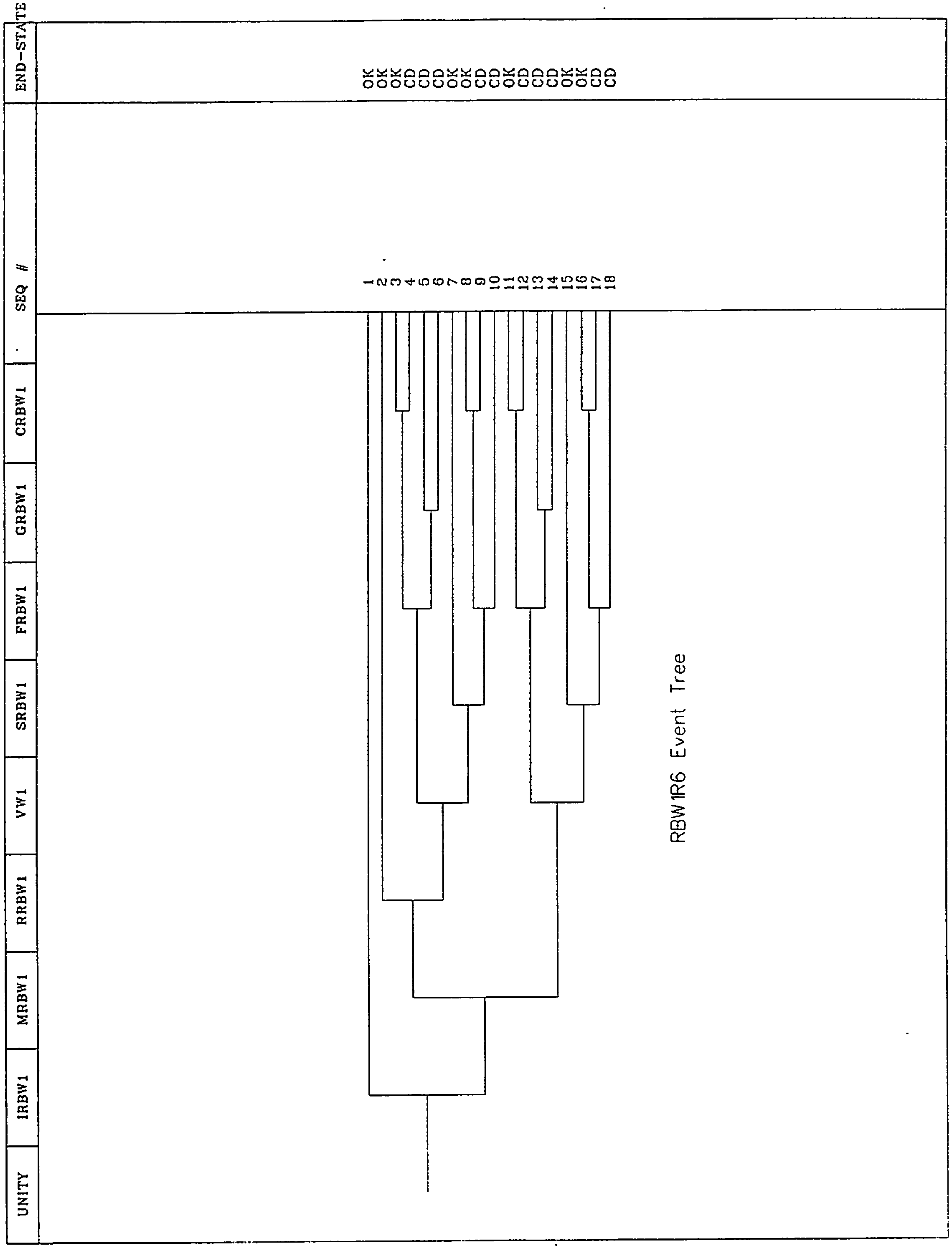
Feed and Bleed the RCS with V failed in RHR2B, Window 4



Gravity from RWST in RHR2A, Window 4



Appendix E.2 Event trees and High Level Fault Trees for Loss of Inventory(RHR2B)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RRBW1
VW1
SRBW1
FRBW1
GRBW1
CRBW1
SEQ #
END-STATE
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4 CD
5 CD
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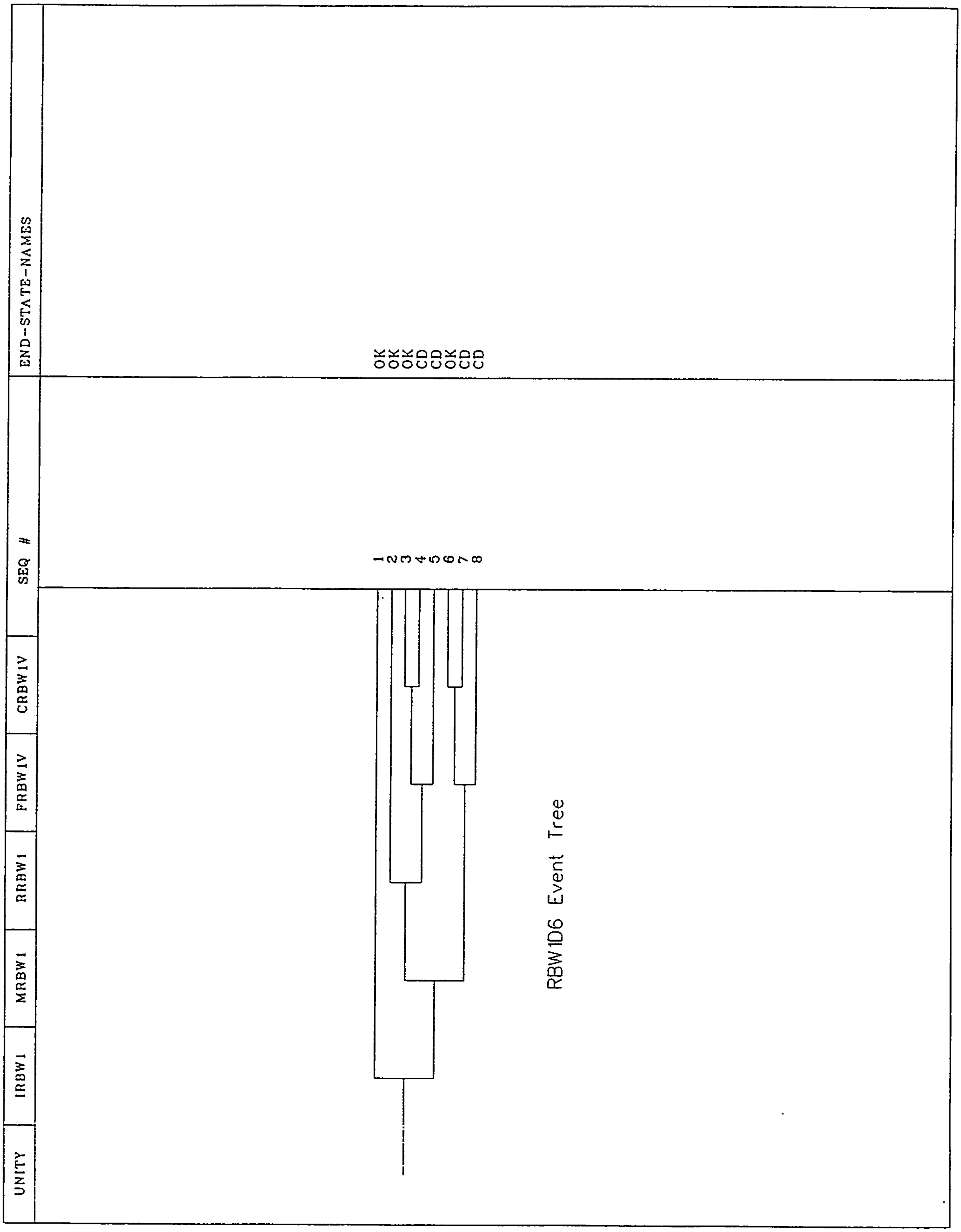
13 CD
14 CD
15 OK
16 OK
17 CD
18 CD
RBW1R6 Event Tree


UNITY
IRBW1
MRBW1
RRBW1
FRBW1V
CRBW1V
SEQ #
END-STATE-NAMES
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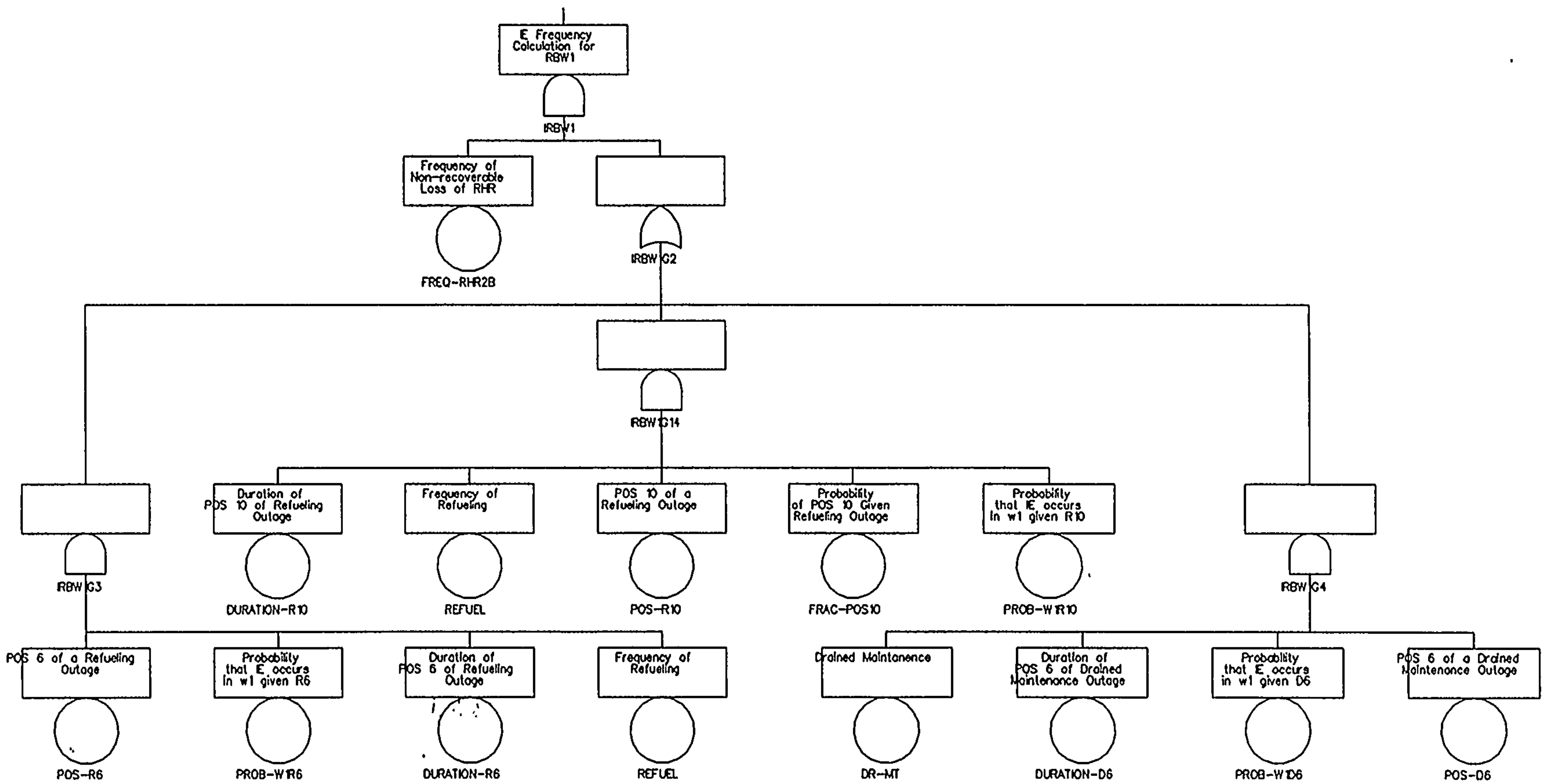
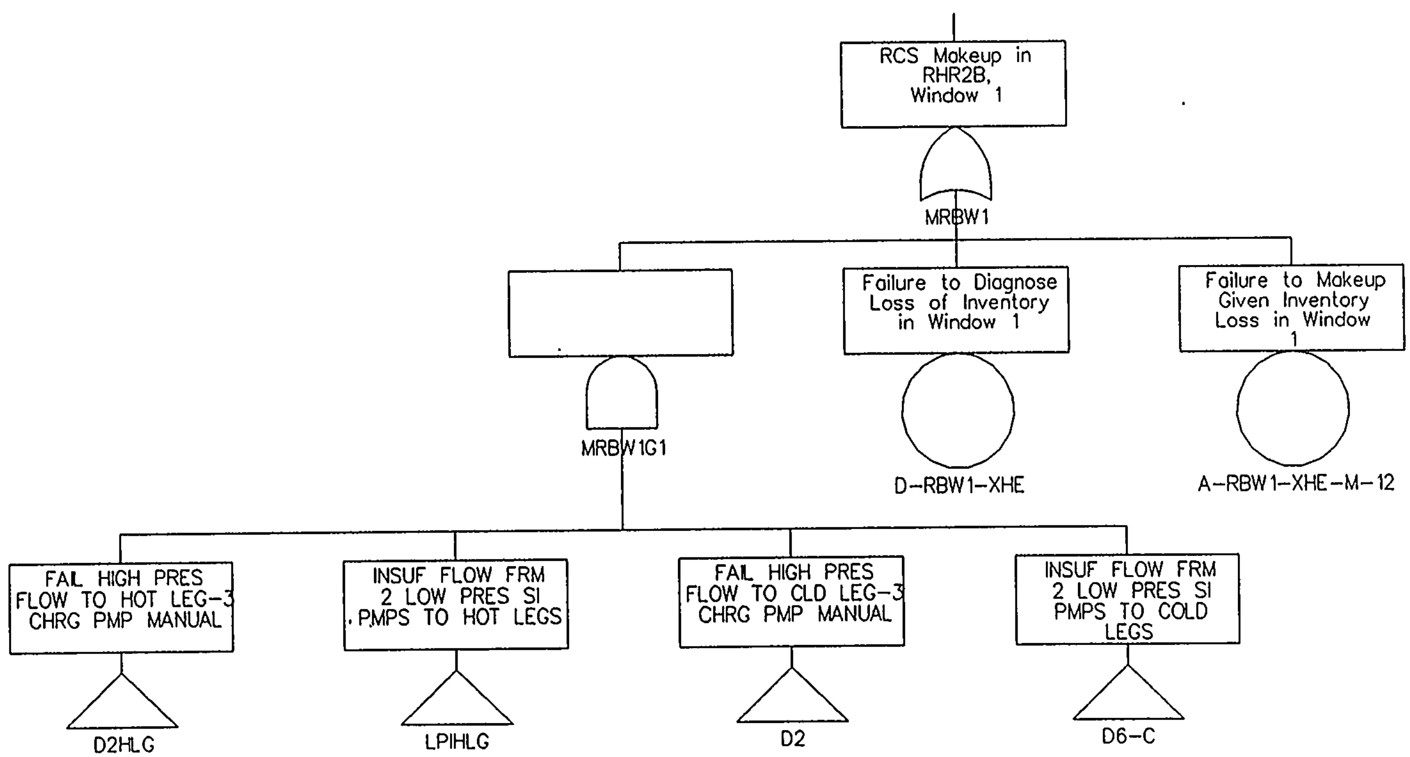
2 OK
3 OK
4 CD
5 CD
6 OK
7 CD
8 CD
RBW1D6 Event Tree

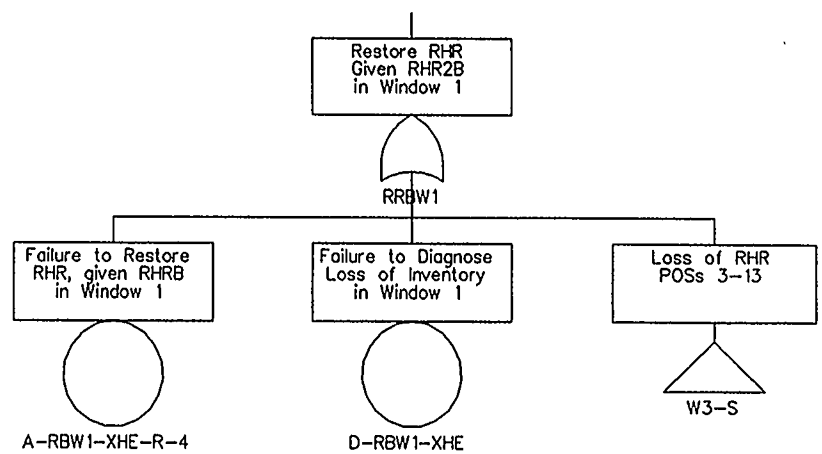
I Top Event for Loss of Inventory in Window 1



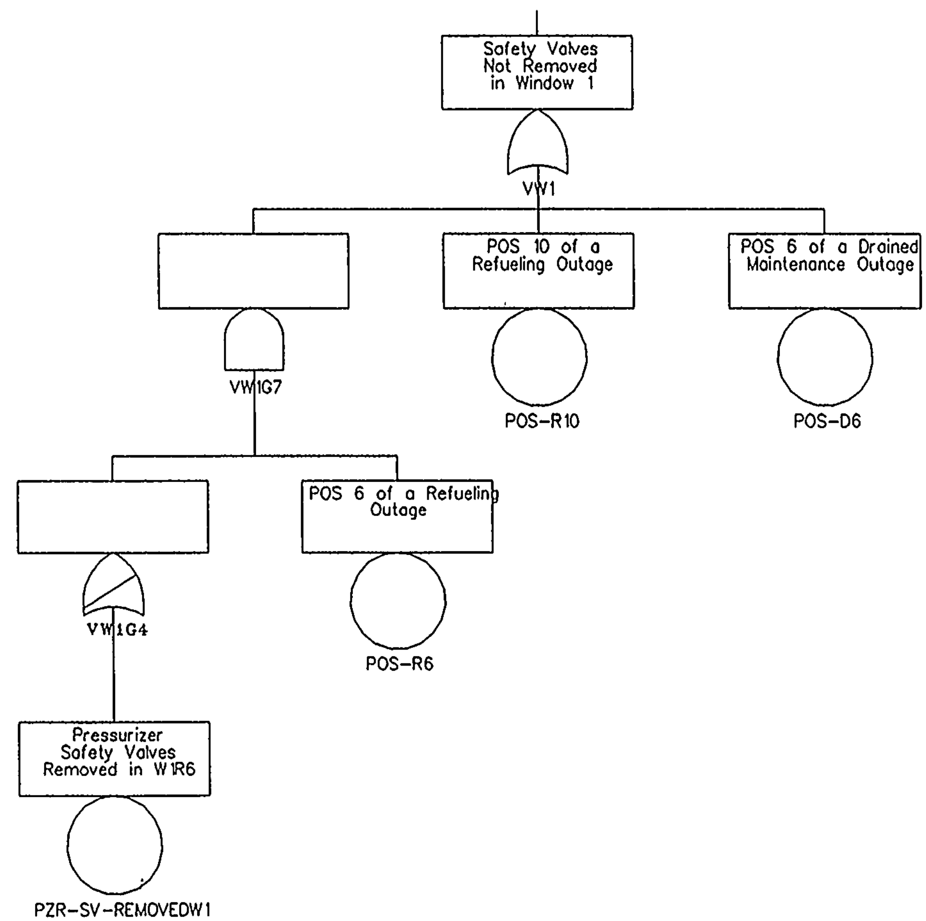
RCS Makeup in Window 1



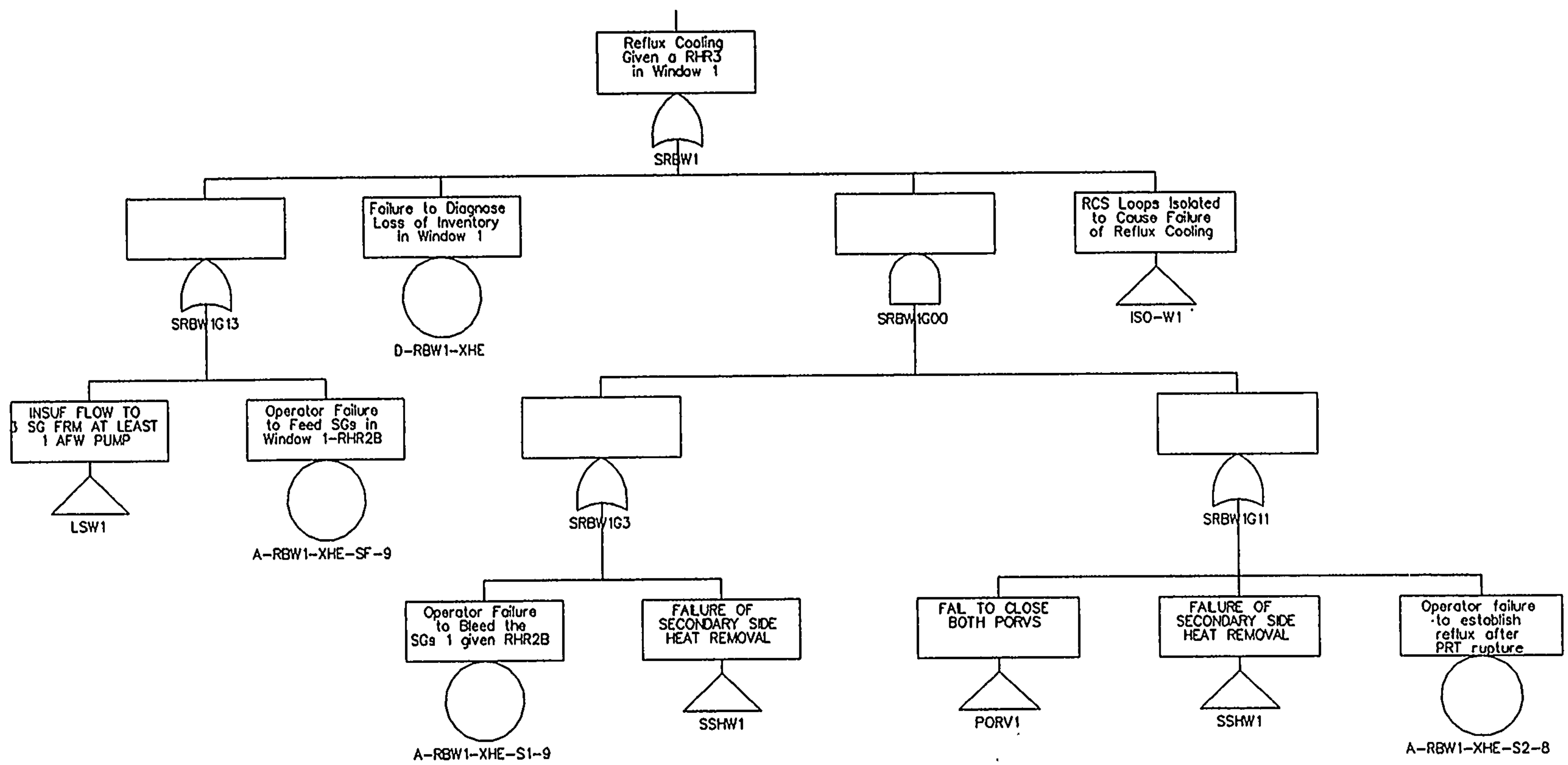
Restore RHR given RHR2B in Window 1



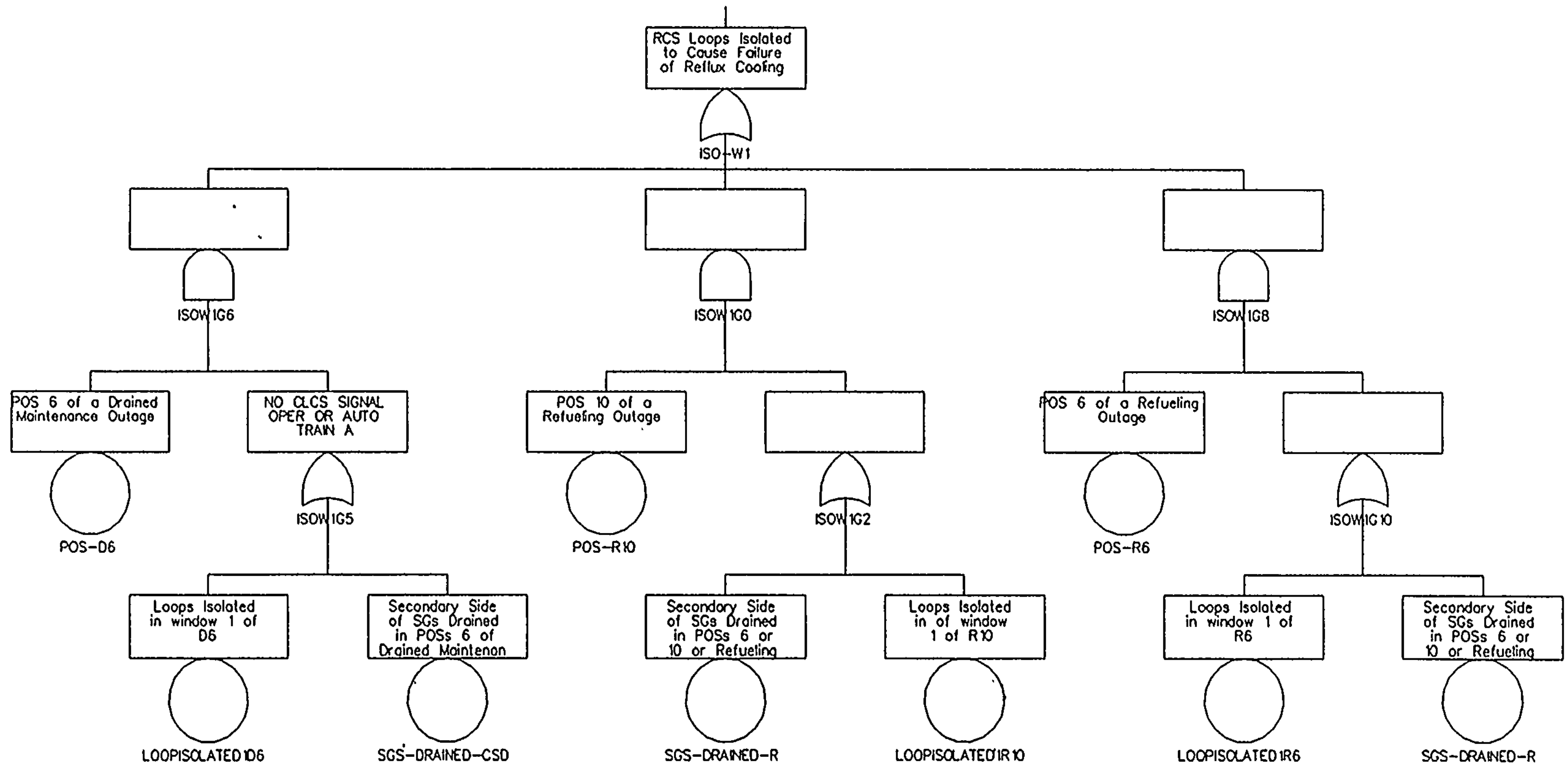
Safety Valves Not Removed in Window 1



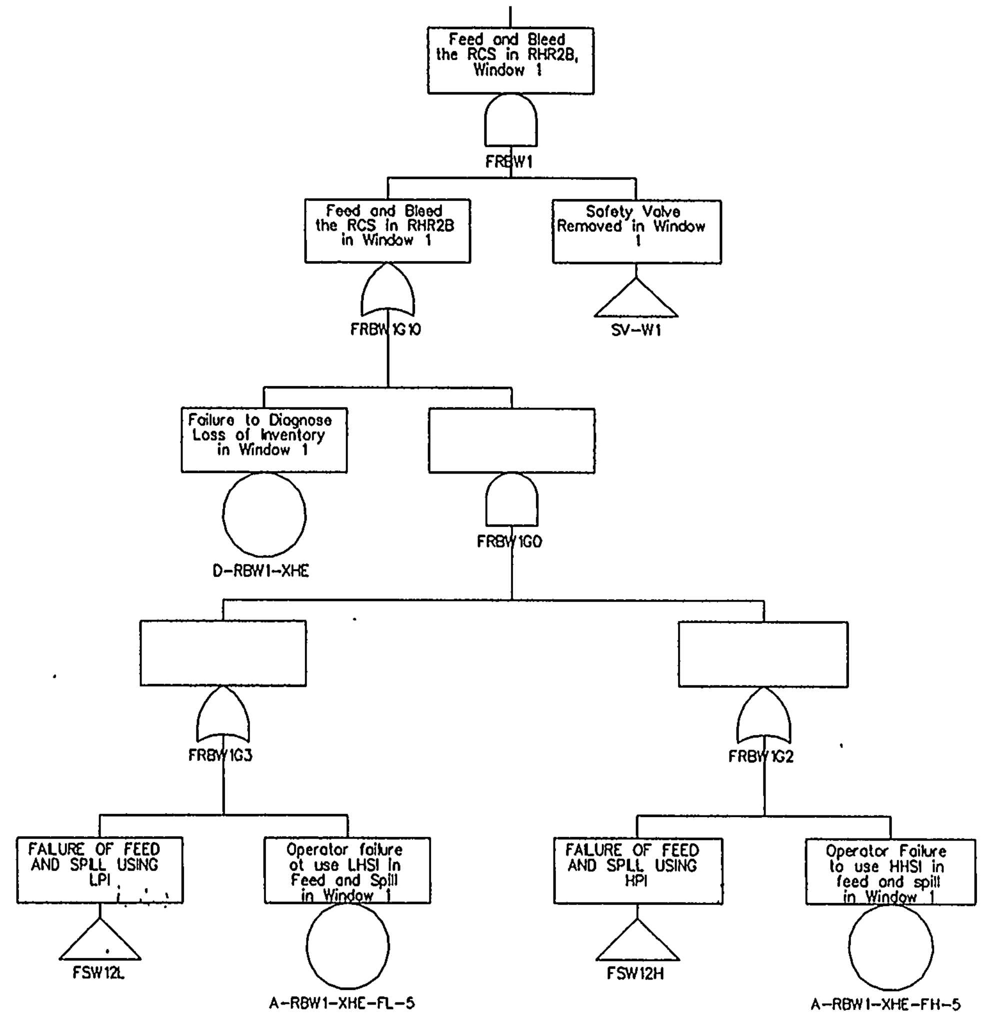
Reflux Cooling in Window 1



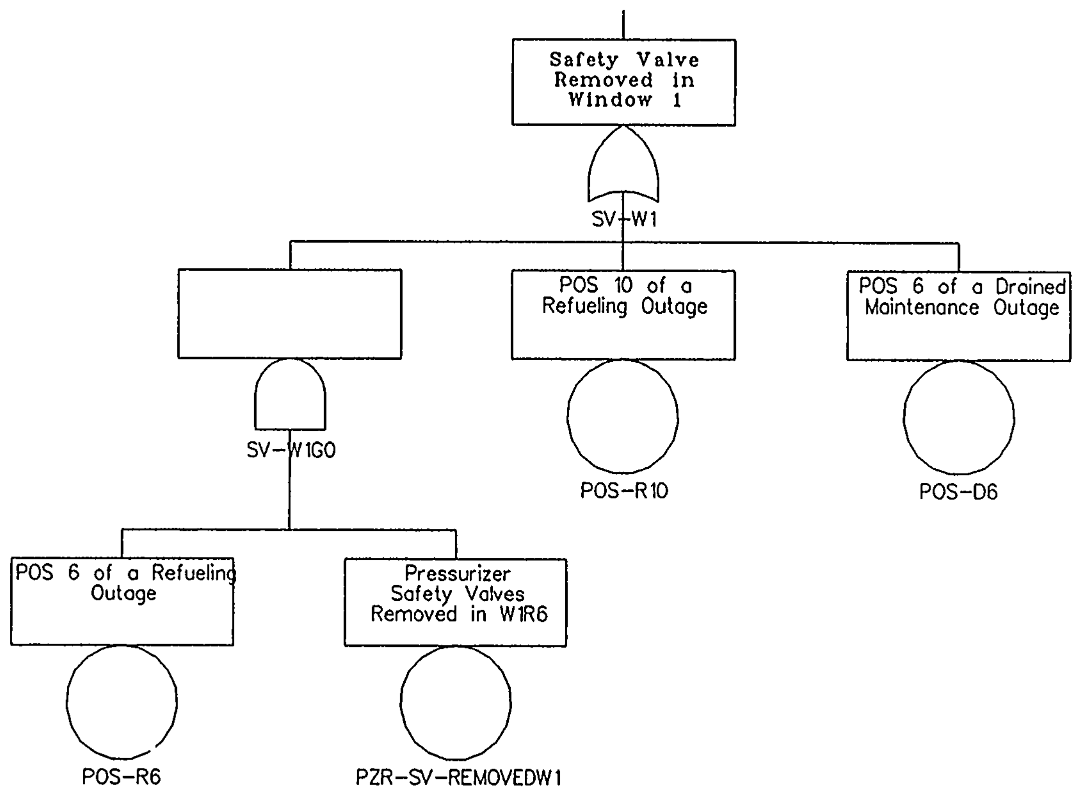
RCS Loops Isolated to Cause Failure of Reflux in Window 1



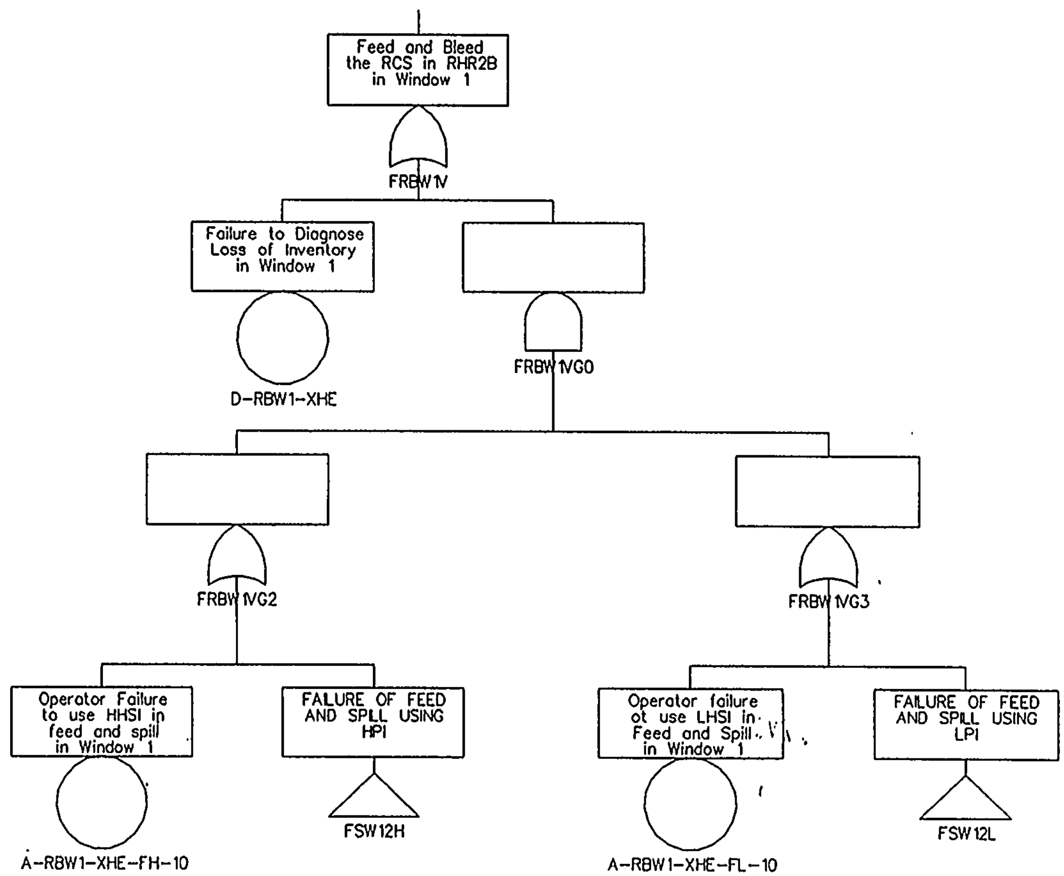
Feed and Bleed the RCS in RHR2B, Window 1



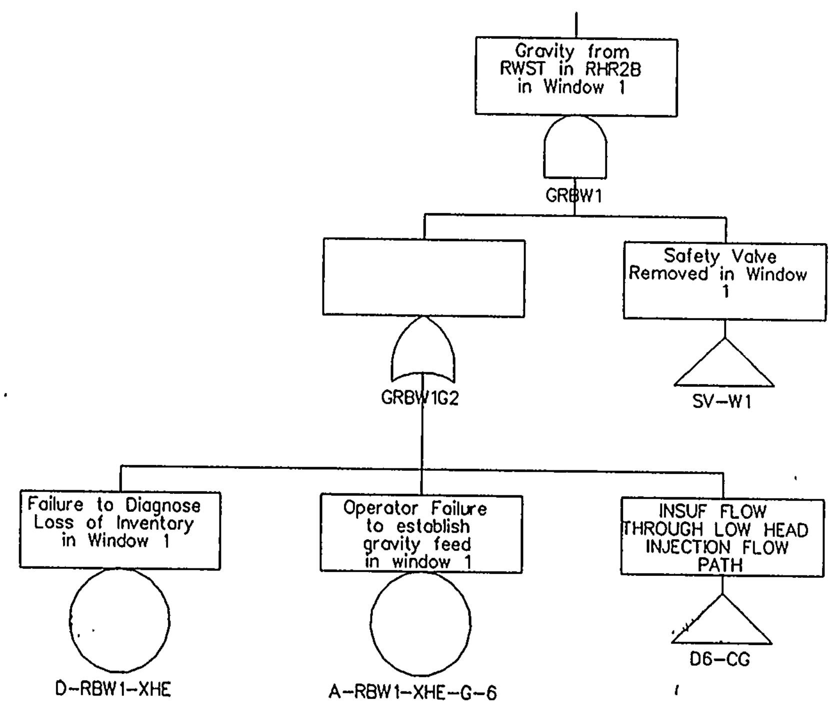
Safety Valves Removed in Window 1



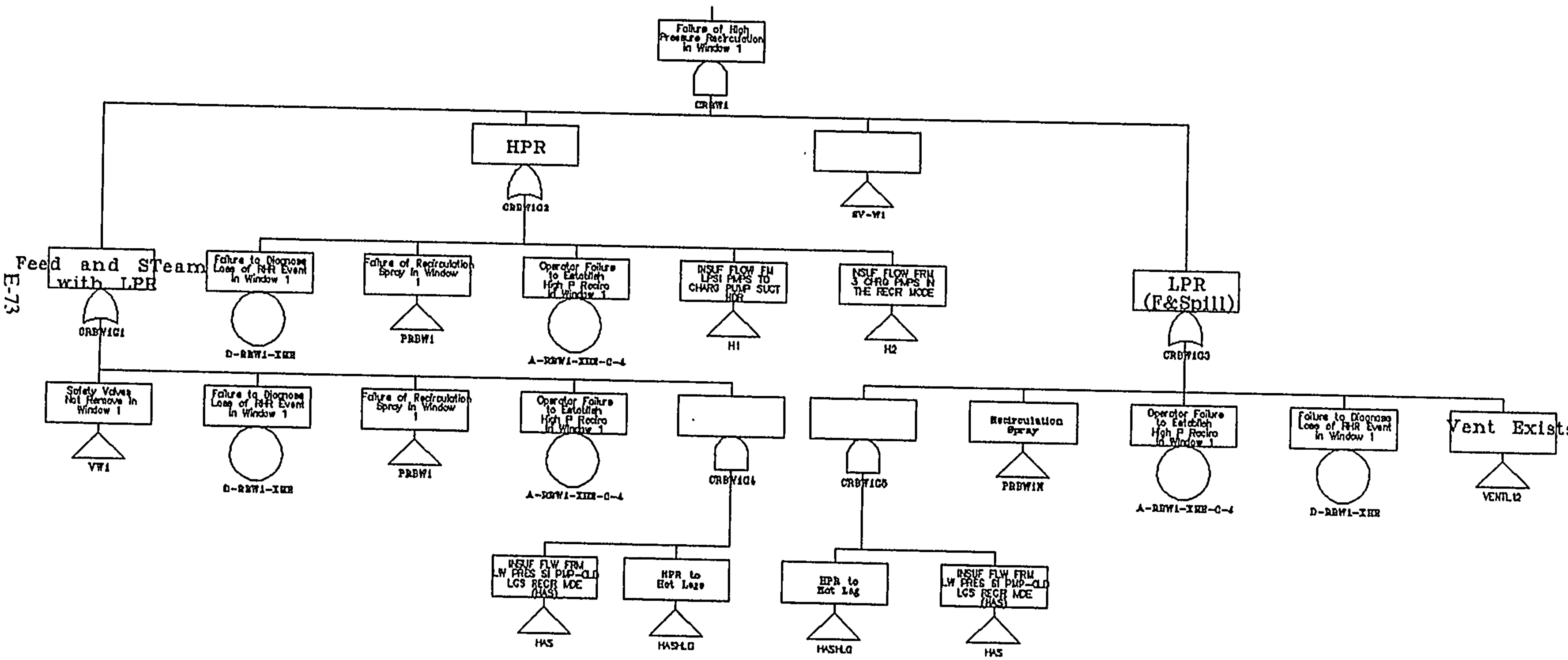
Feed and Bleed the RCS with V failed in RHR2B, Window 1



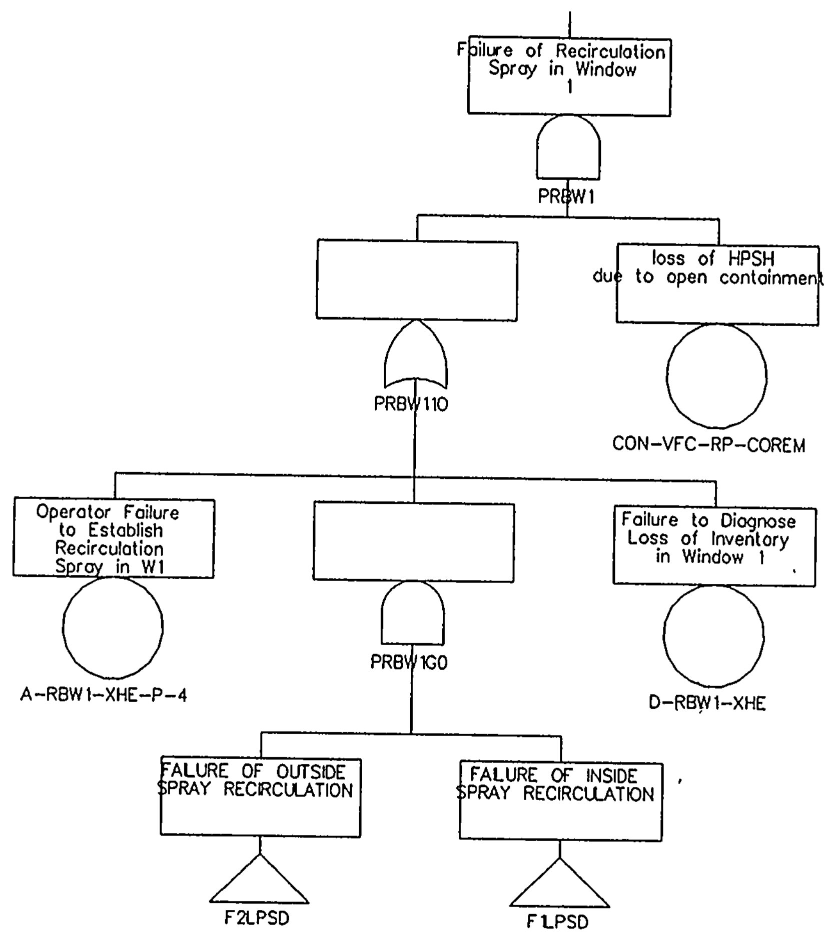
Gravity from RWST in RHR2B, Window 1



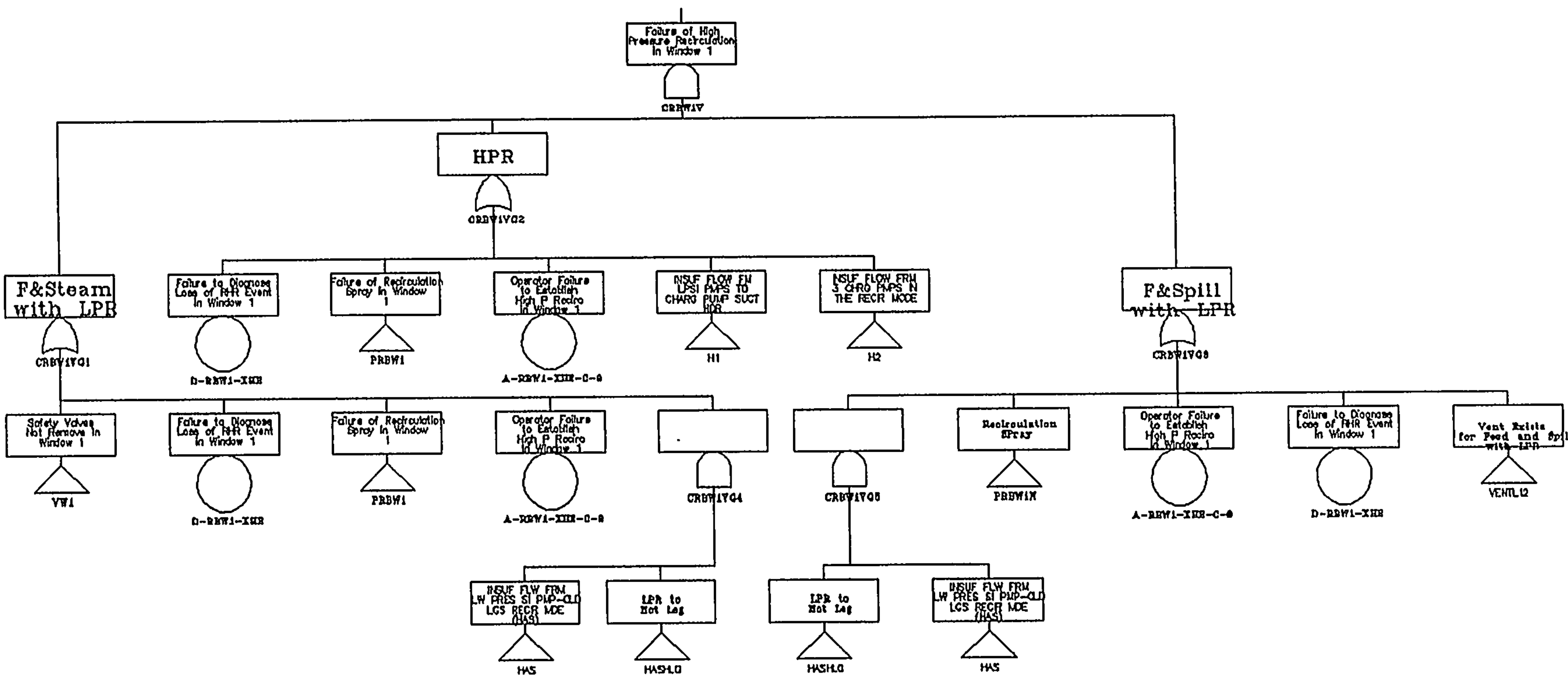
Failure of High Pressure Recirculation in Window 1

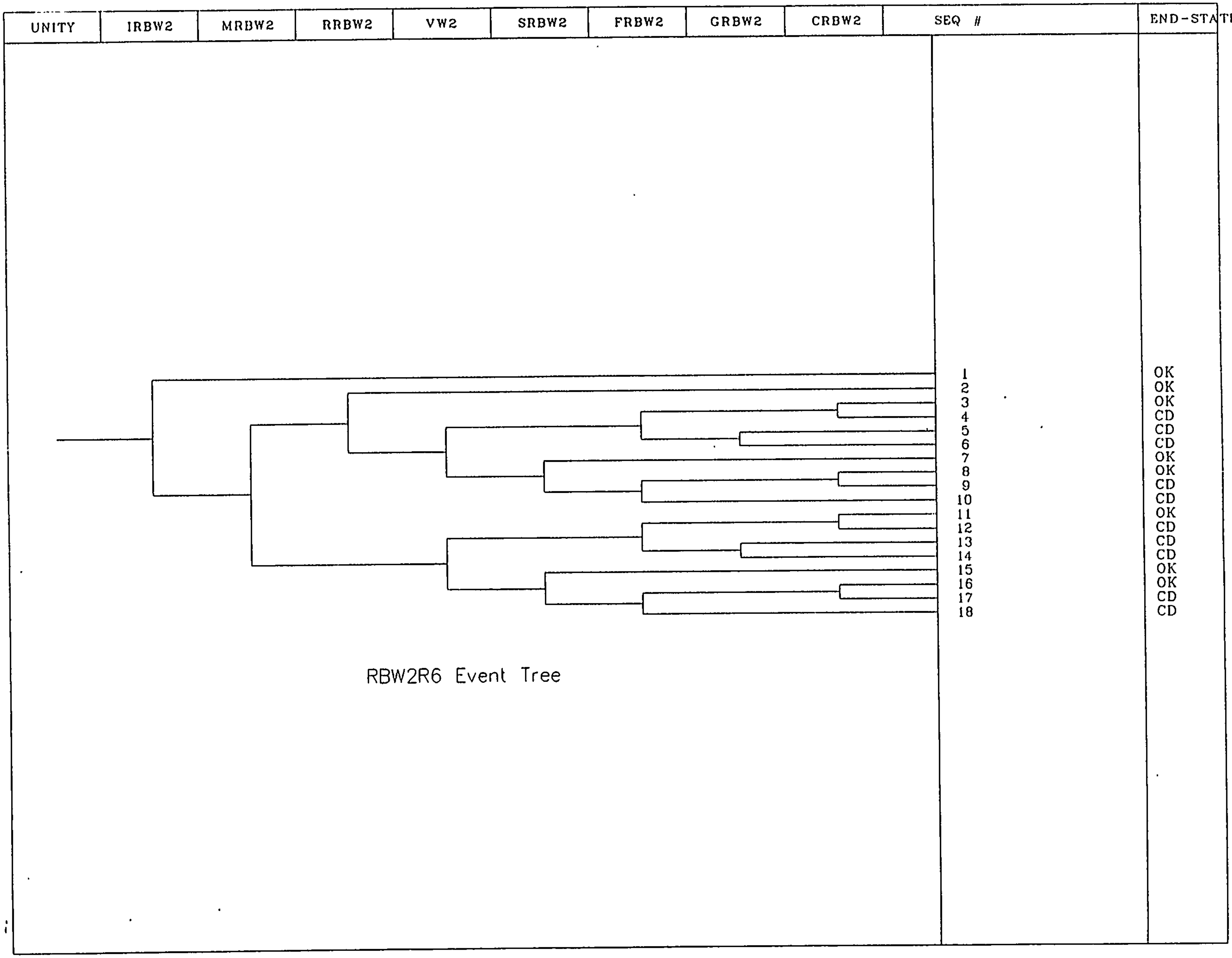


Failure of Recirculation Spray in Window 1—cause HPR failure

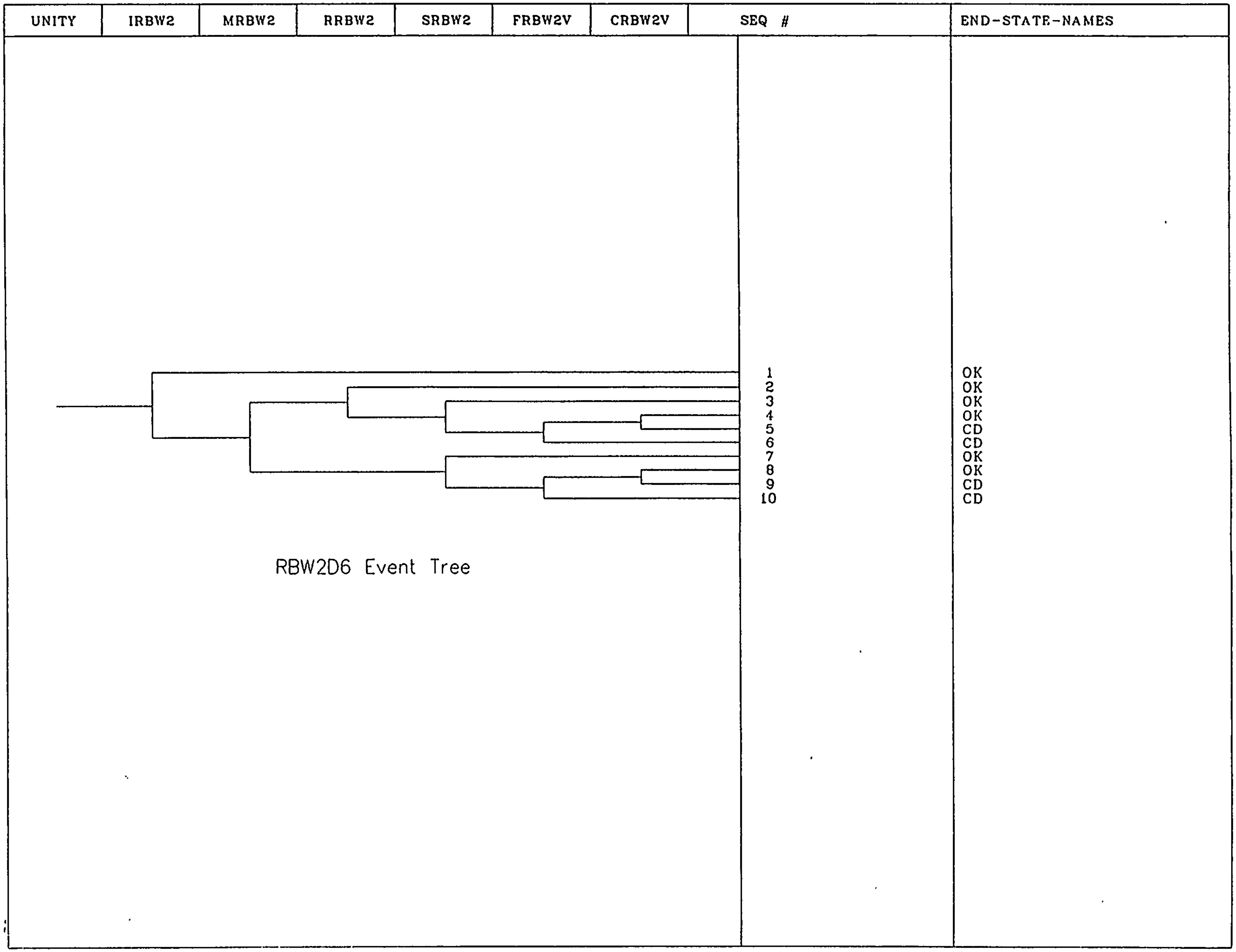


Failure of High Pressure Recirculation in Window 1



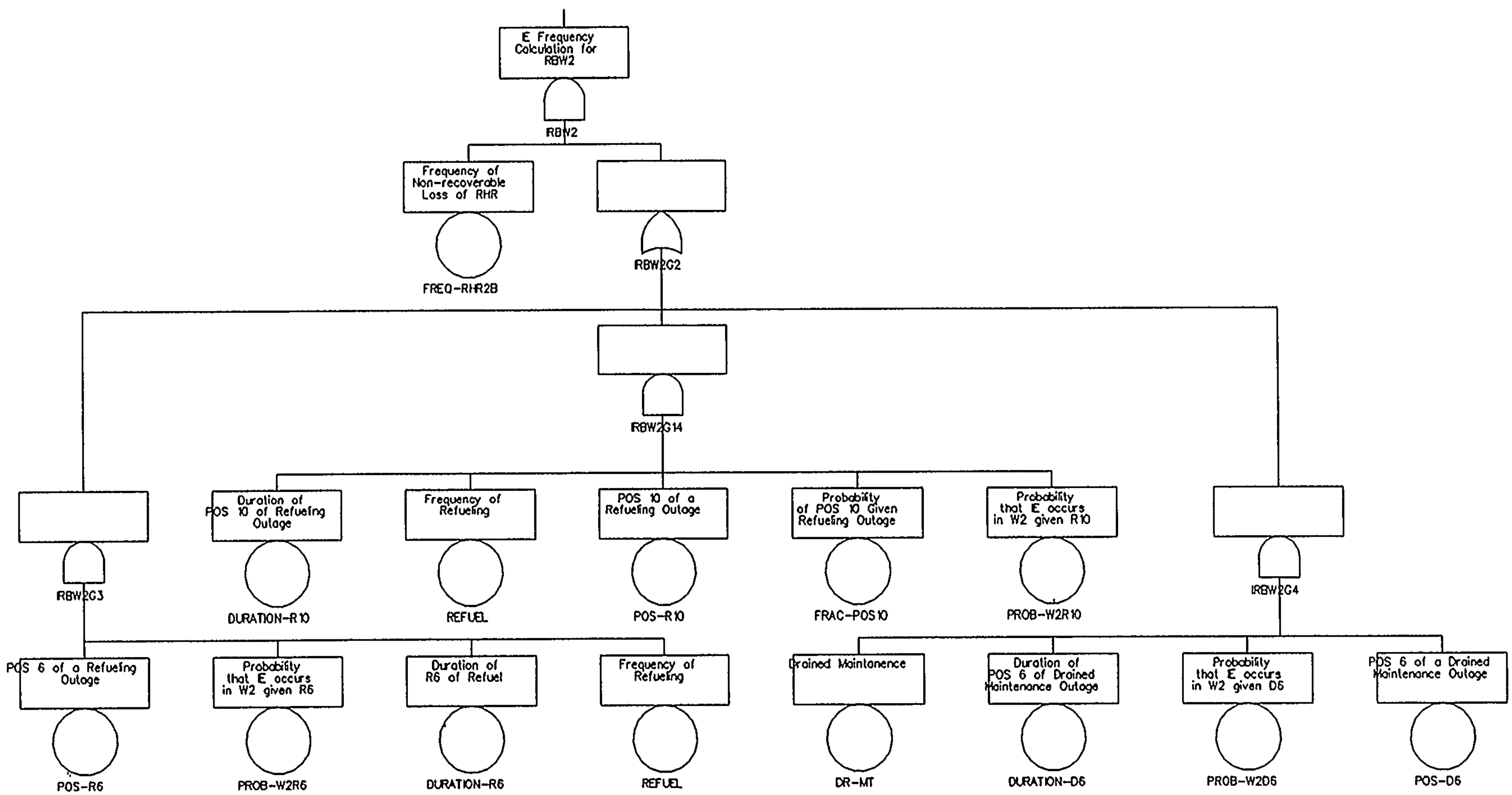


RBW2R6 Event Tree

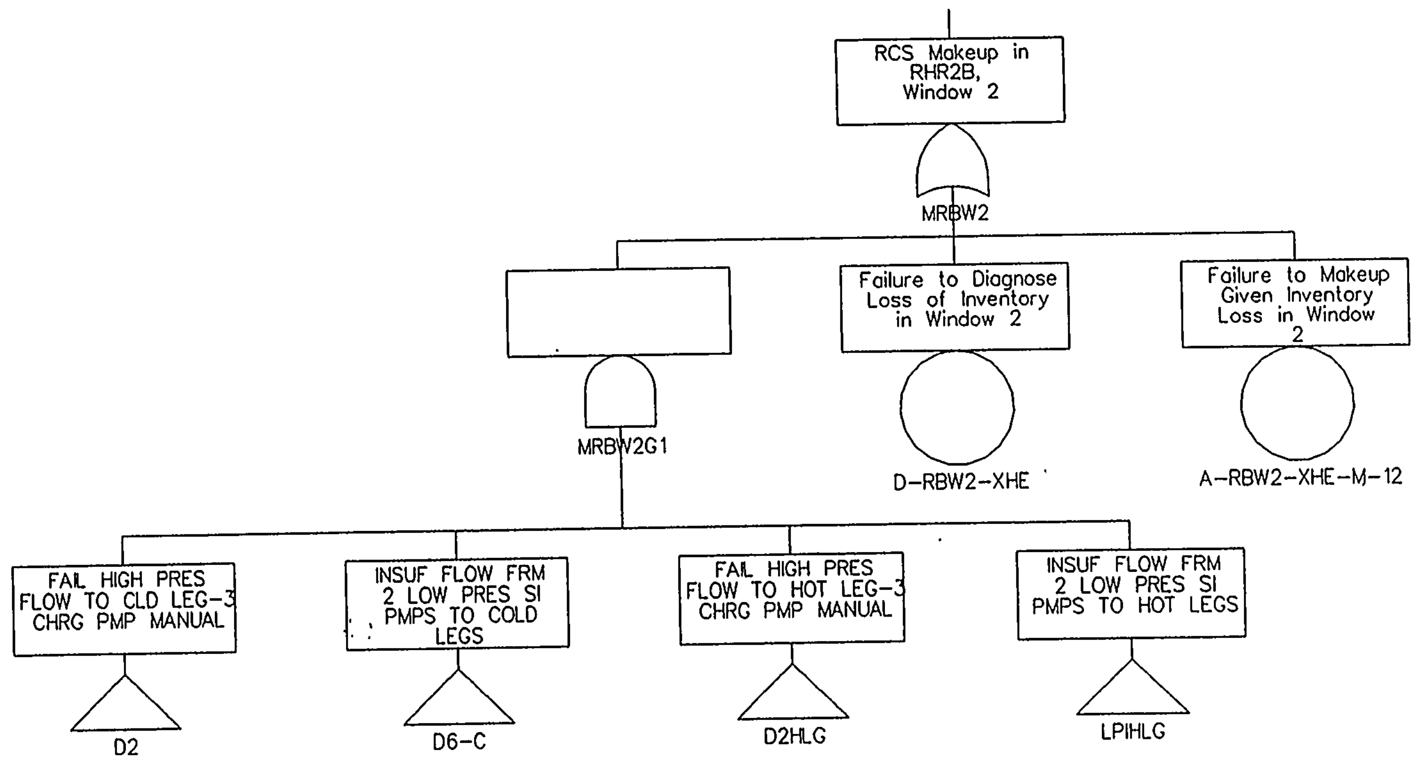


RBW2D6 Event Tree

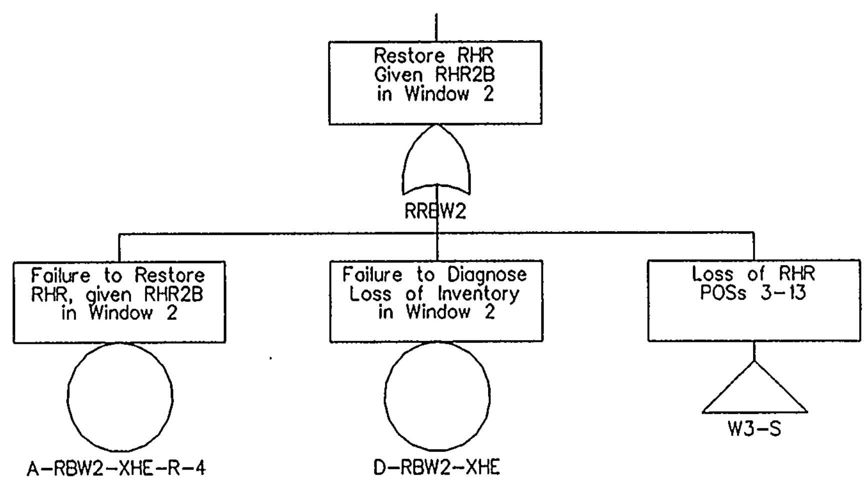
I Top Event for Loss of Inventory in Window 2



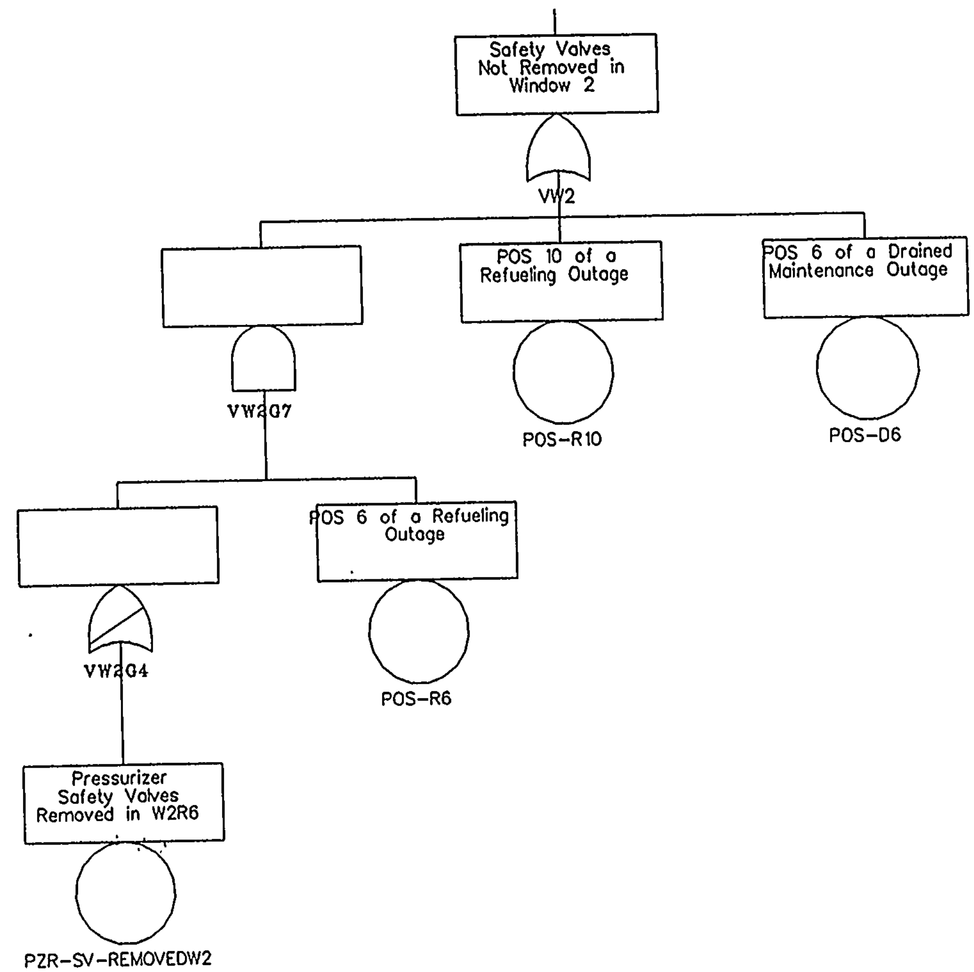
RCS Makeup in Window 2



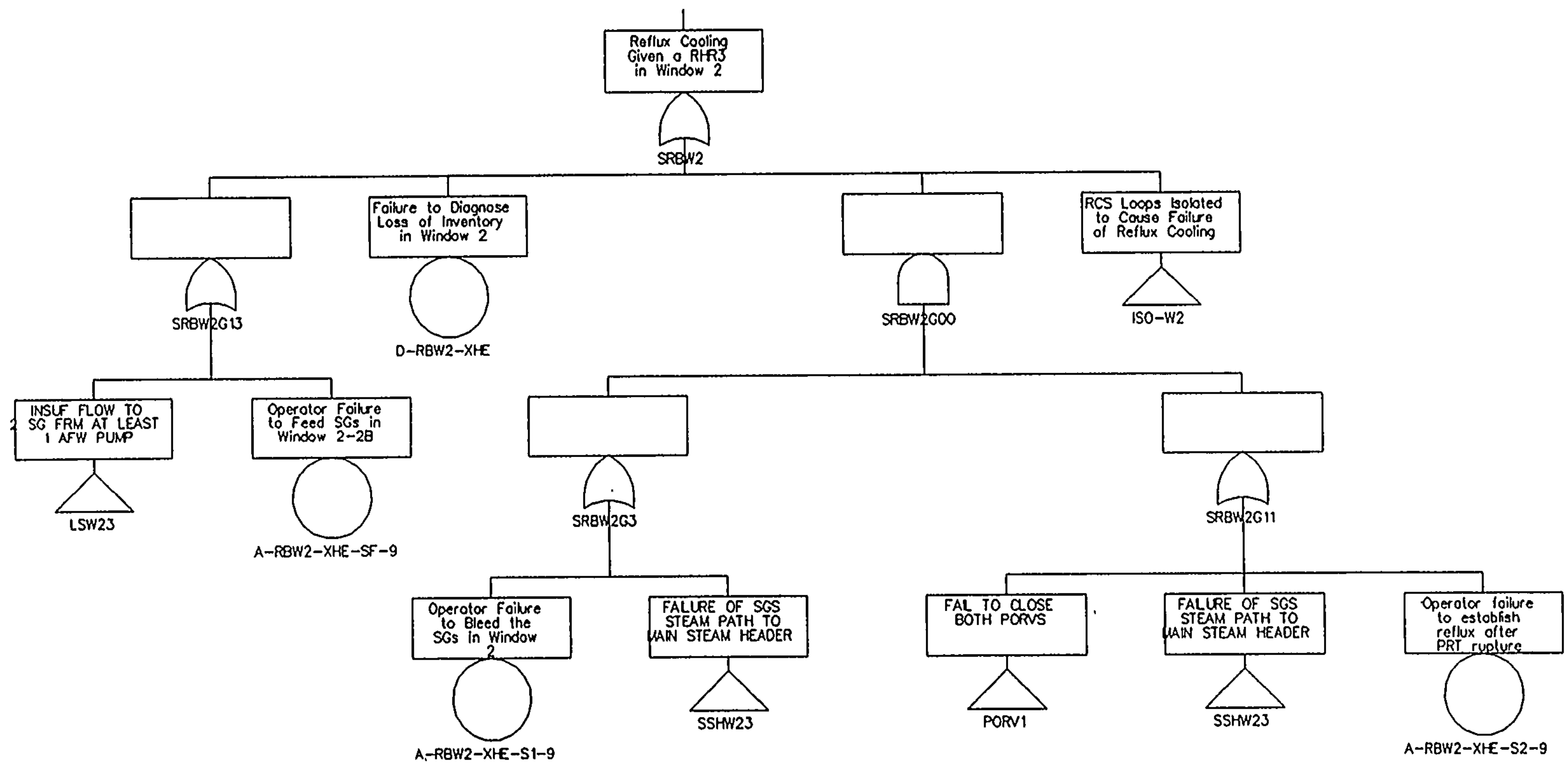
Restore RHR given RHR2B in Window 2



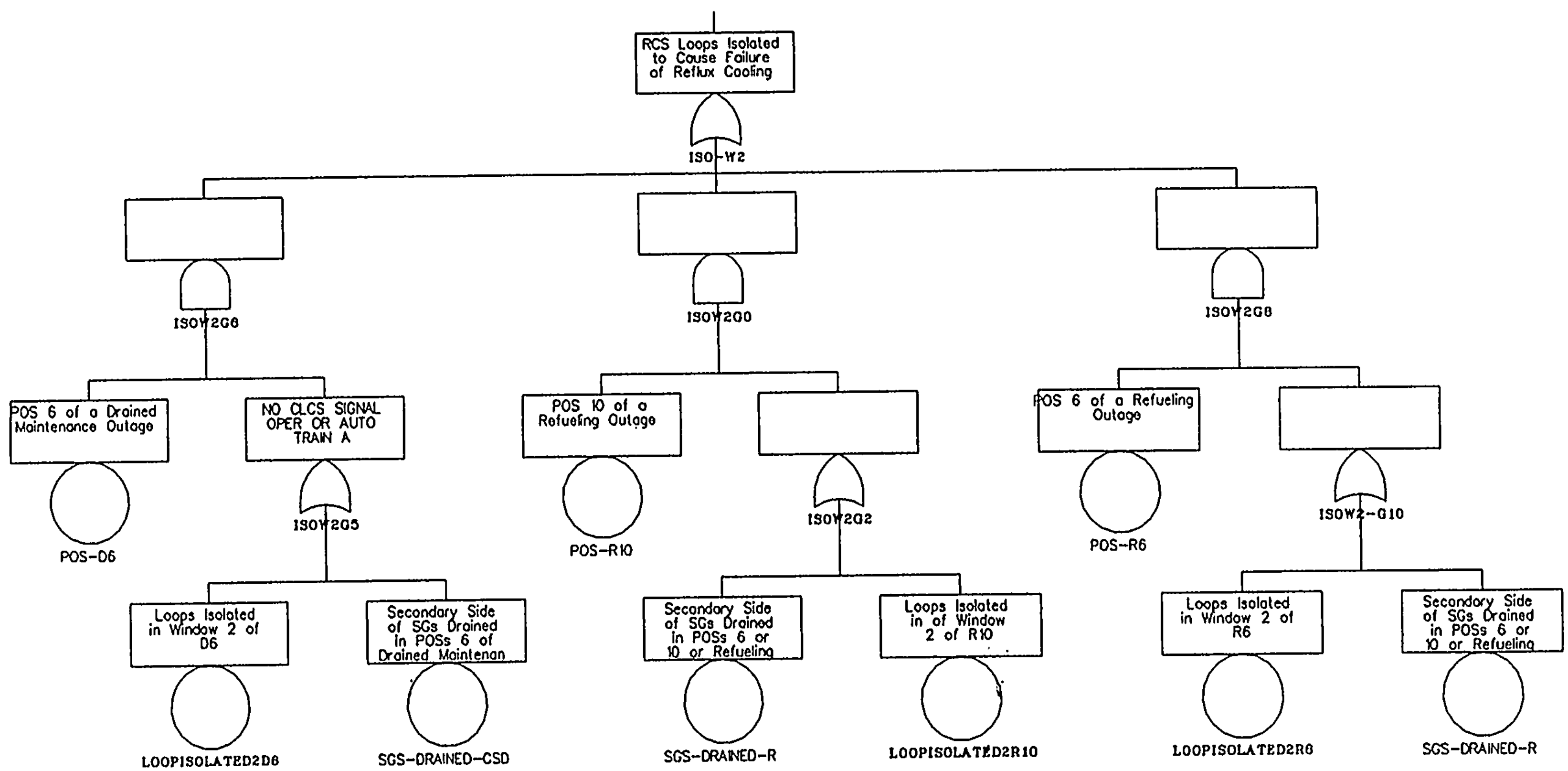
Safety Valves Not Removed in Window 2



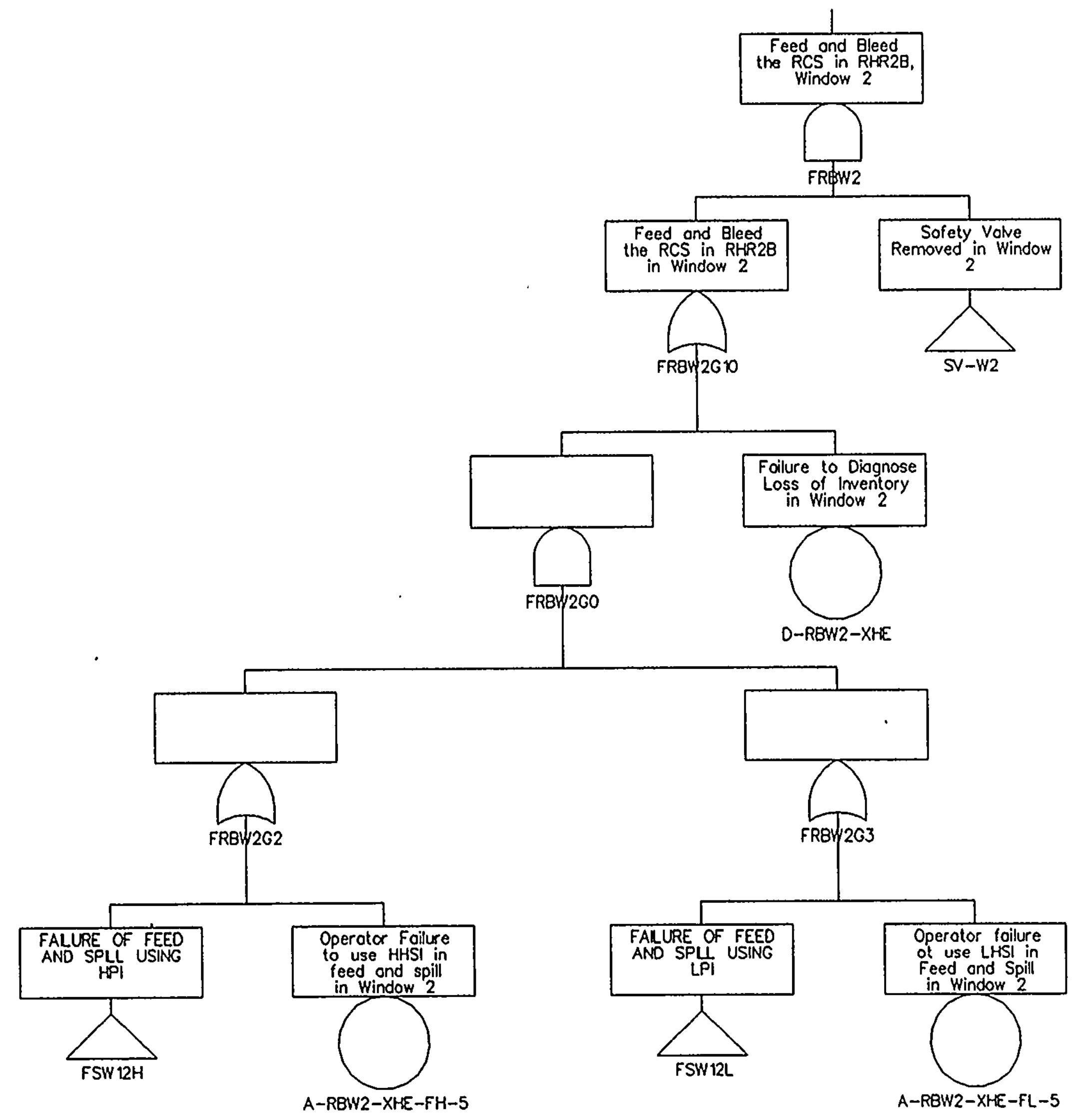
Reflux Cooling in Window 2



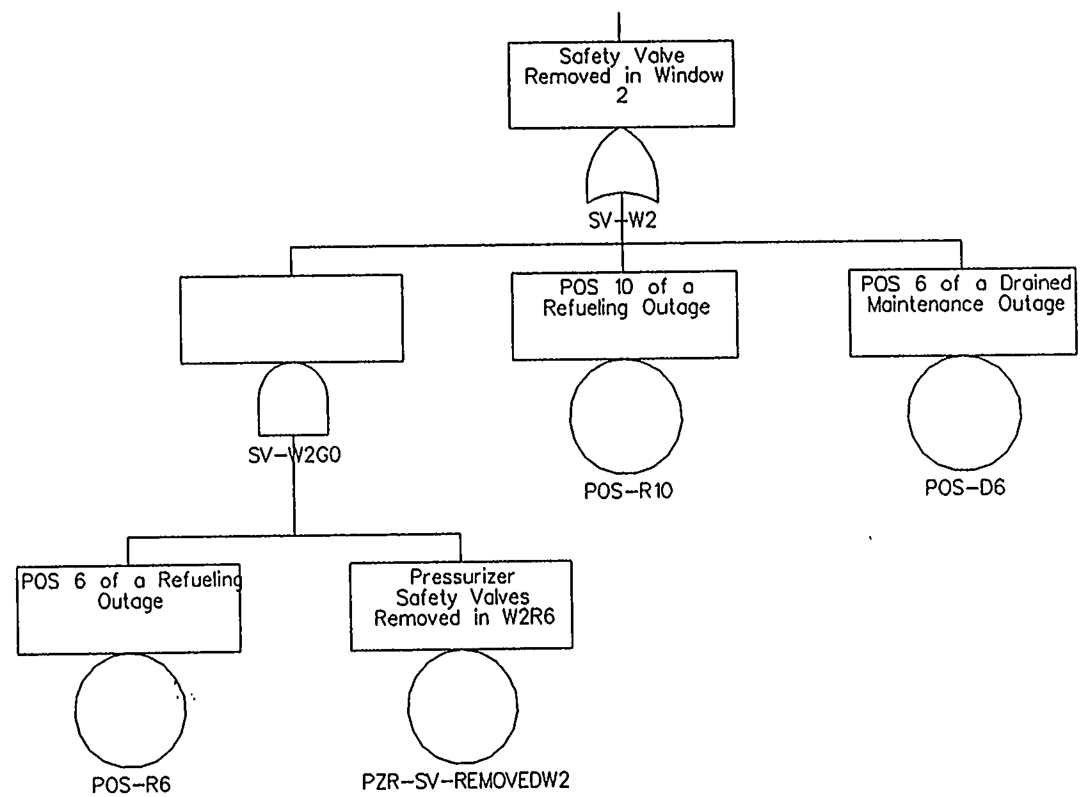
RCS Loops Isolated to Cause Failure of Reflux in Window 2



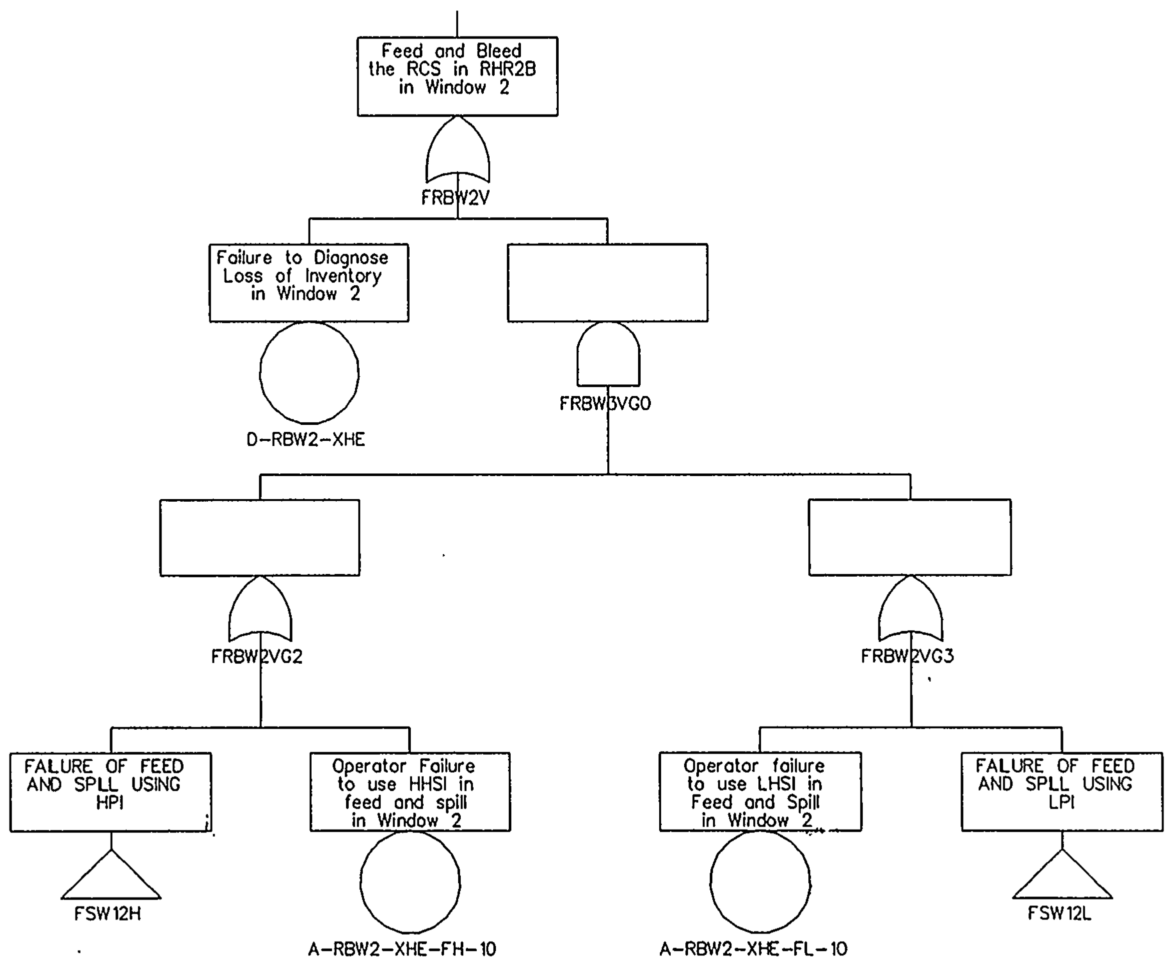
Feed and Bleed the RCS in RHR2B, Window 2



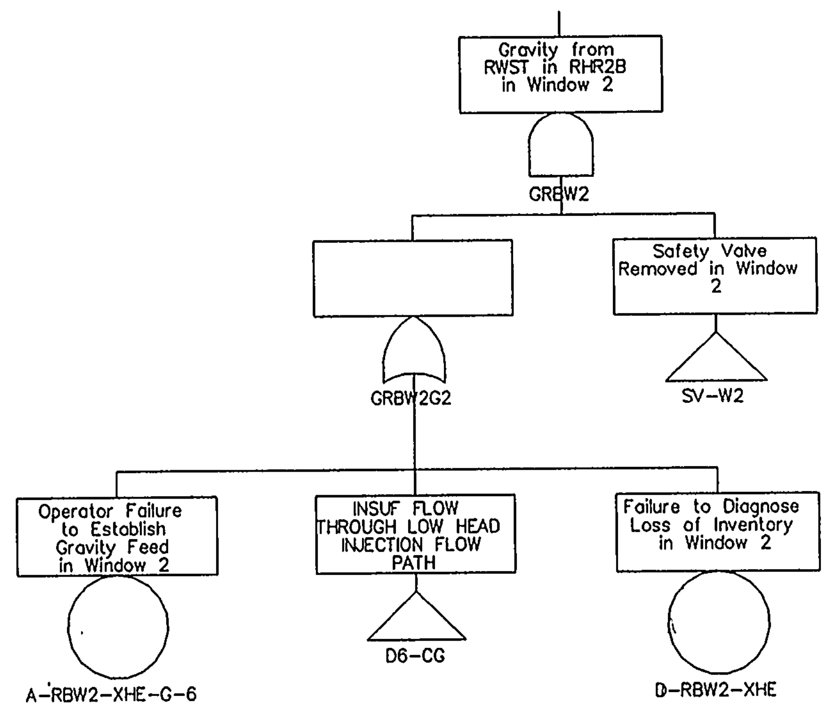
Safety Valves Removed in Window 2



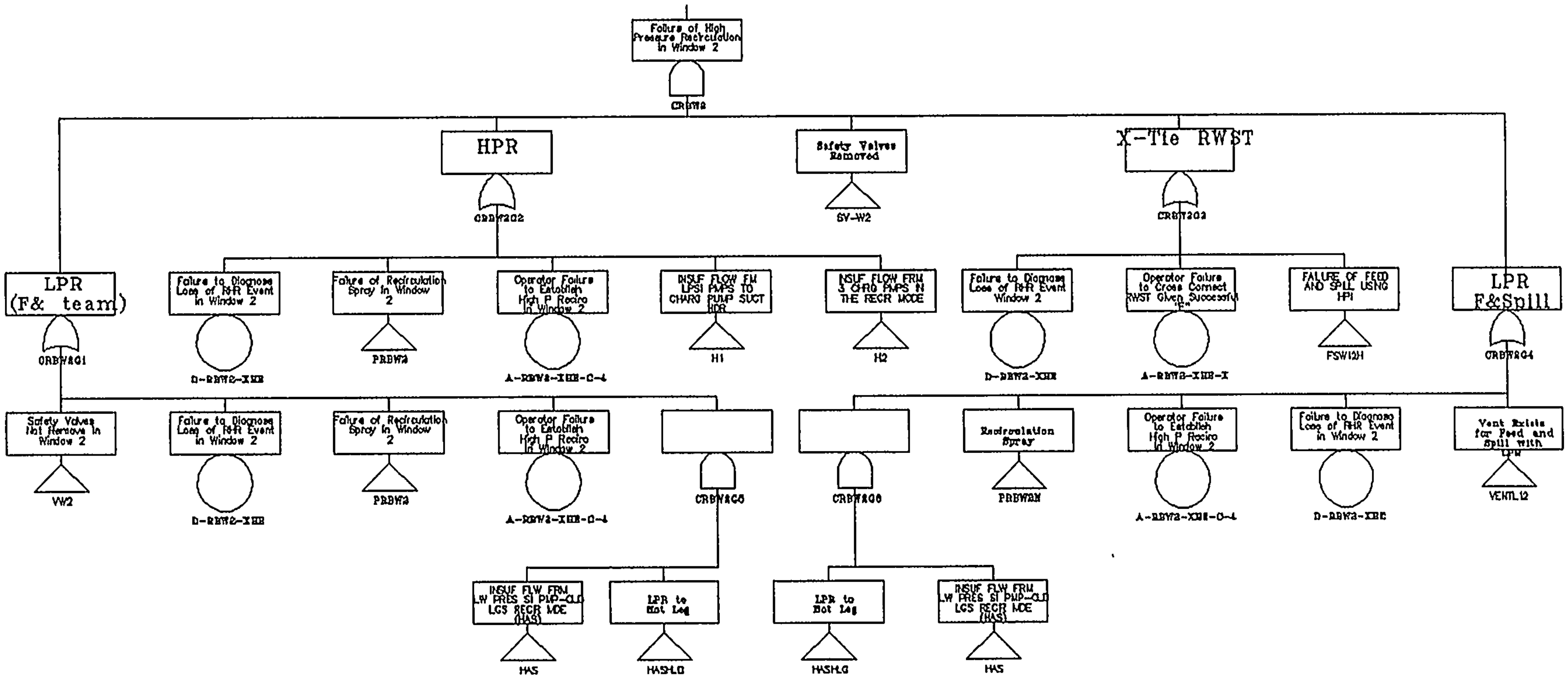
Feed and Bleed the RCS with V failed in RHR2B, Window 2



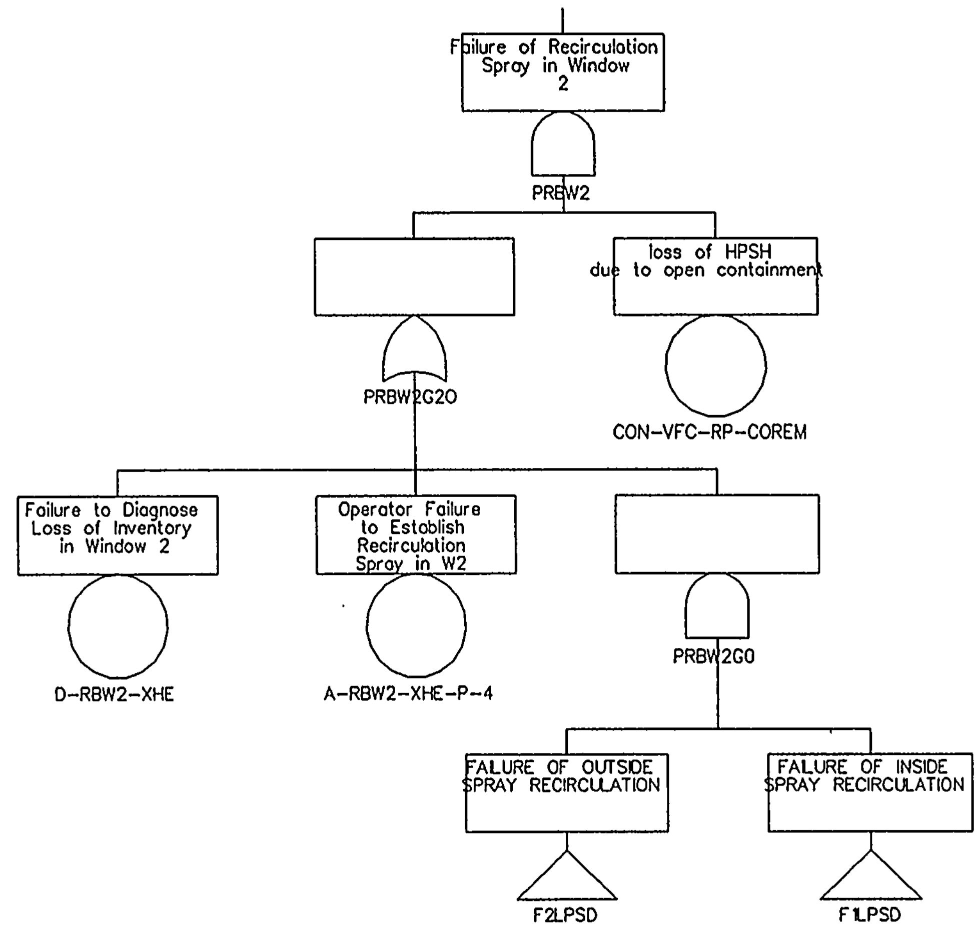
Gravity from RWST in RHR2B, Window 2



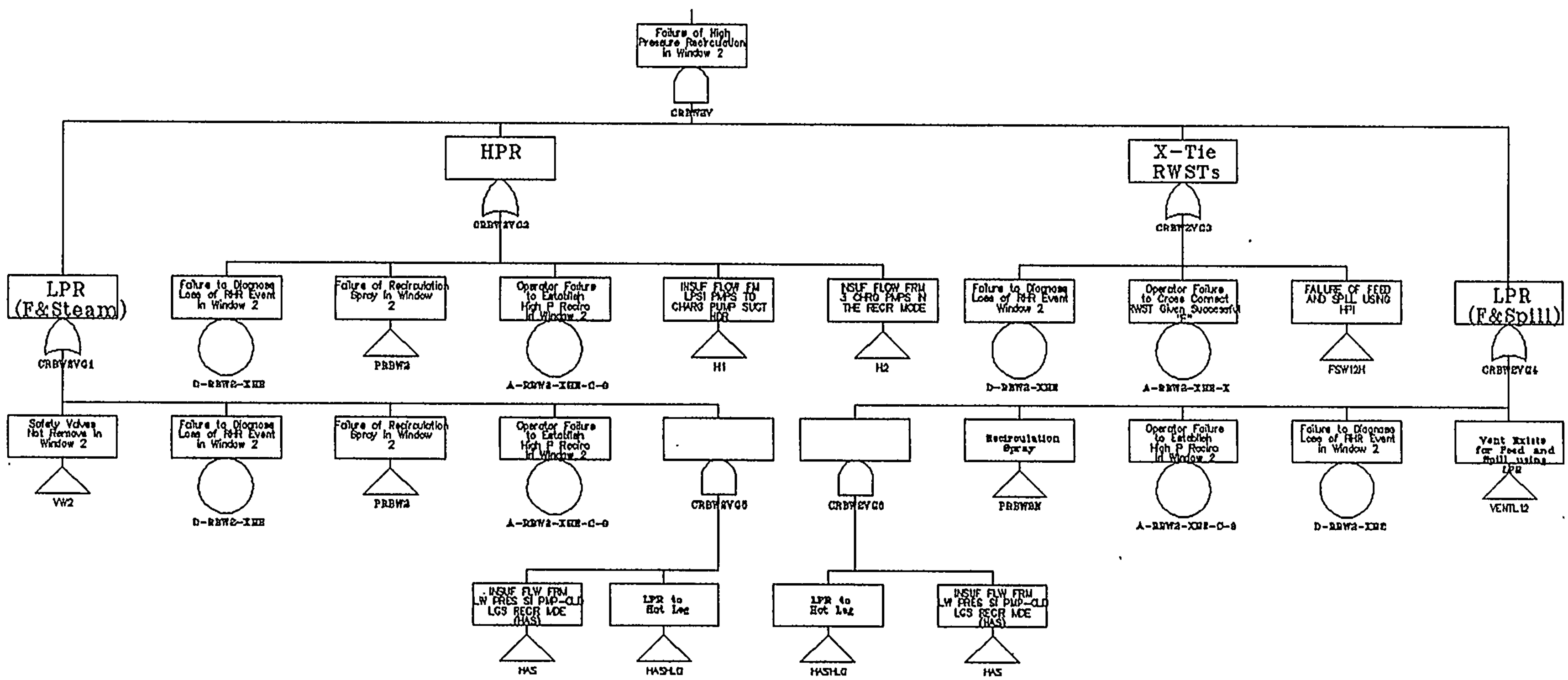
Failure of High Pressure Recirculation in Window 2

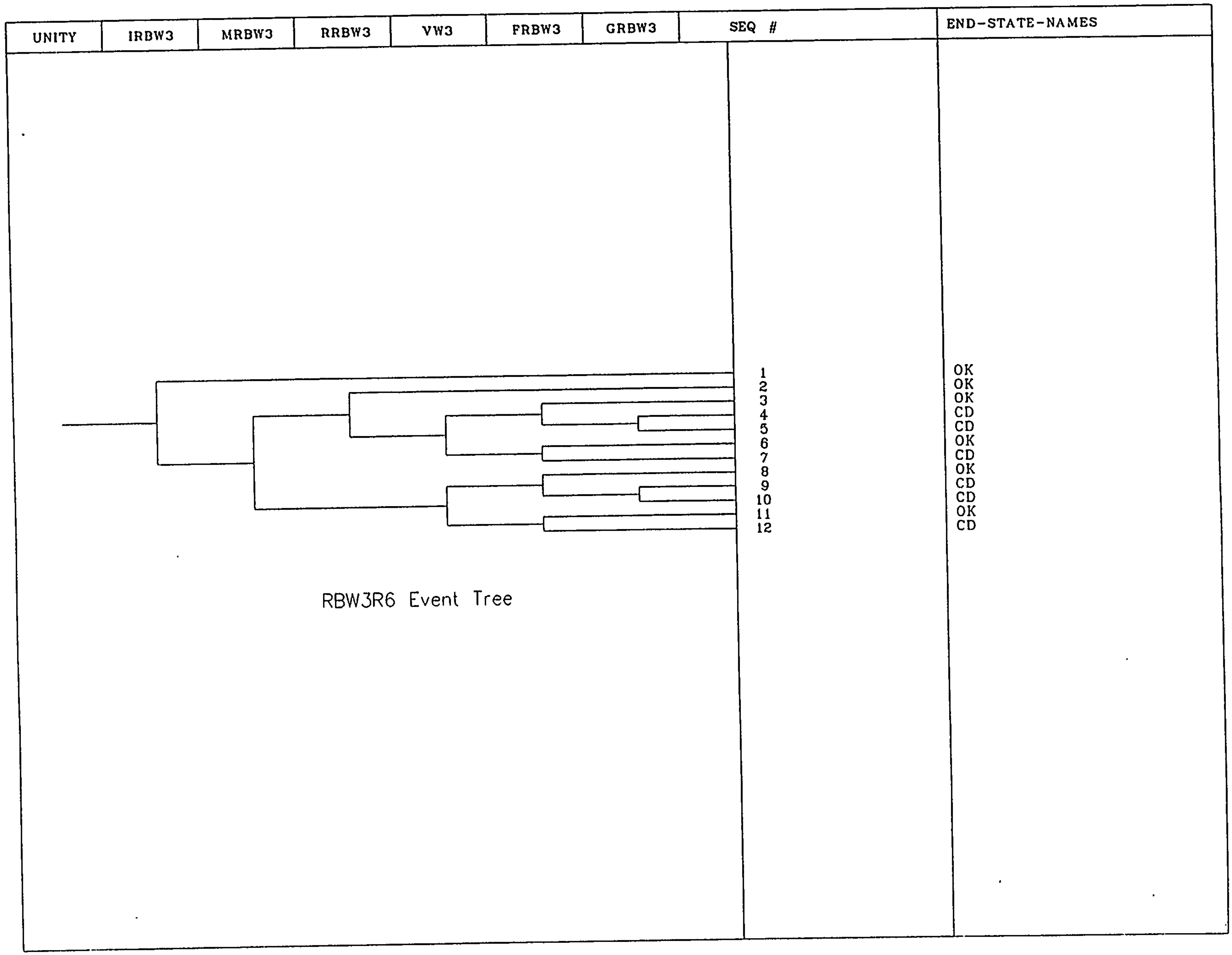


Failure of Recirculation Spray in Window 2—cause HPR failure

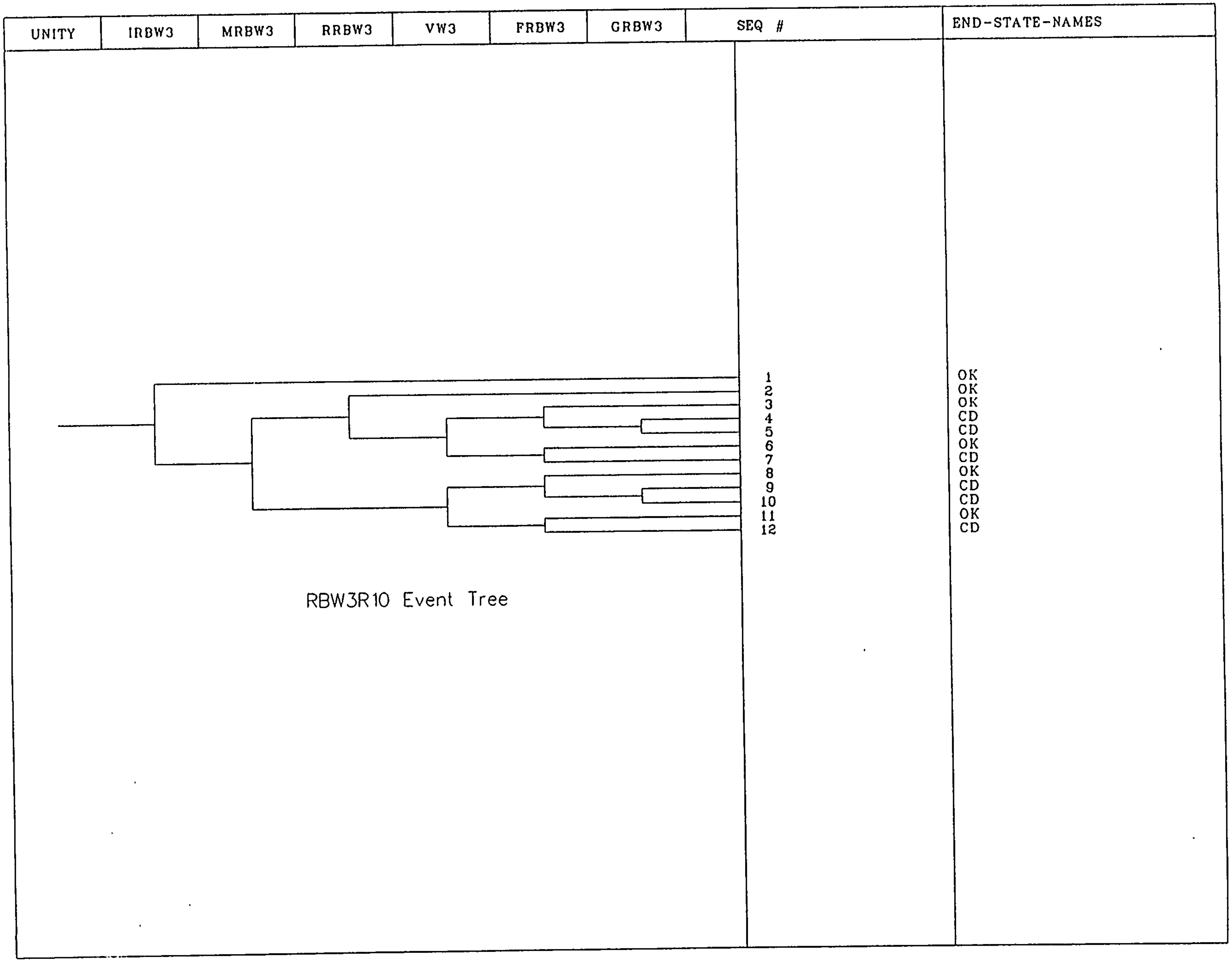


Failure of High Pressure Recirculation in Window 2





RBW3R6 Event Tree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IRBW3
MRBW3
RRBW3
VW3
FRBW3
GRBW3
SEQ #
END-STATE-NAMES
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4 CD
5 CD
6 OK
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9 CD
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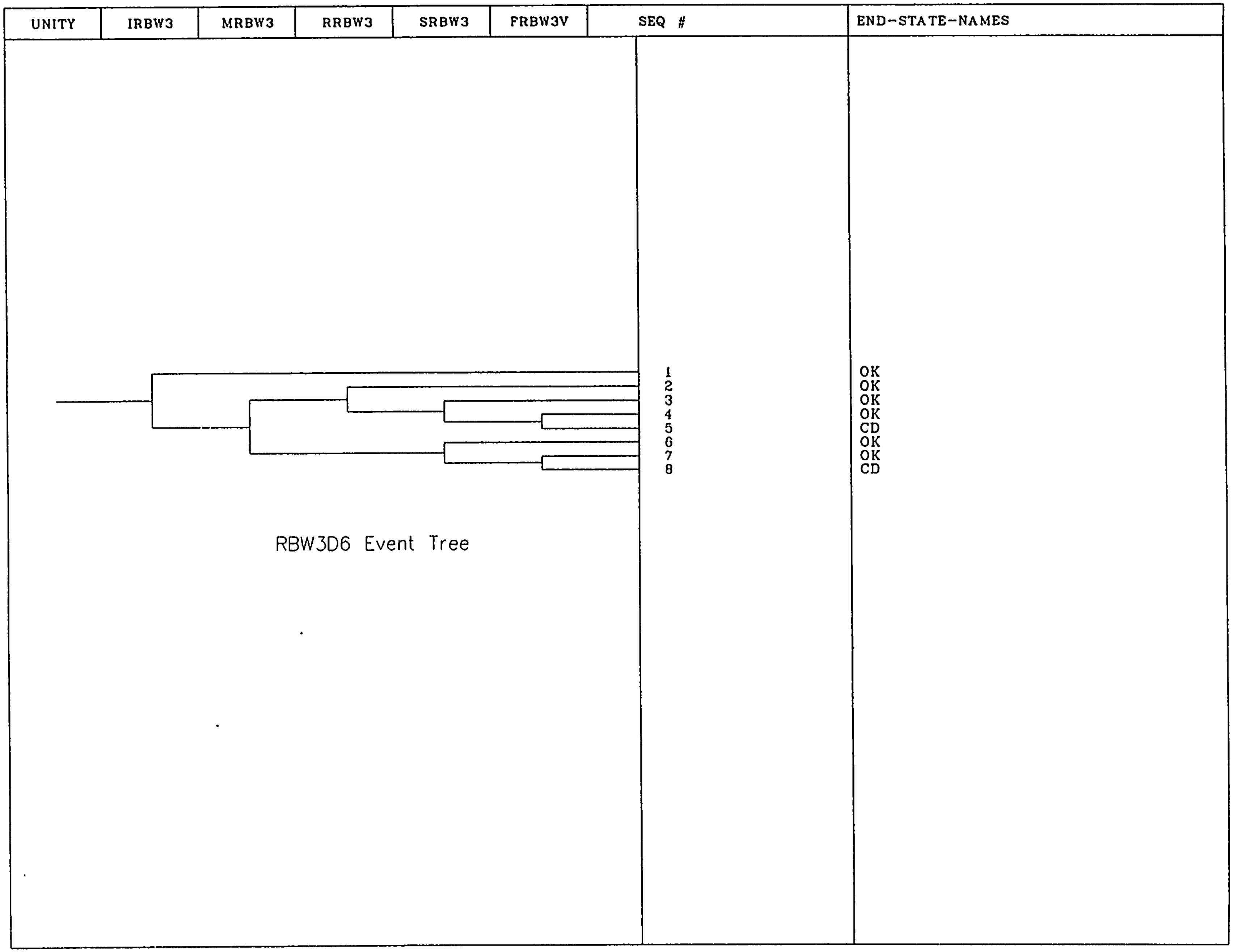
11 OK
12 CD
RBW3R10 Event Tree


UNITY
IRBW3
MRBW3
RRBW3
SRBW3
FRBW3V
SEQ #
END-STATE-NAMES
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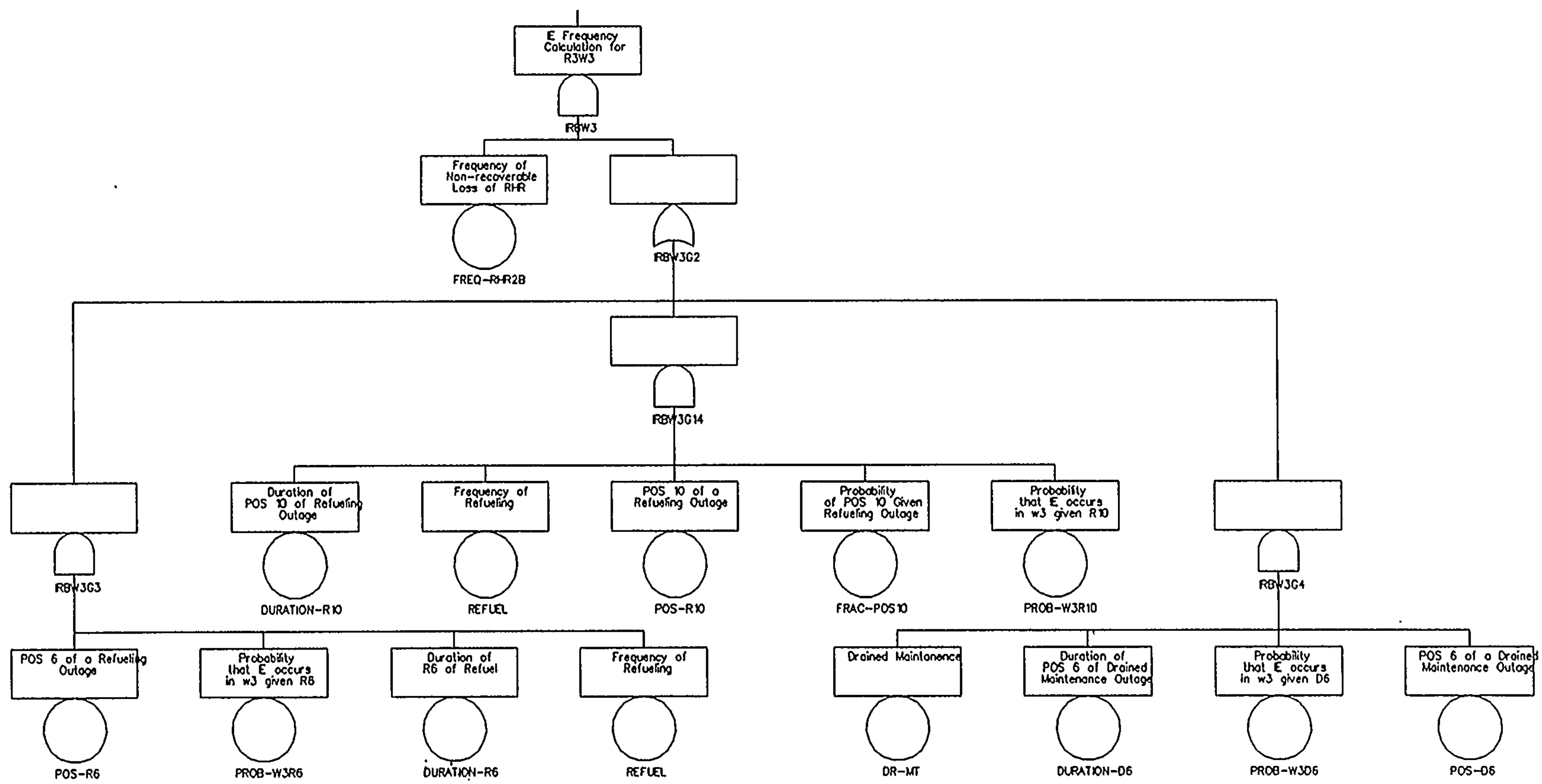
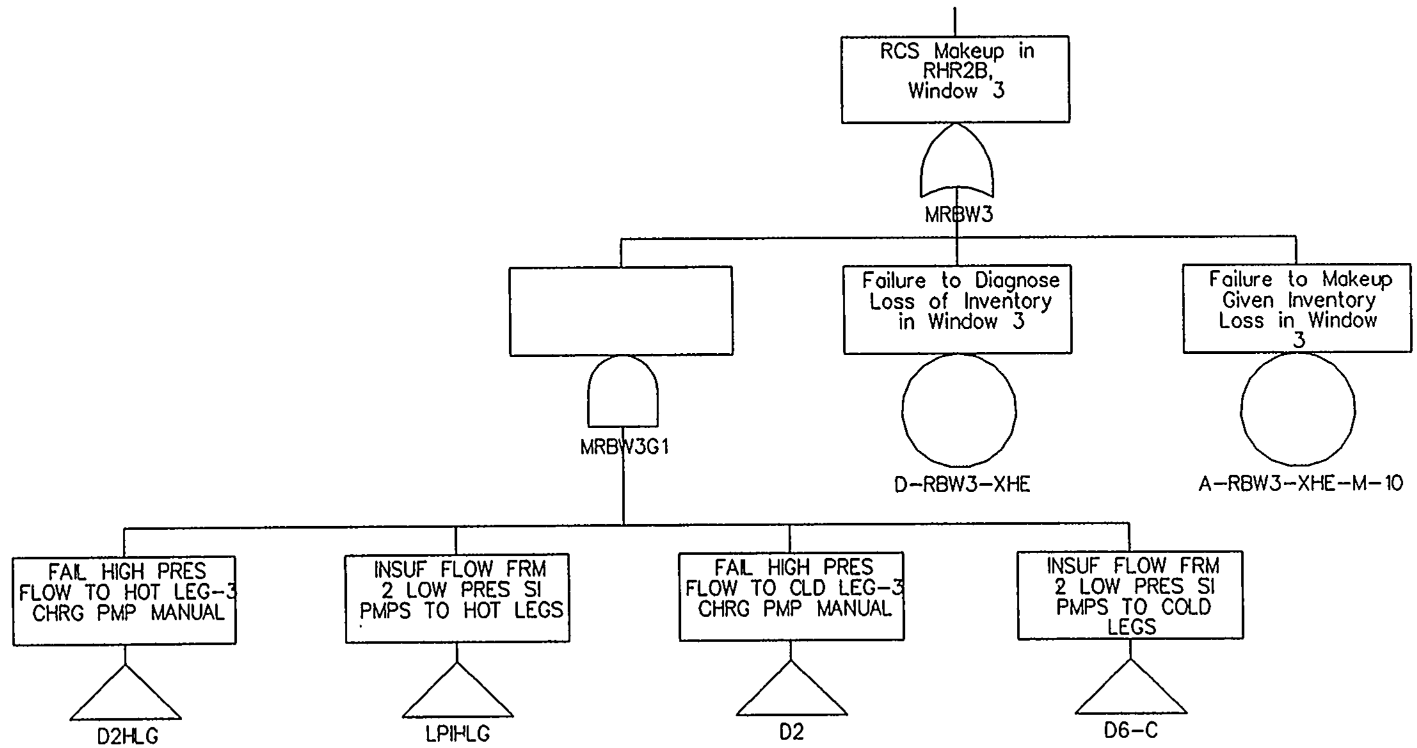
2 OK
3 OK
4 OK
5 CD
6 OK
7 OK
8 CD
RBW3D6 Event Tree

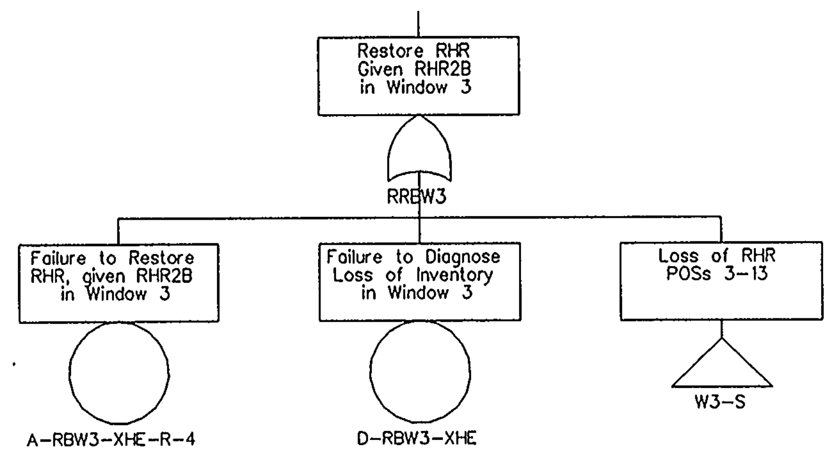
I Top Event for Loss of Inventory in Window 3



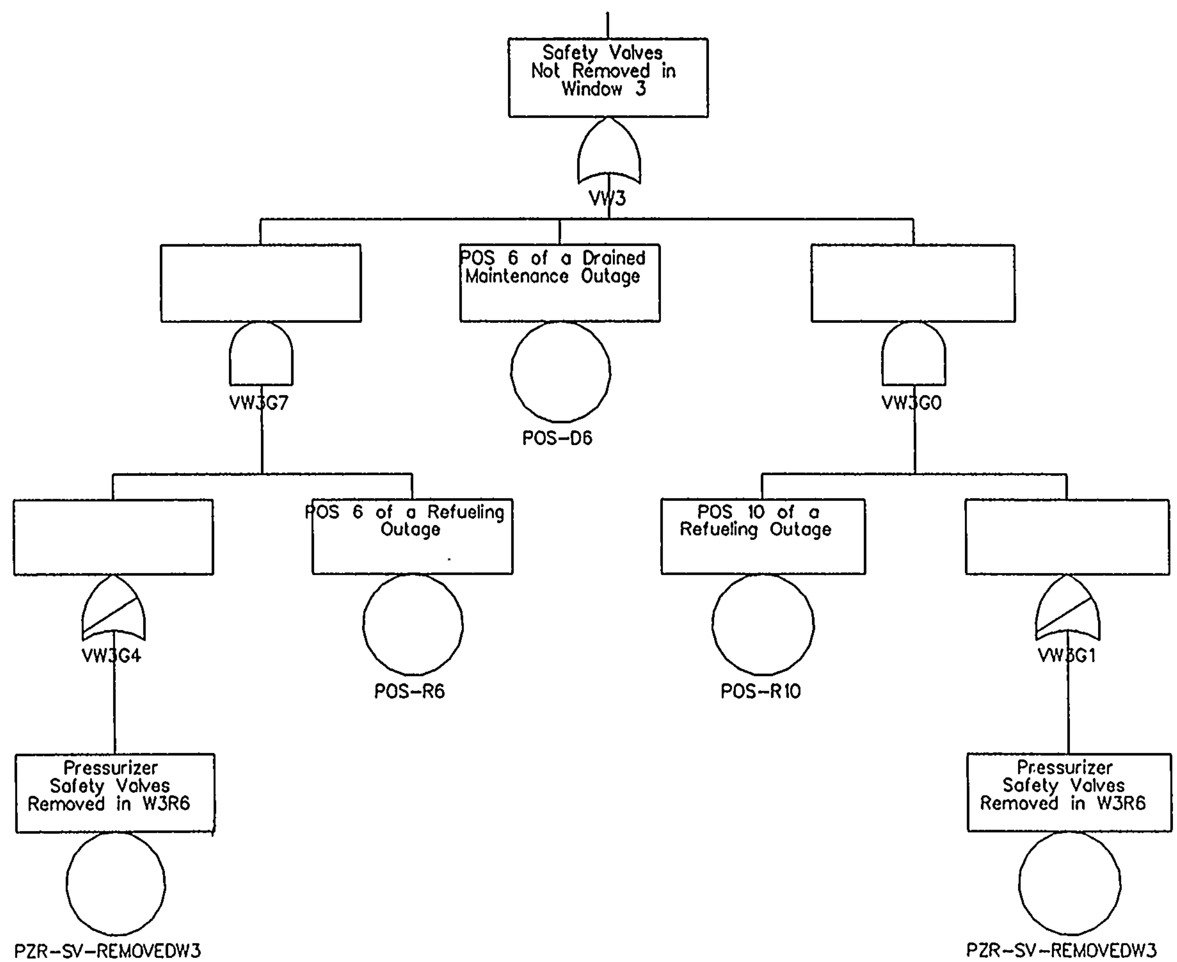
RCS Makeup in Window 3



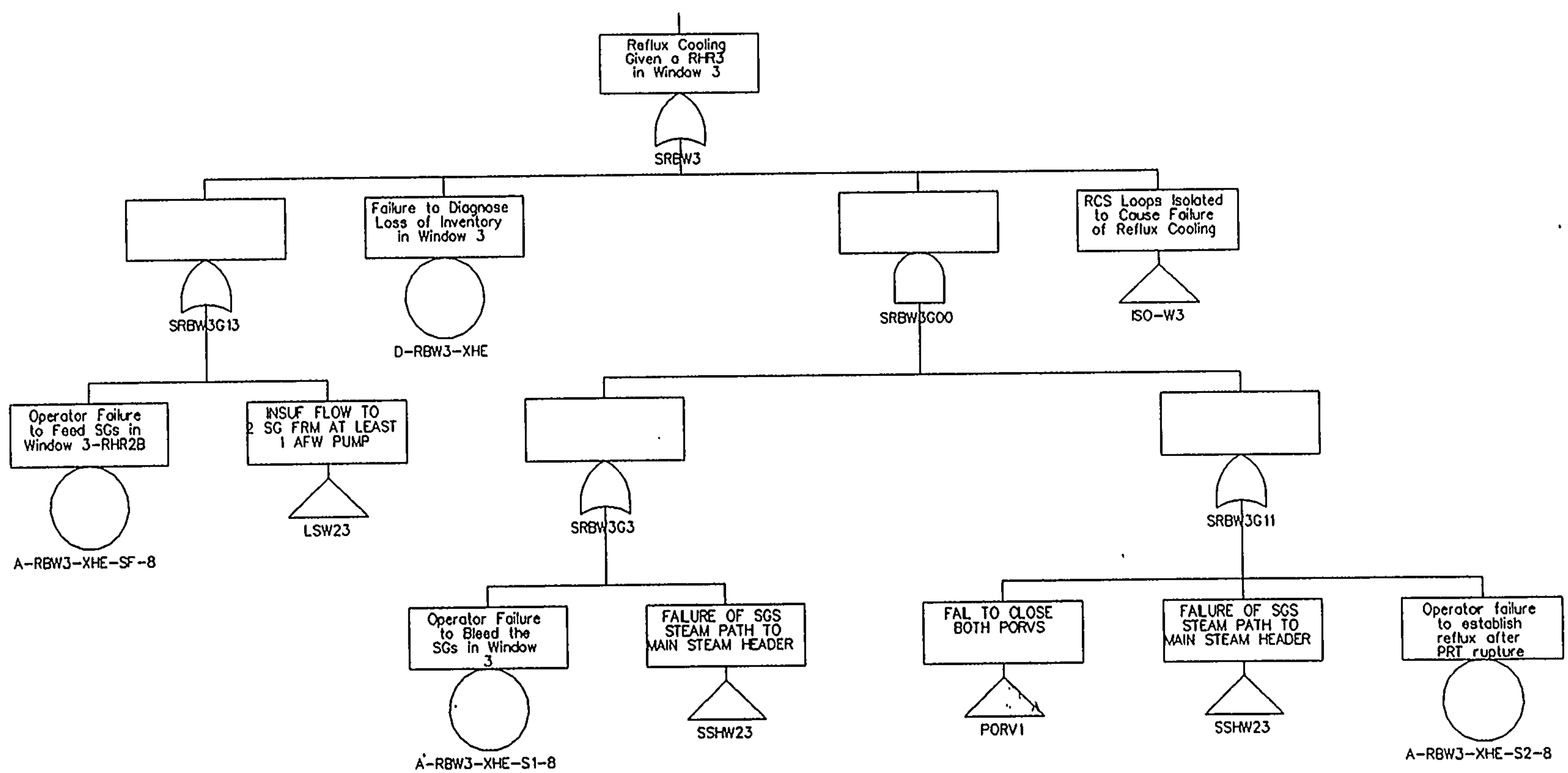
Restore RHR given RHR2B in Window 3



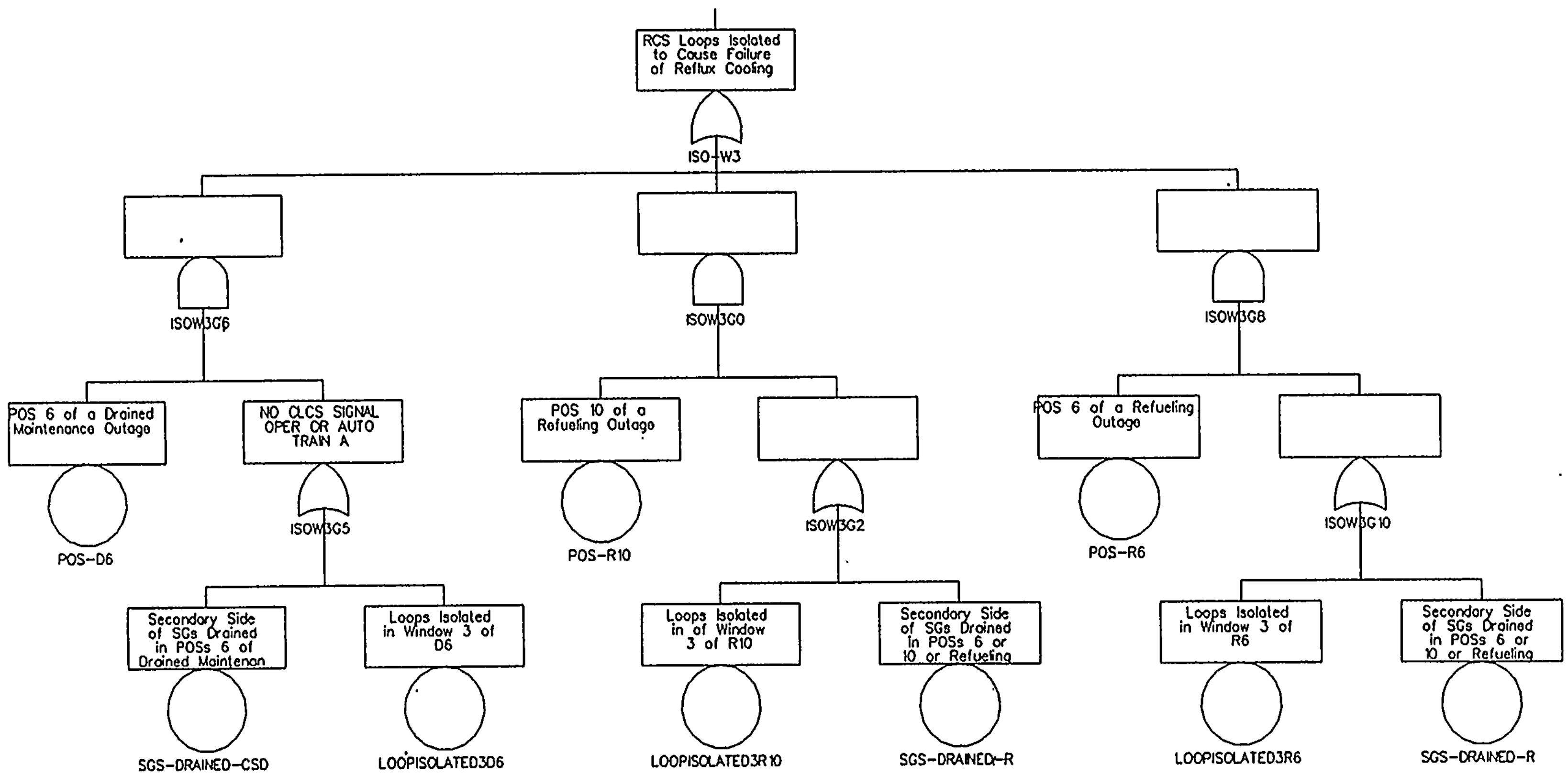
Safety Valves Not Removed in Window 3



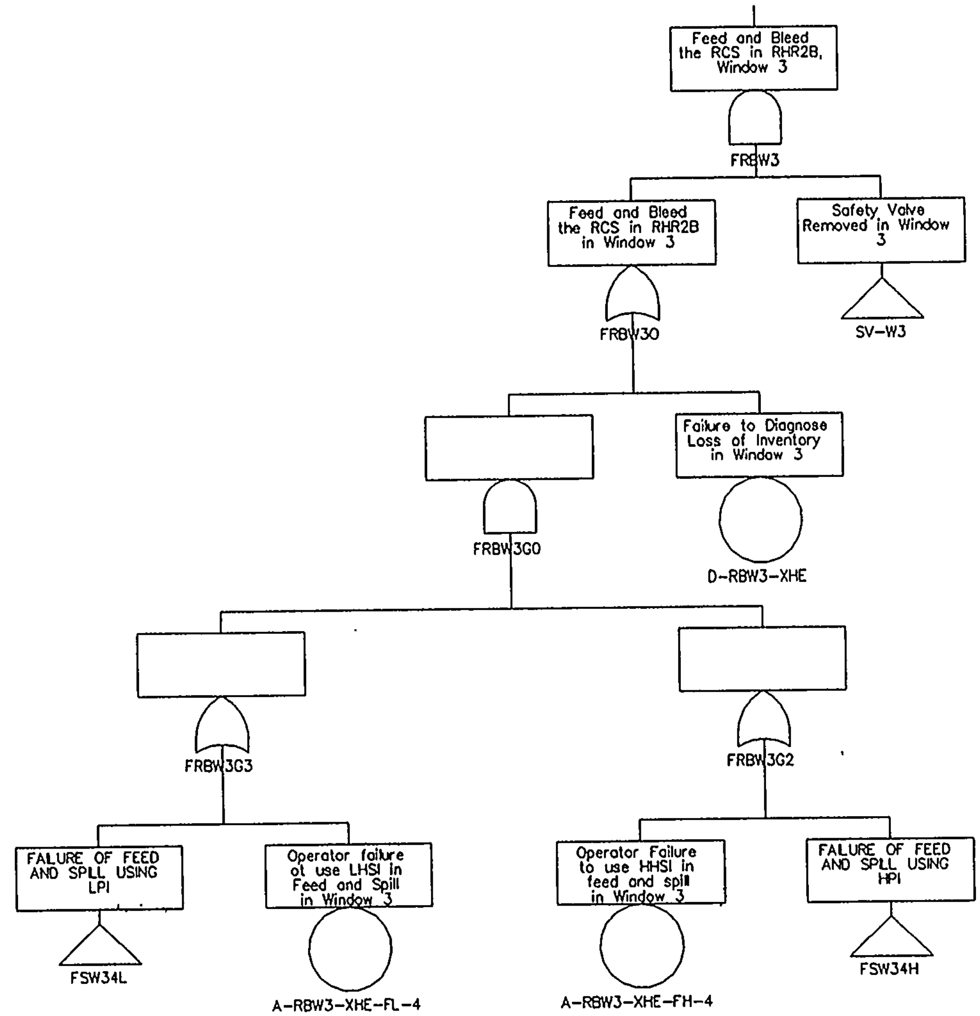
Reflux Cooling in Window 3



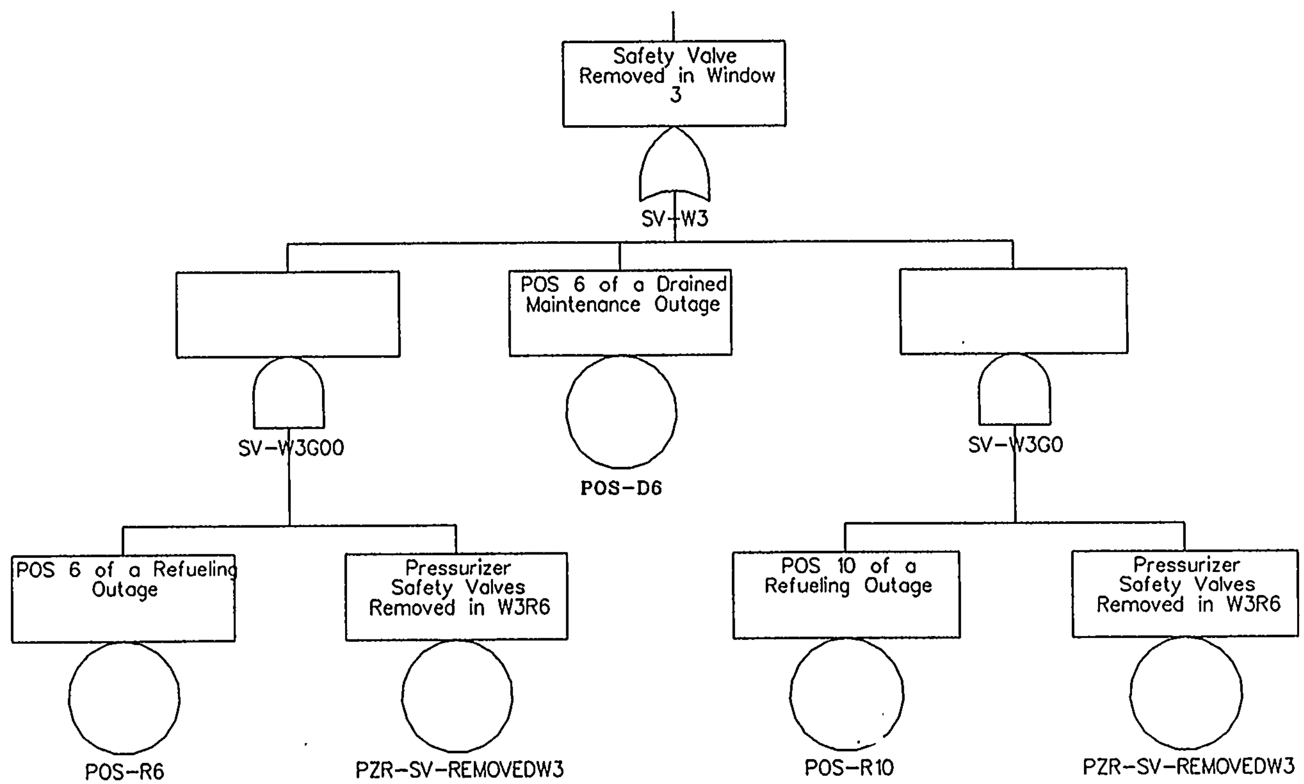
RCS Loops Isolated to Cause Failure of Reflux in Window 3



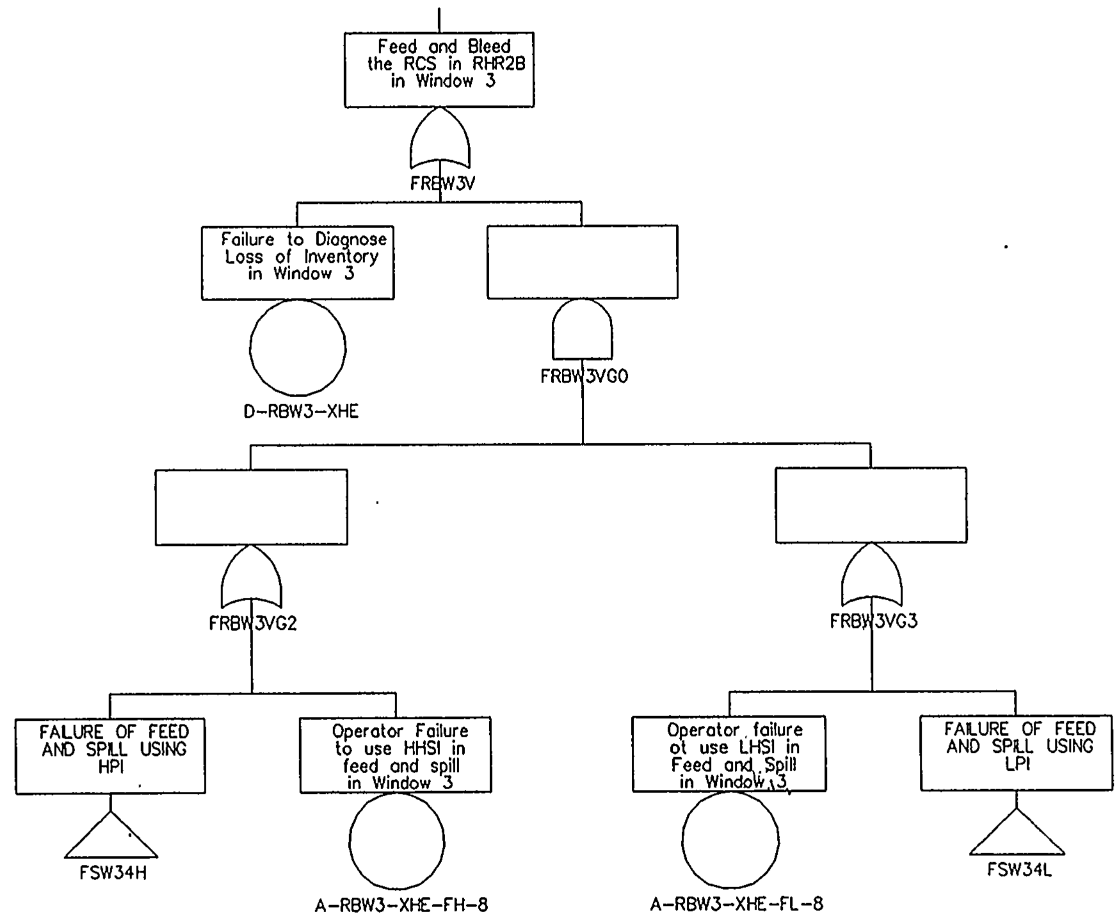
Feed and Bleed the RCS in RHR2B, Window 3



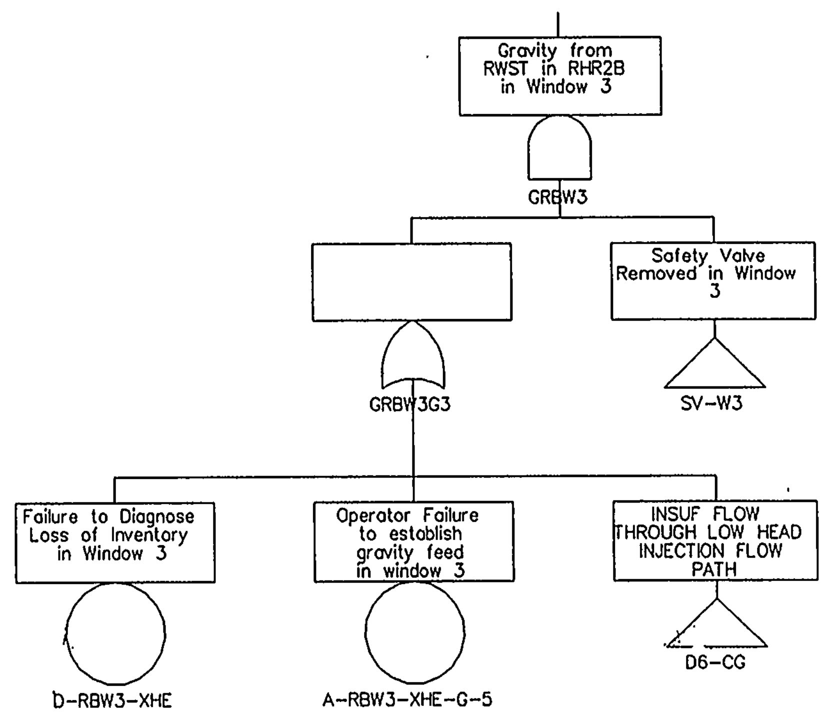
Safety Valves Removed in Window 3

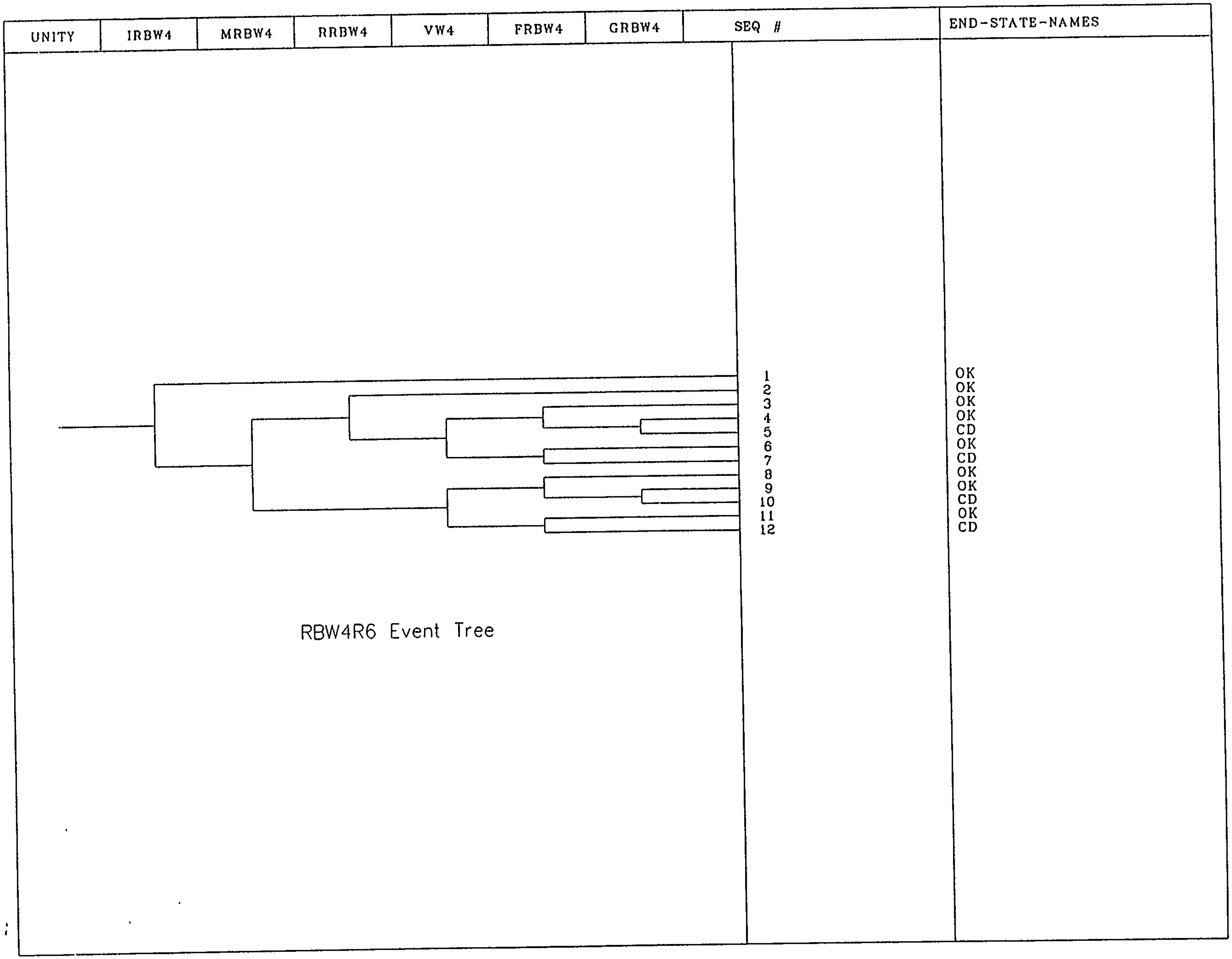


Feed and Bleed the RCS with V failed in RHR2B, Window 3



Gravity from RWST in RHR2B, Window 3

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MRBW4
RRBW4
VW4
FRBW4
GRBW4
SEQ #
END-STATE-NAMES
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3 OK
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5 CD
6 OK
7 CD
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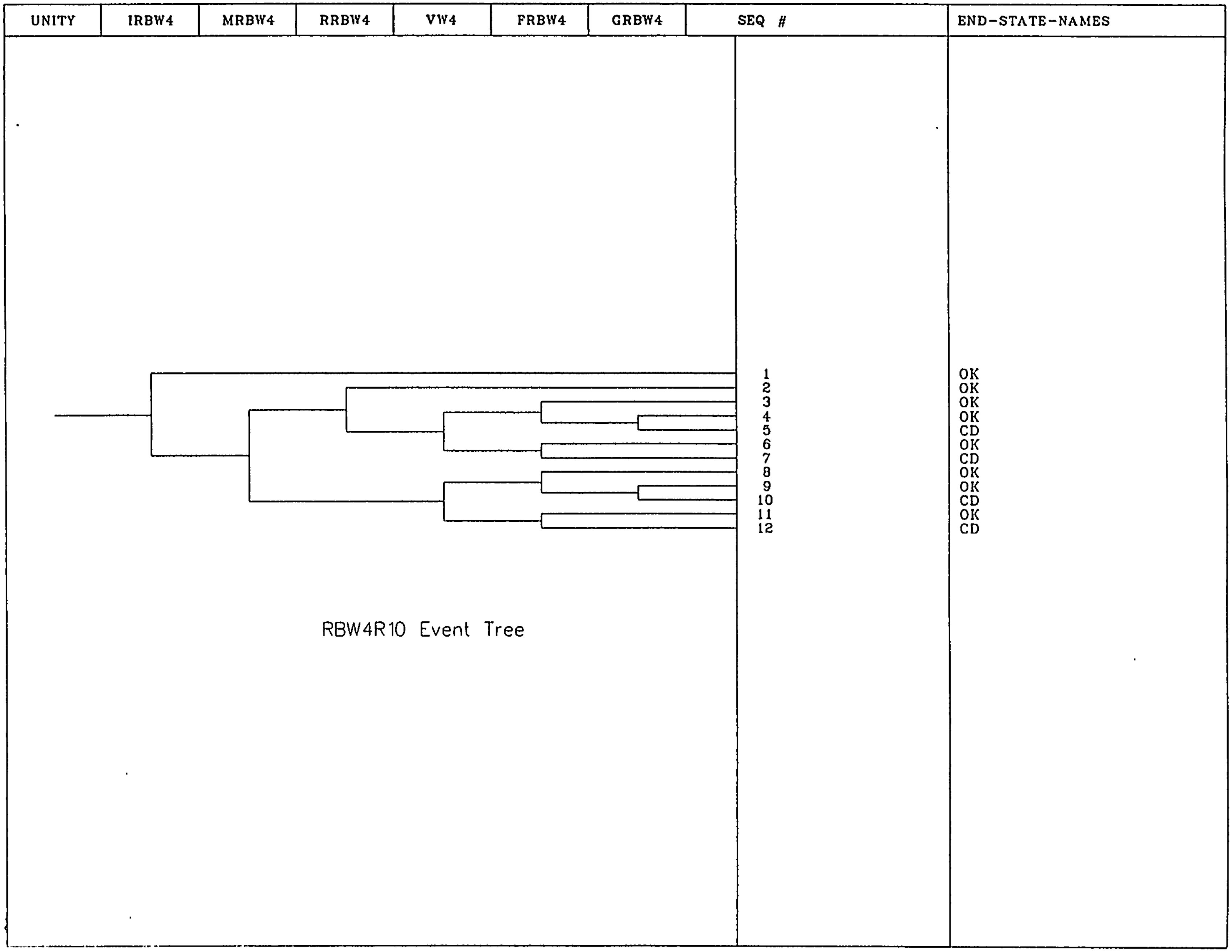
9 OK
10 CD
11 OK
12 CD
RBW4R6 Event Tree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MRBW4
RRBW4
VW4
FRBW4
GRBW4
SEQ #
END-STATE-NAMES
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5 CD
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7 CD
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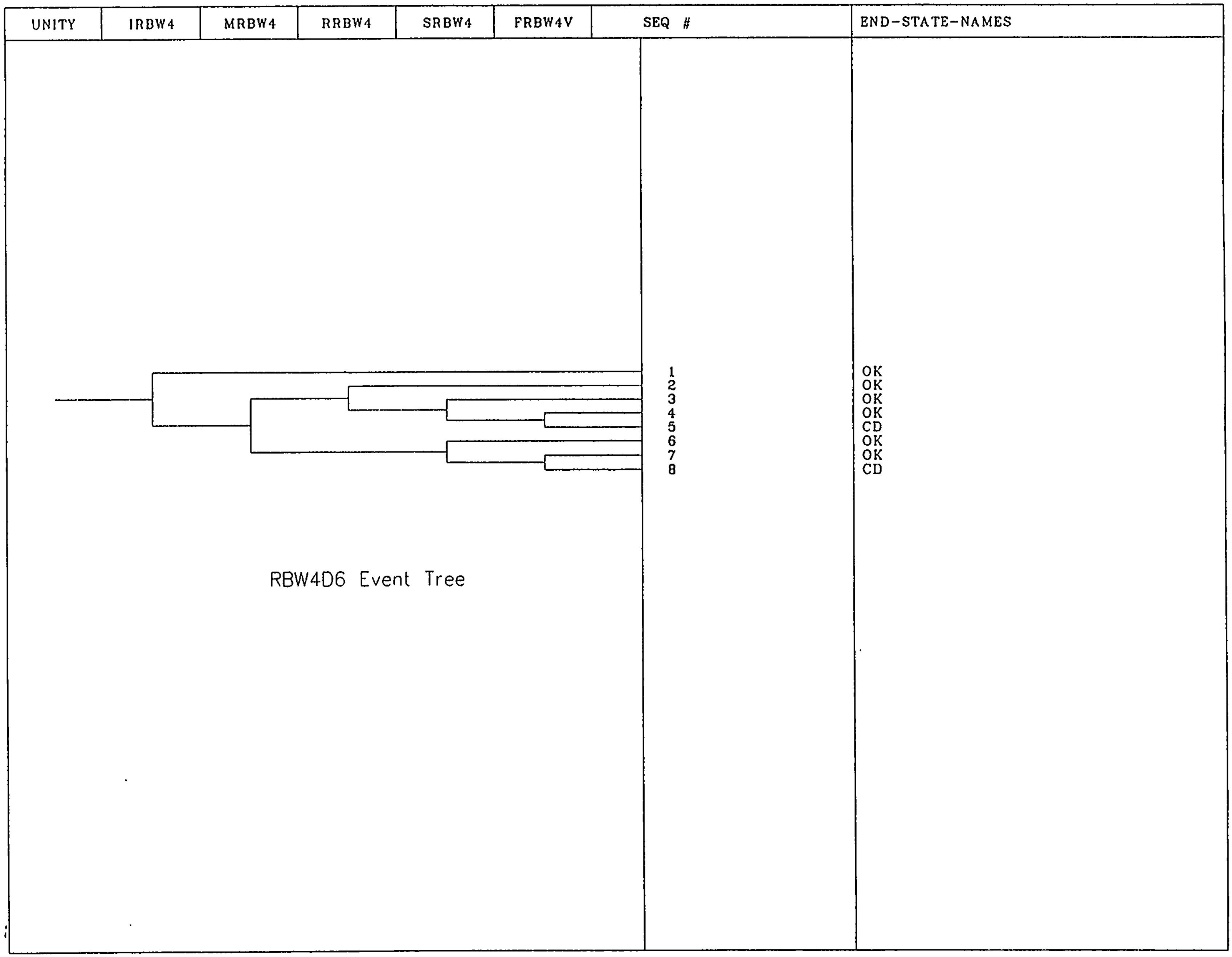
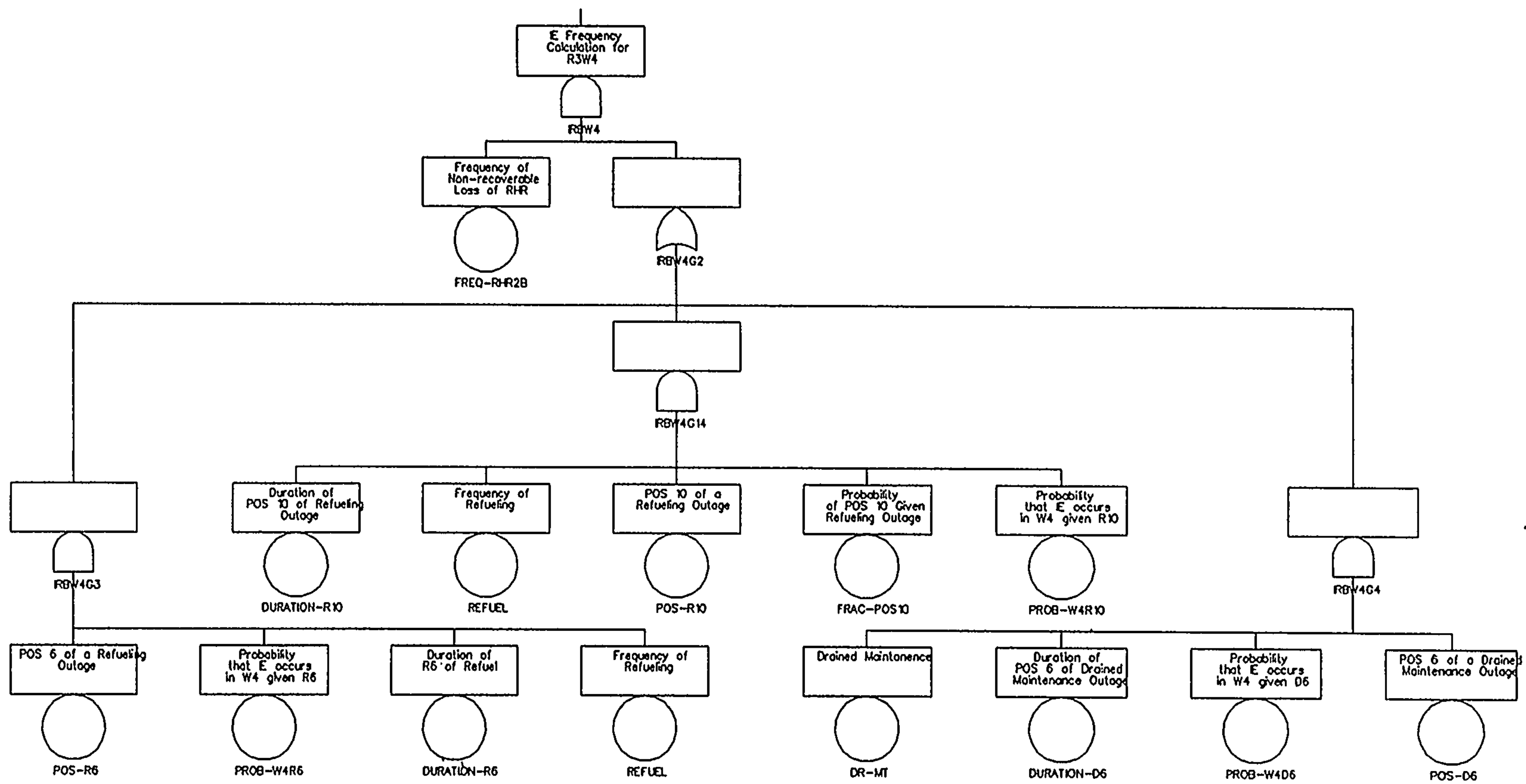
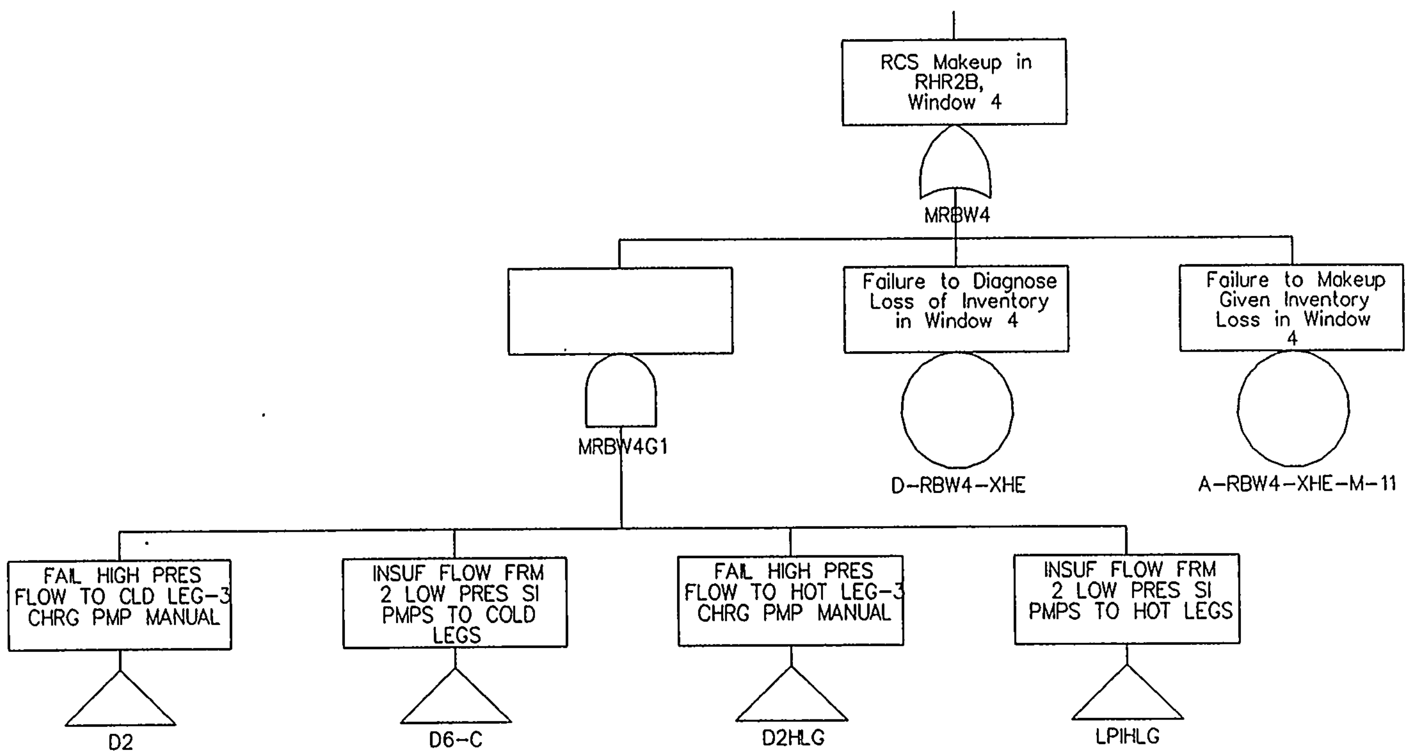
9 OK
10 CD
11 OK
12 CD
RBW4R10 Event Tree


UNITY
IRBW4
MRBW4
RRBW4
SRBW4
FRBW4V
SEQ #
END-STATE-NAMES
1 OK
2 OK
3 OK
4 OK
5 CD
6 OK
7 OK
8 CD
RBW4D6 Event Tree

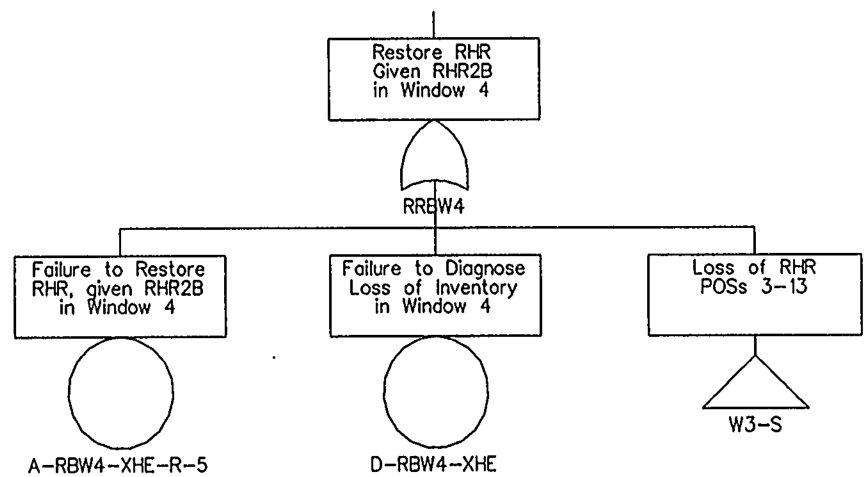
I Top Event for Loss of Inventory in Window 4



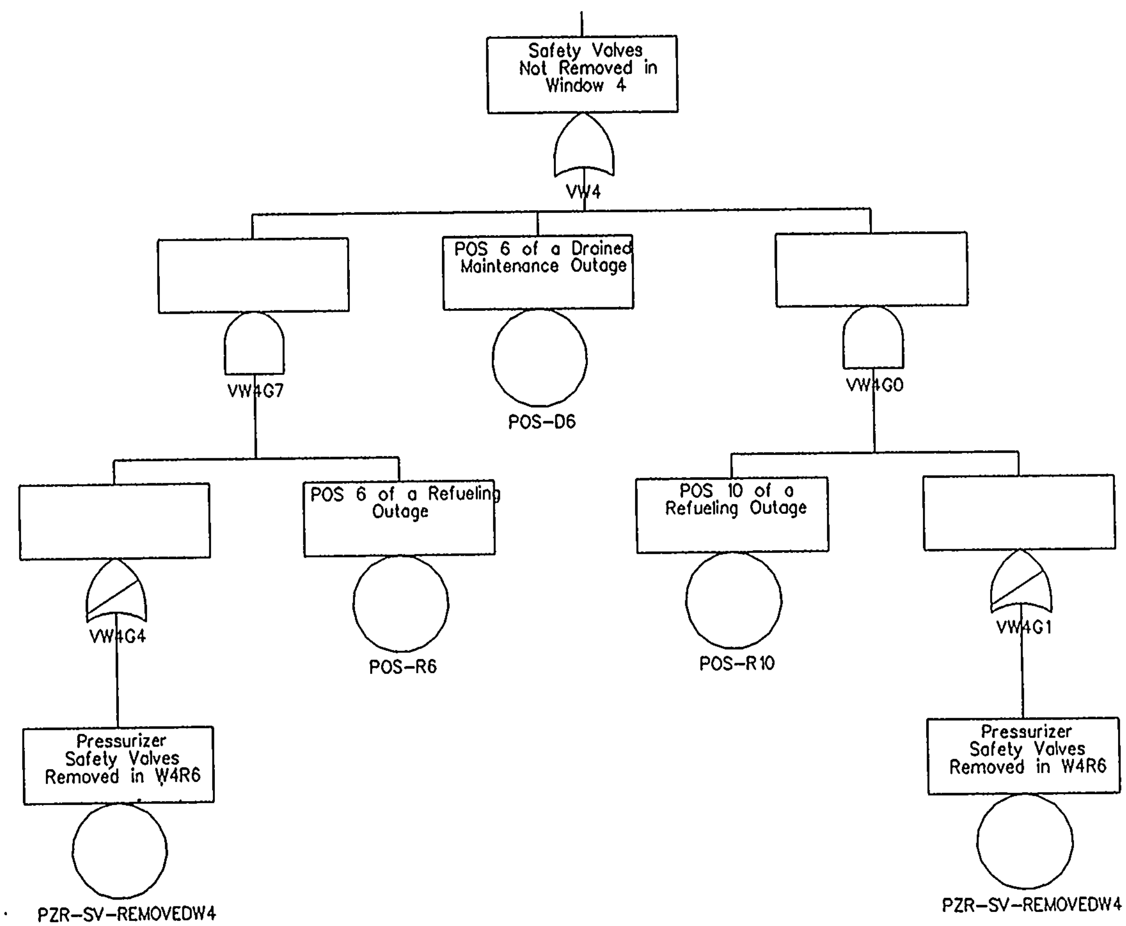
RCS Makeup in Window 4



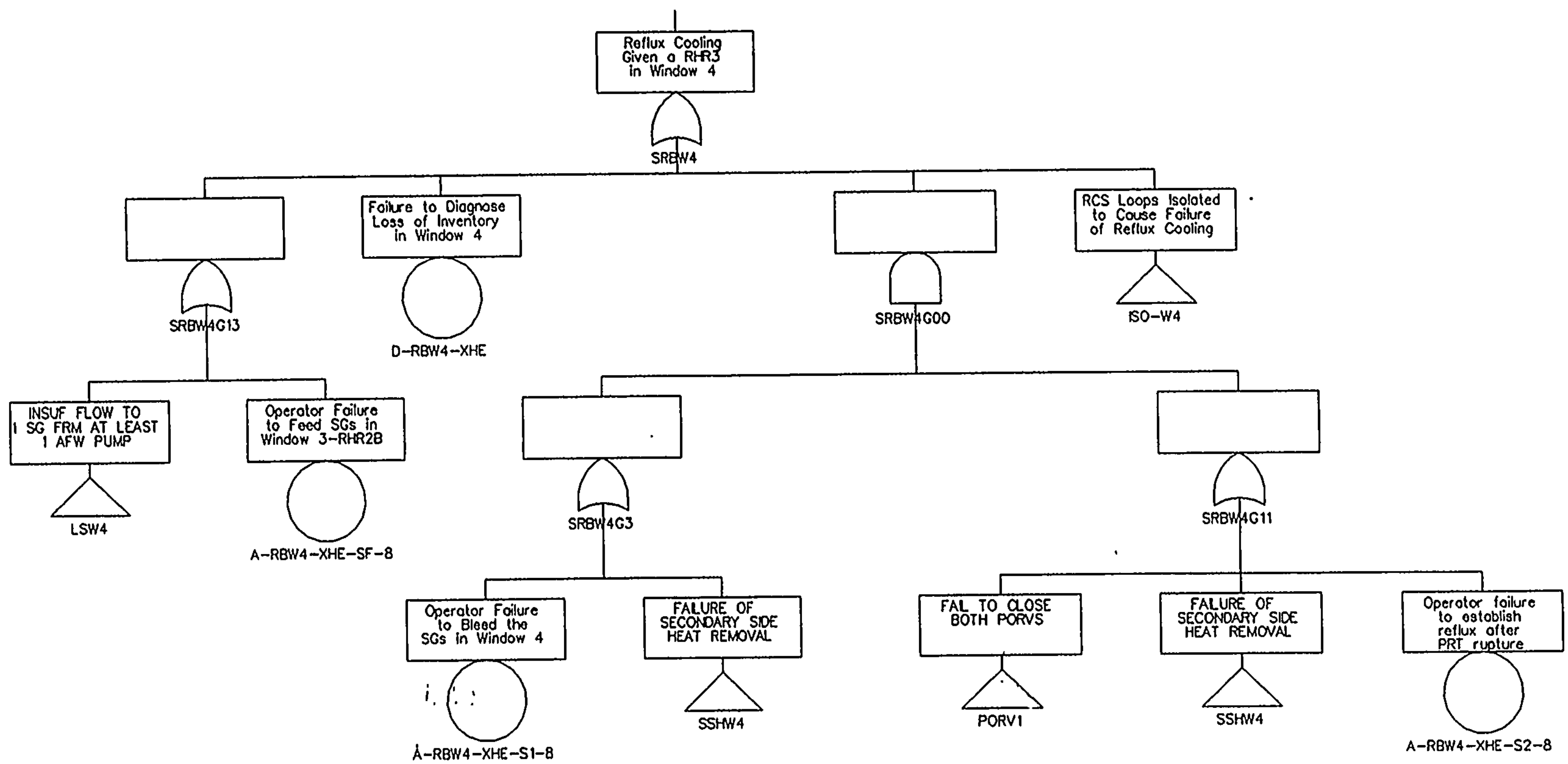
Restore RHR given RHR2B in Window 4



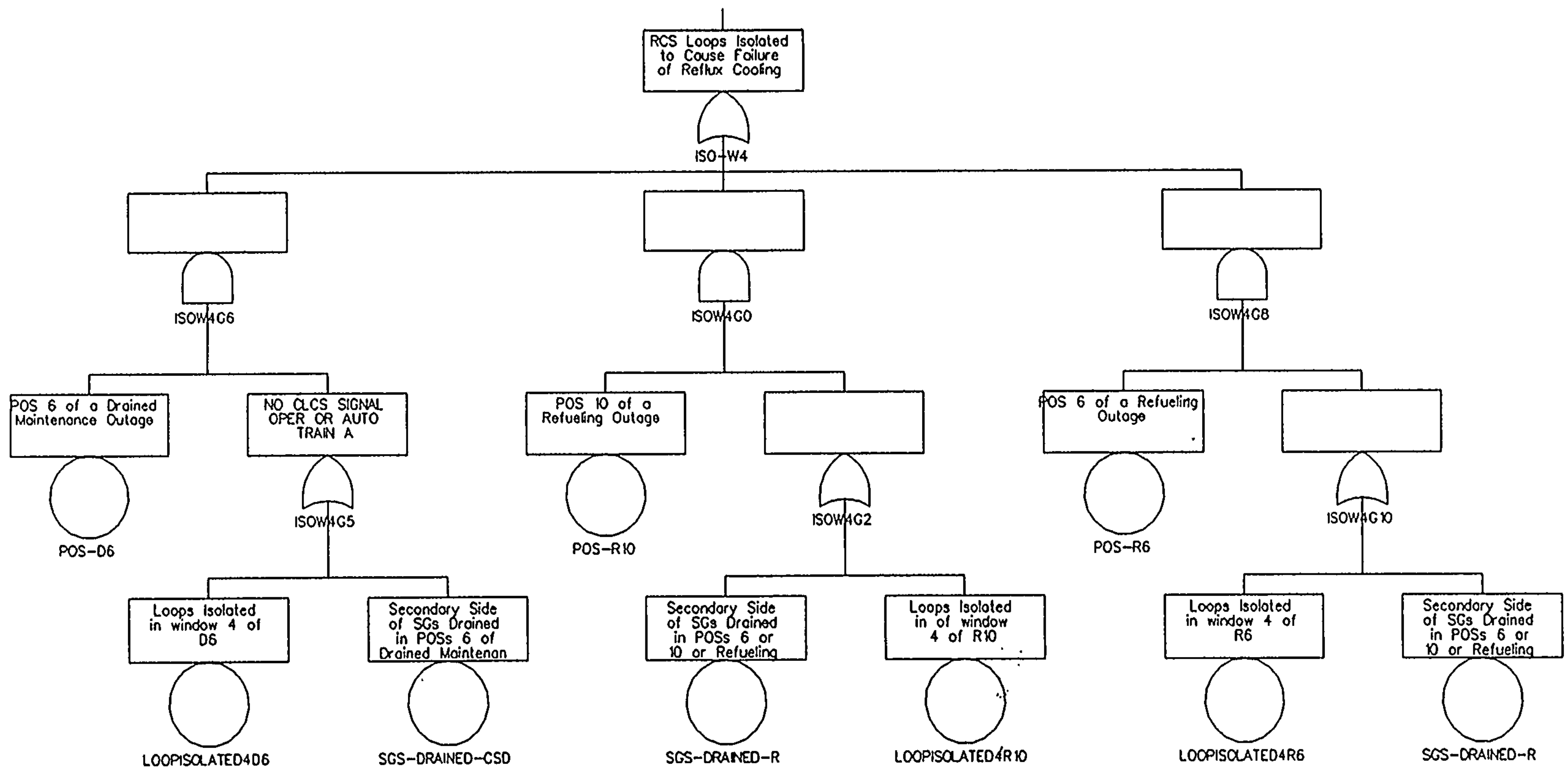
Safety Valves Not Removed in Window 4



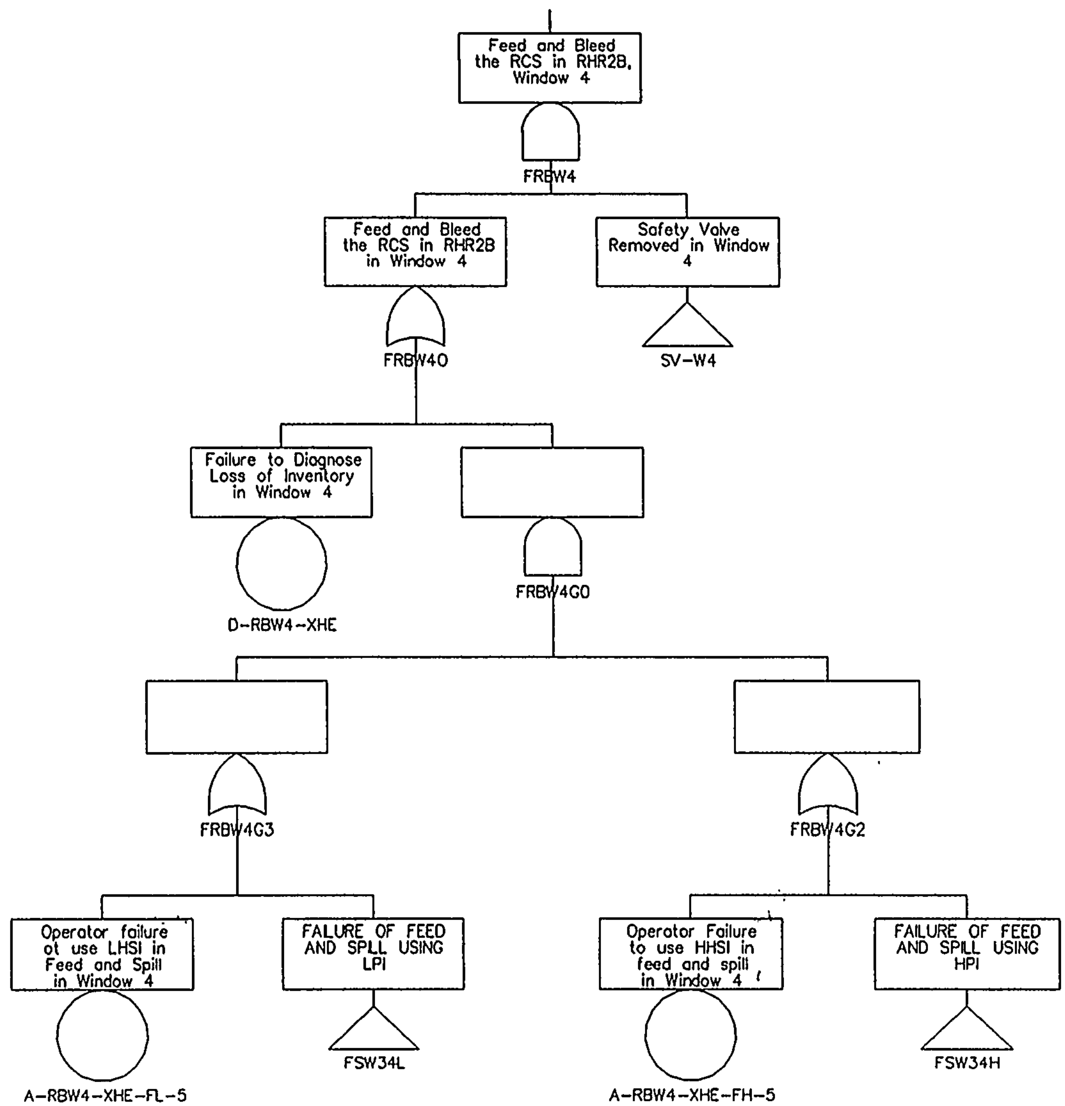
Reflux Cooling in Window 4



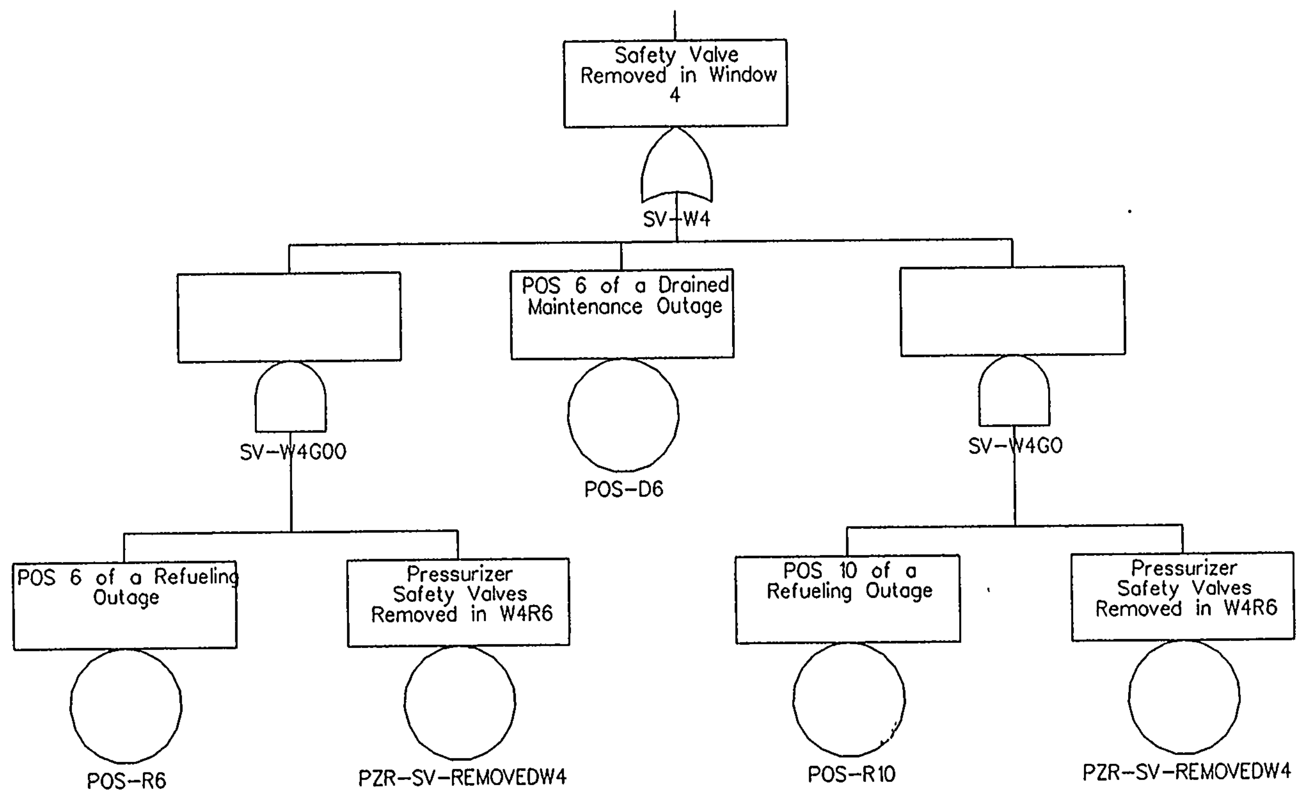
RCS Loops Isolated to Cause Failure of Reflux in Window 4



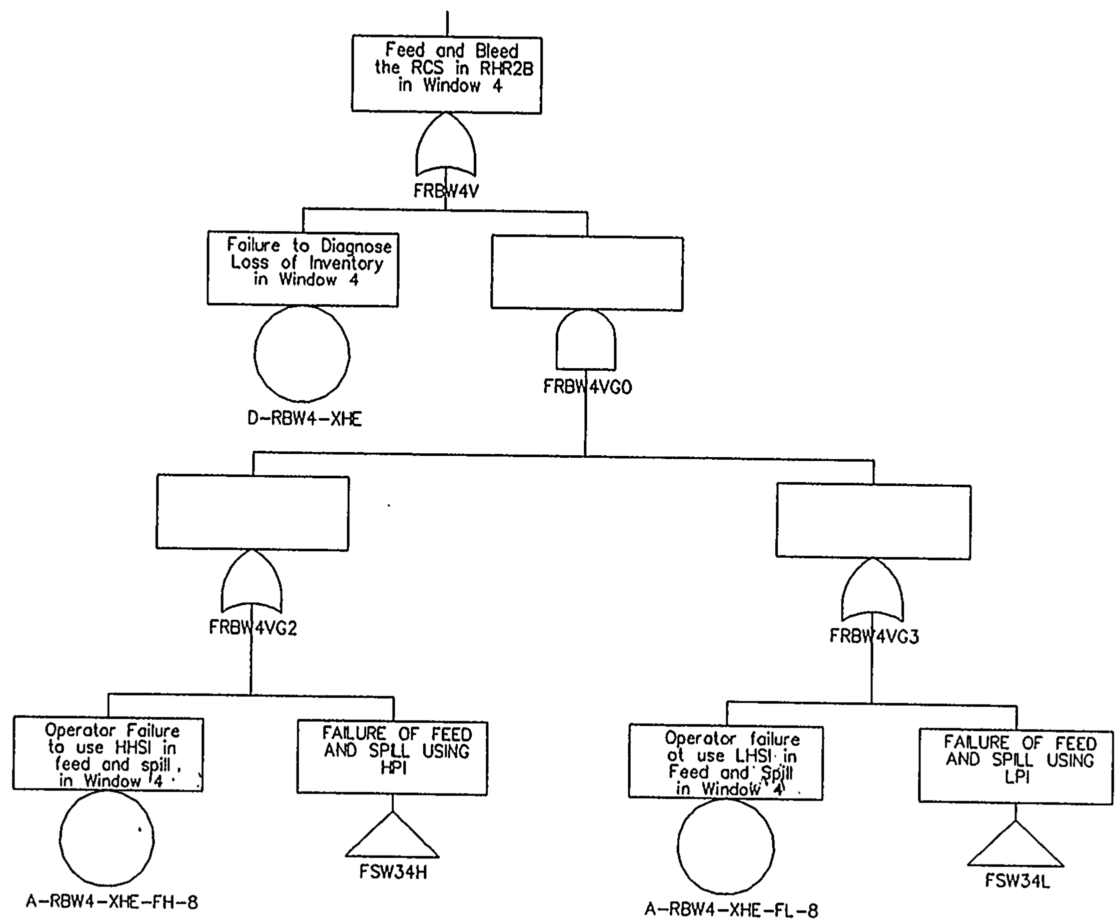
Feed and Bleed the RCS in RHR2B, Window 4



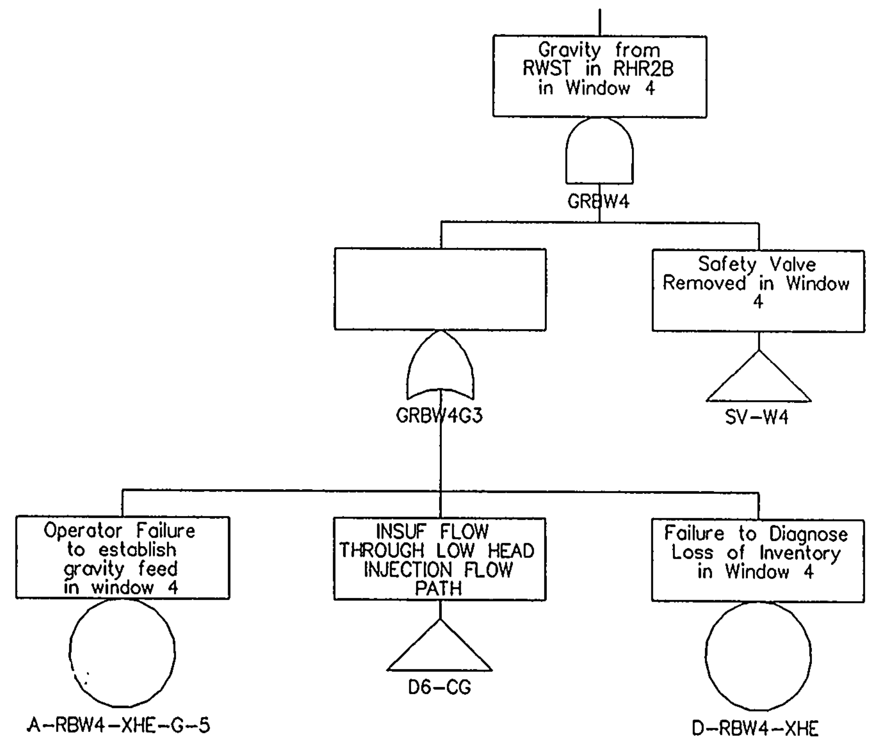
Safety Valves Removed in Window 4



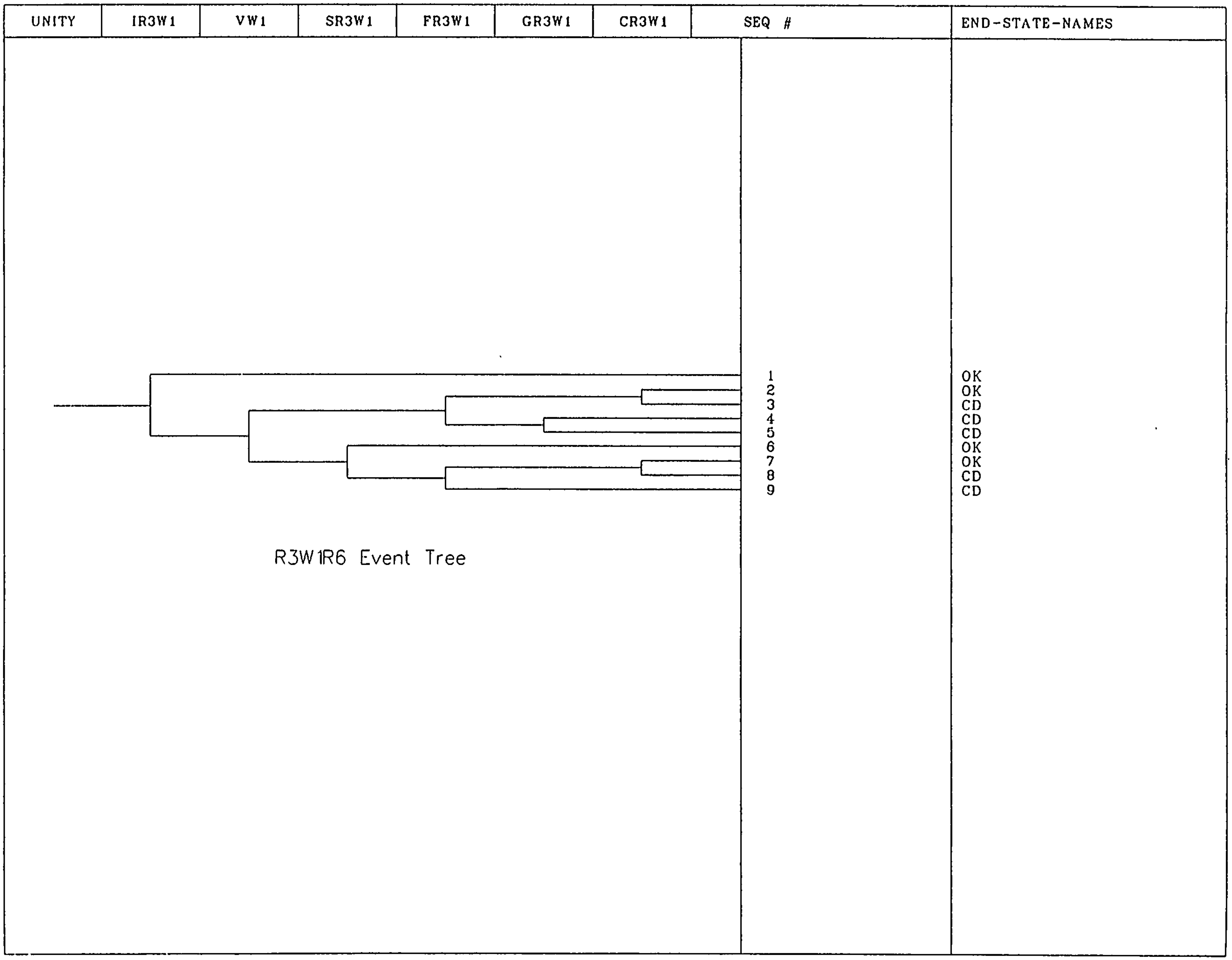
Feed and Bleed the RCS with V failed in RHR2B, Window 4

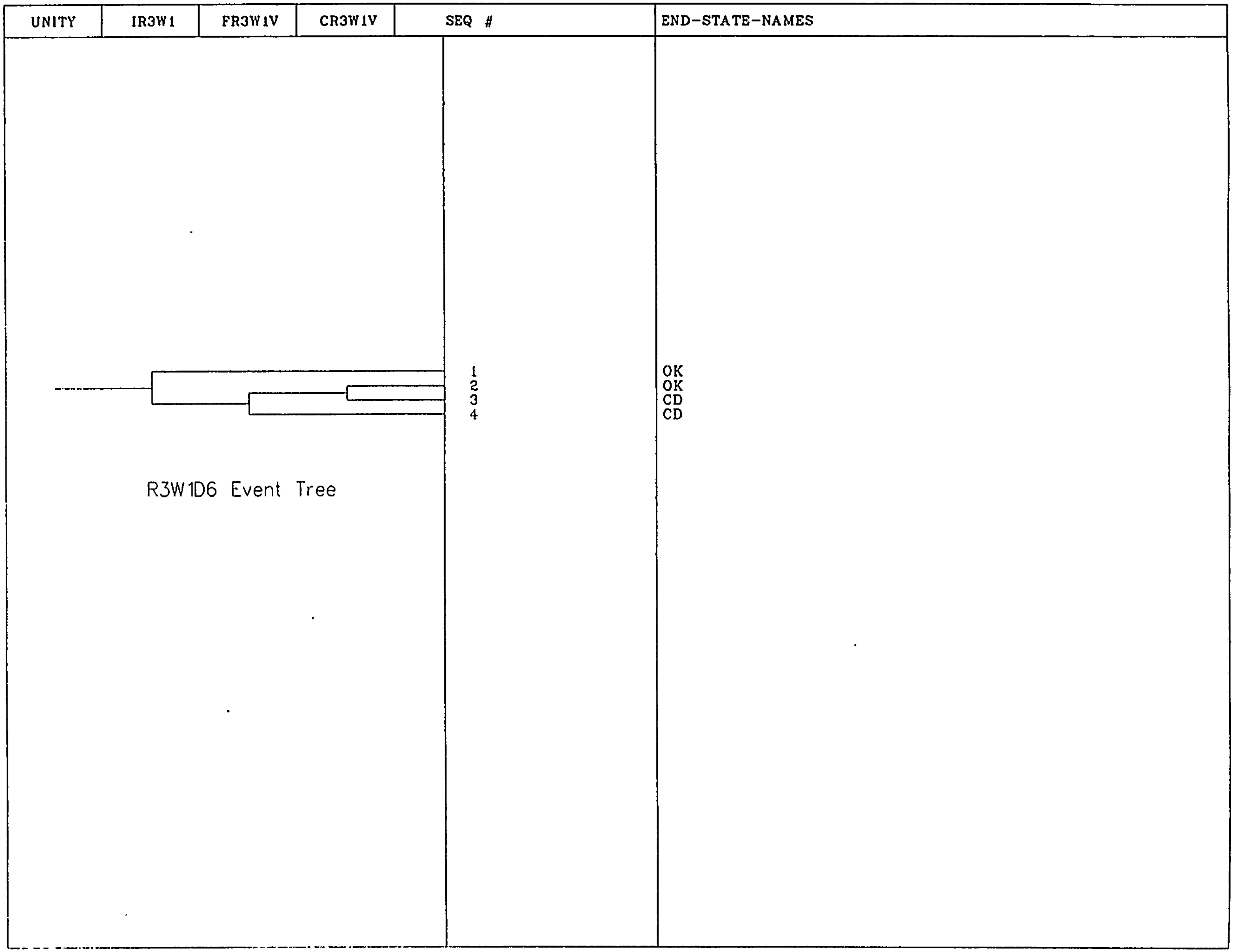


Gravity from RWST in RHR2B, Window 4

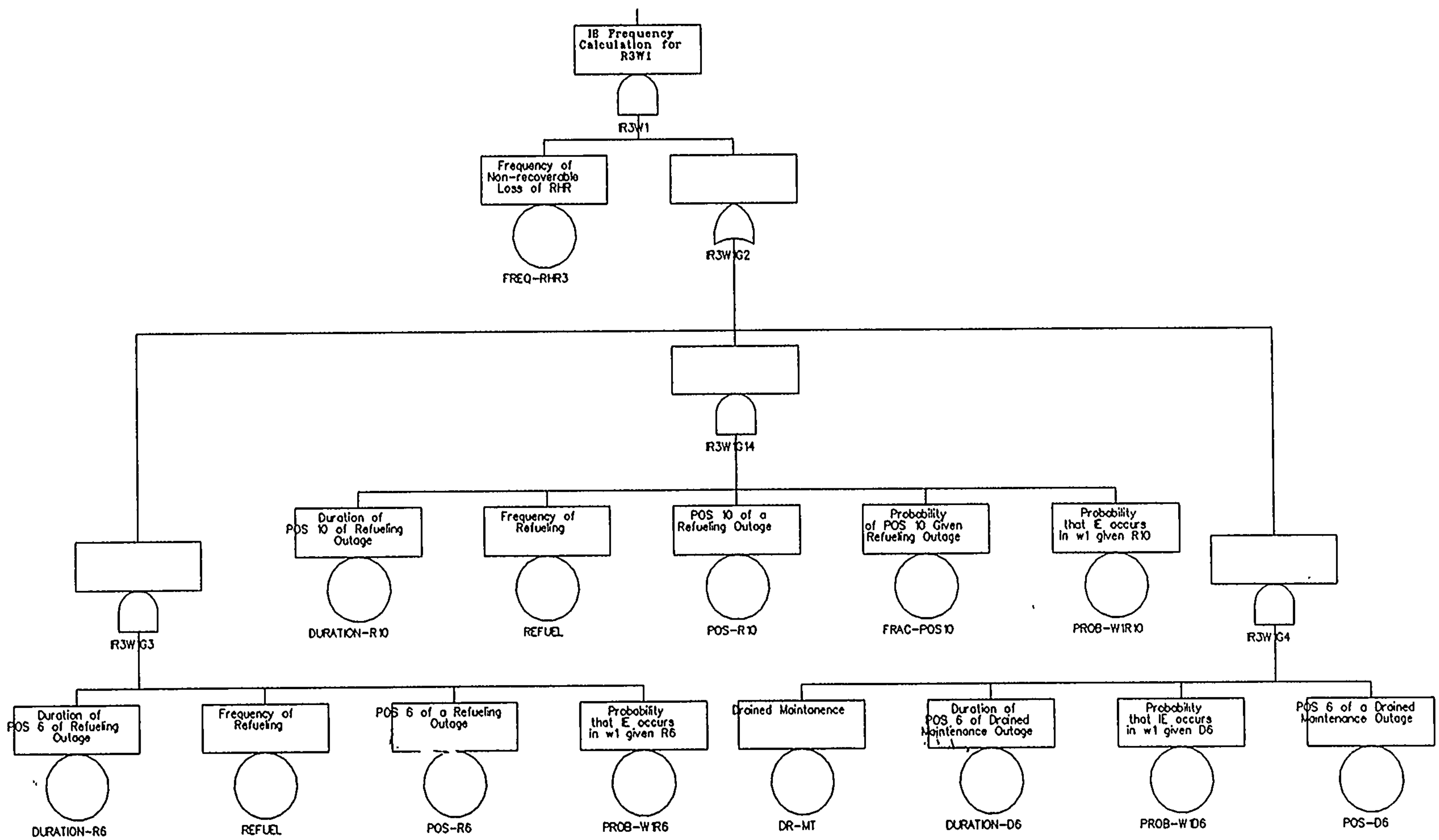


Appendix E.3 Event Tree and High Level Fault Trees for Non-recoverable Loss of RHR(RHR3)

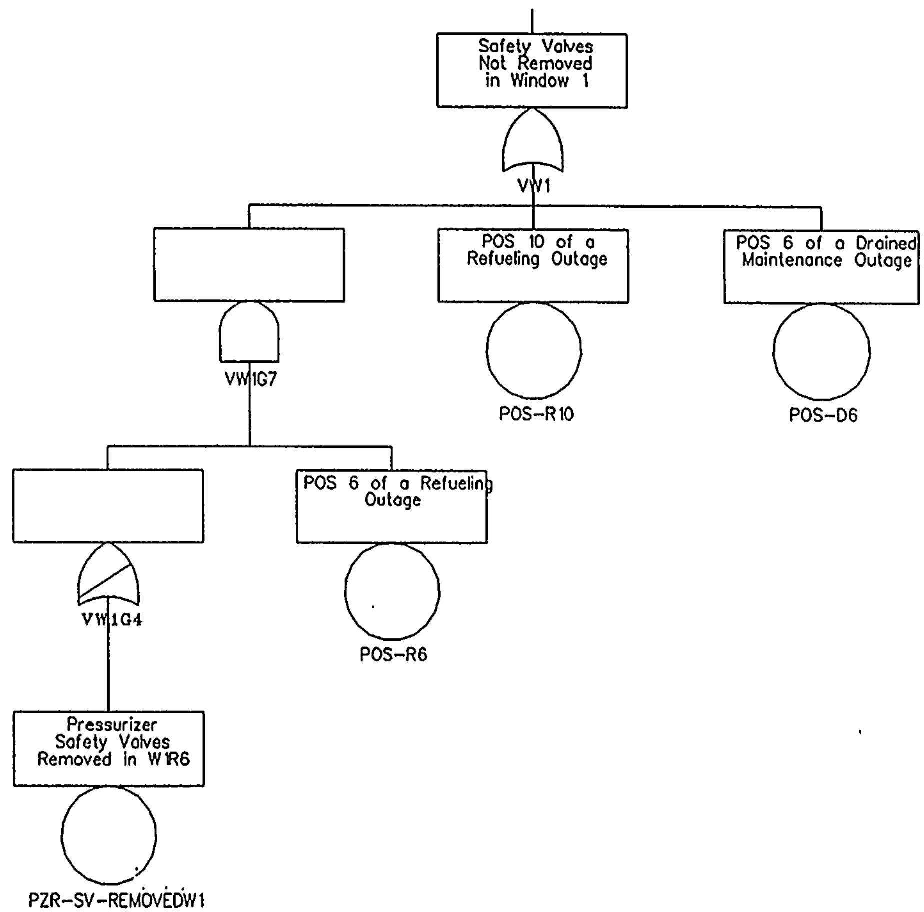

UNITY
IR3W1
VW1
SR3W1
FR3W1
GR3W1
CR3W1
SEQ #
END-STATE-NAMES
1 OK
2 OK
3 CD
4 CD
5 CD
6 OK
7 OK
8 CD
9 CD
R3W1R6 Event Tree


UNITY
IR3W1
FR3W1V
CR3W1V
SEQ #
END-STATE-NAMES
1 OK
2 OK
3 CD
4 CD
R3W1D6 Event Tree

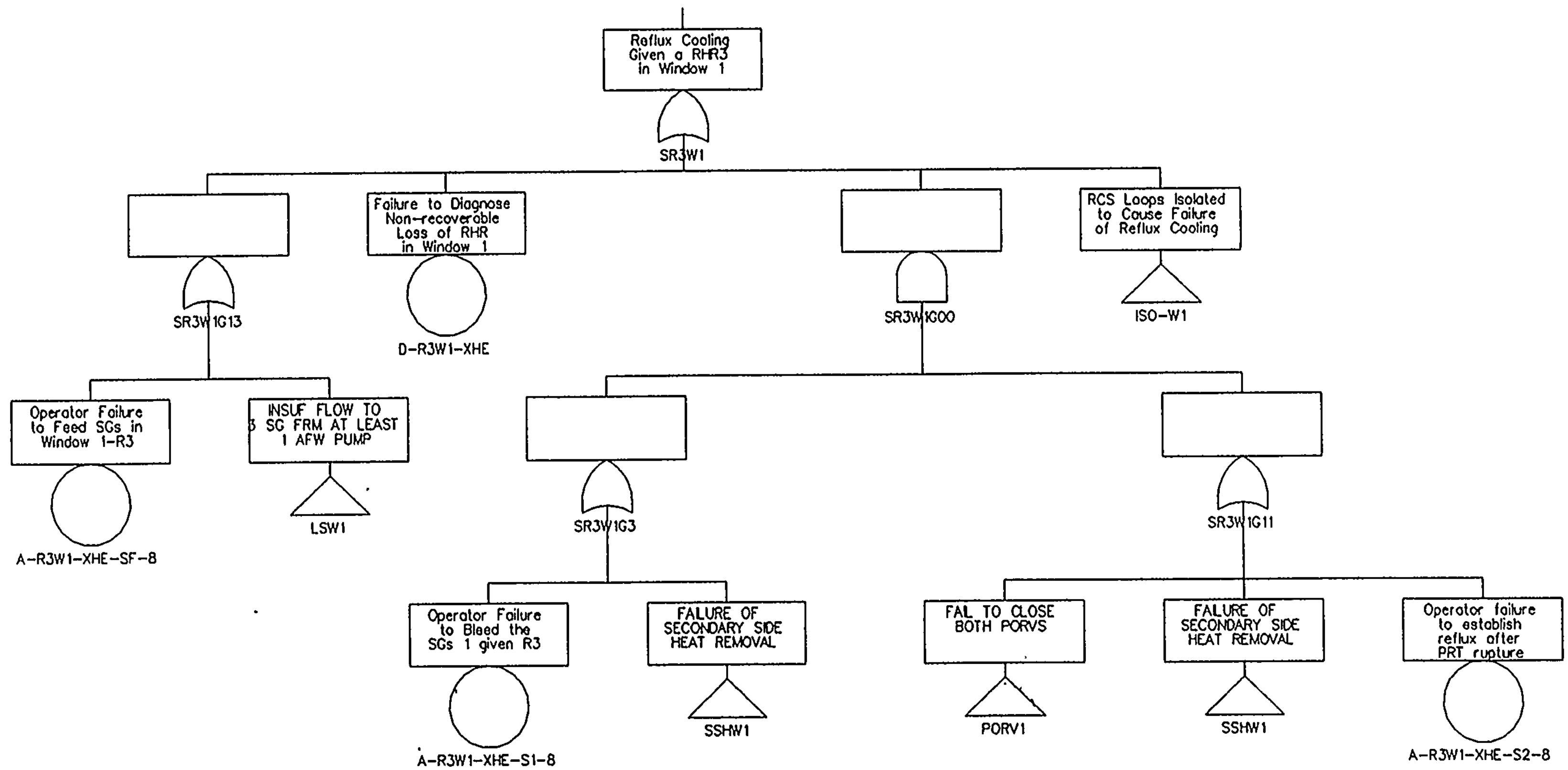
I Top Event for Loss of RHR – R3 in Window 1



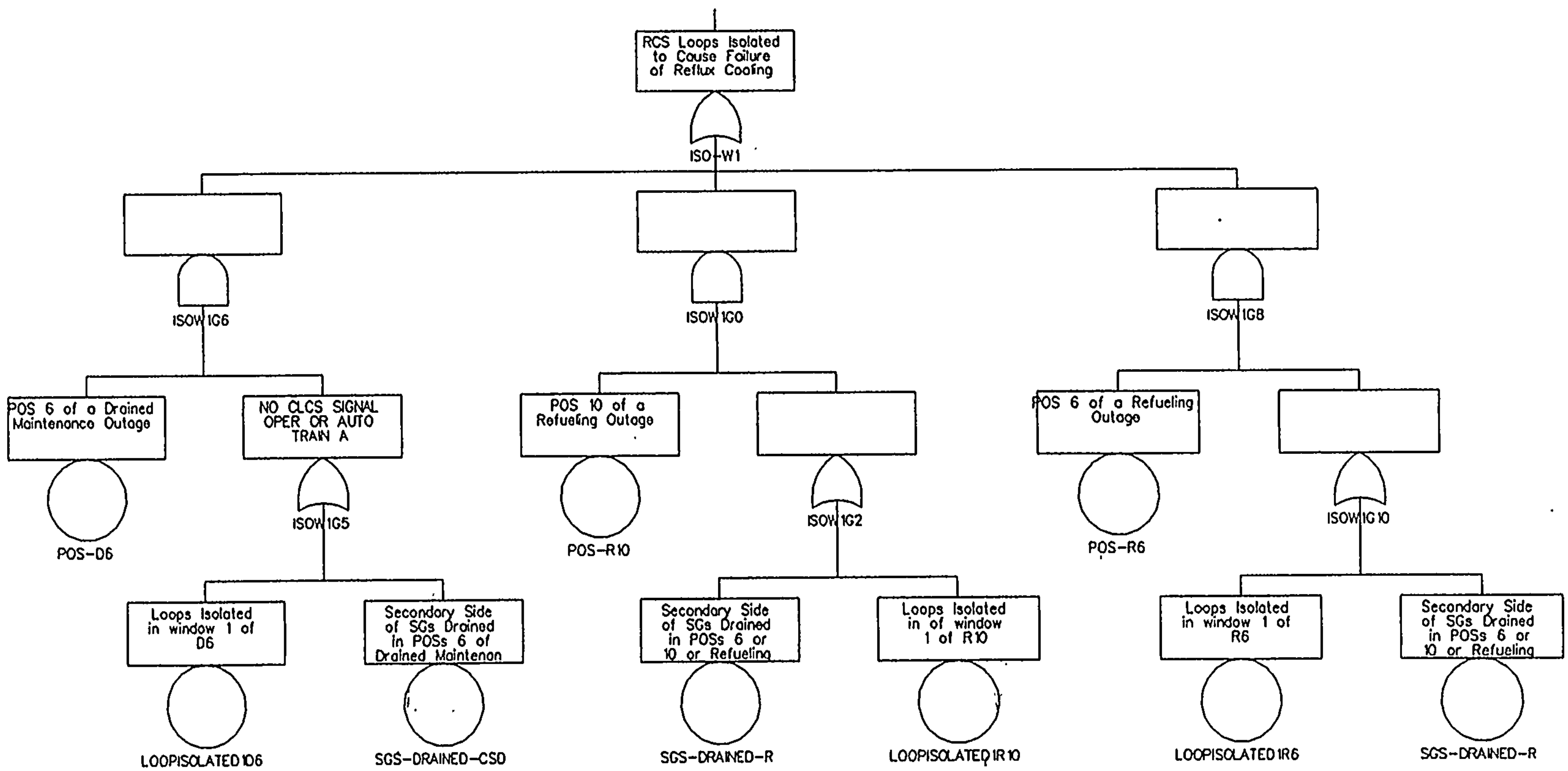
Safety Valves Not Removed in Window 1



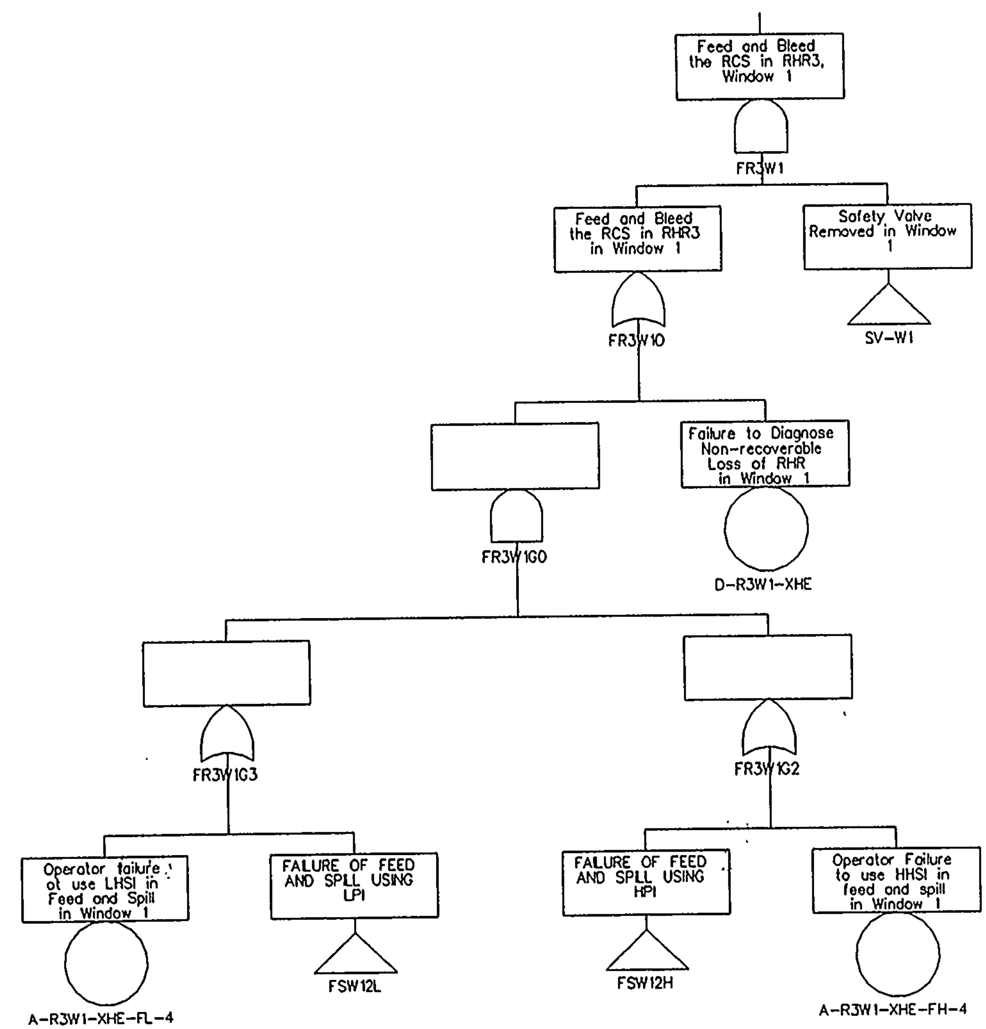
Reflux Cooling Given RHR3 in Window 1



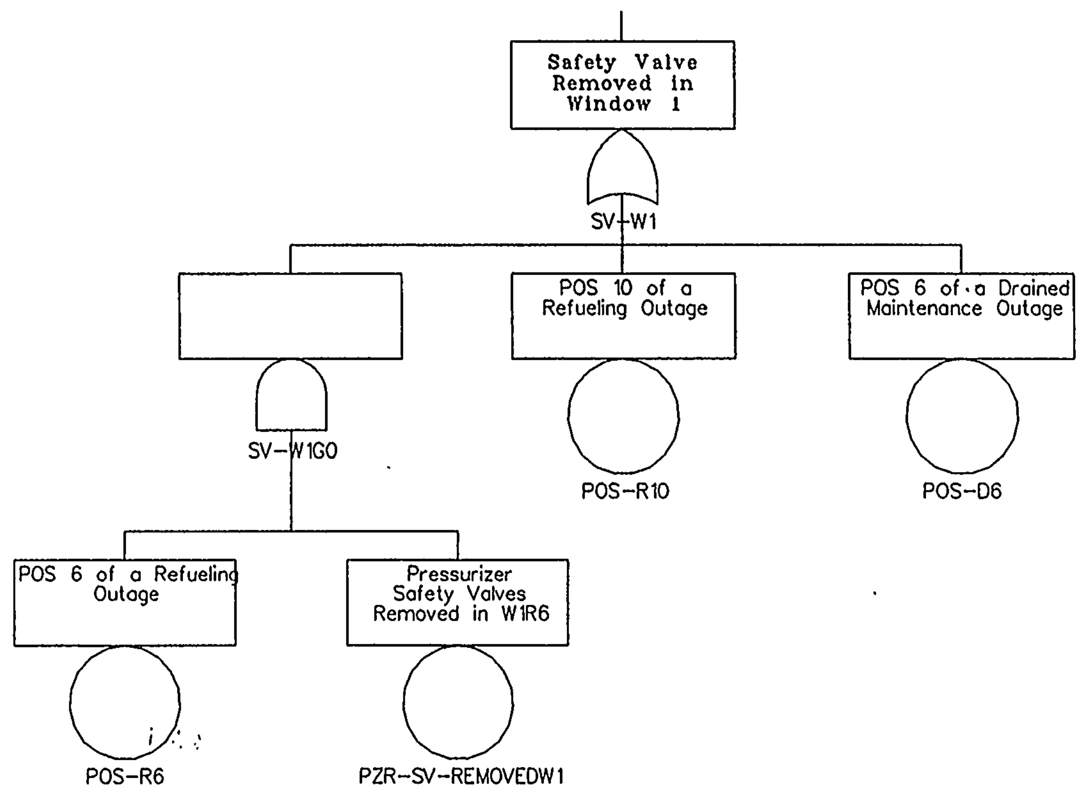
RCS Loops Isolated to Cause Failure of Reflux in Window 1



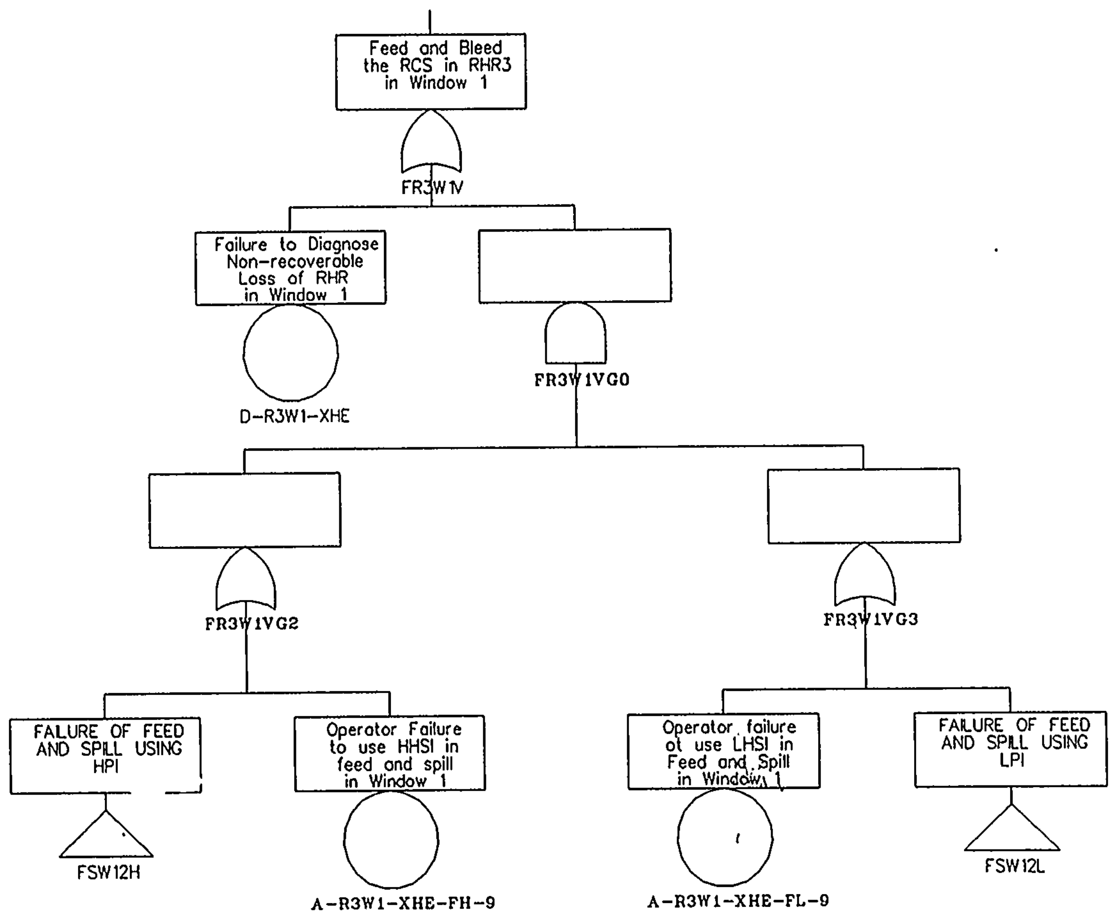
Feed and Bleed the RCS in RHR3, Window 1



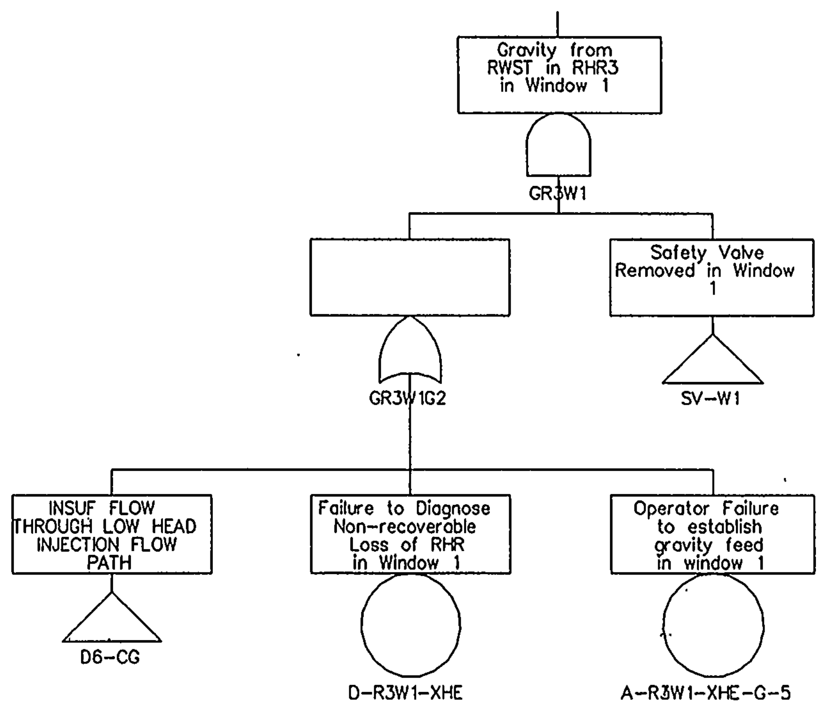
Safety Valves Removed in Window 1



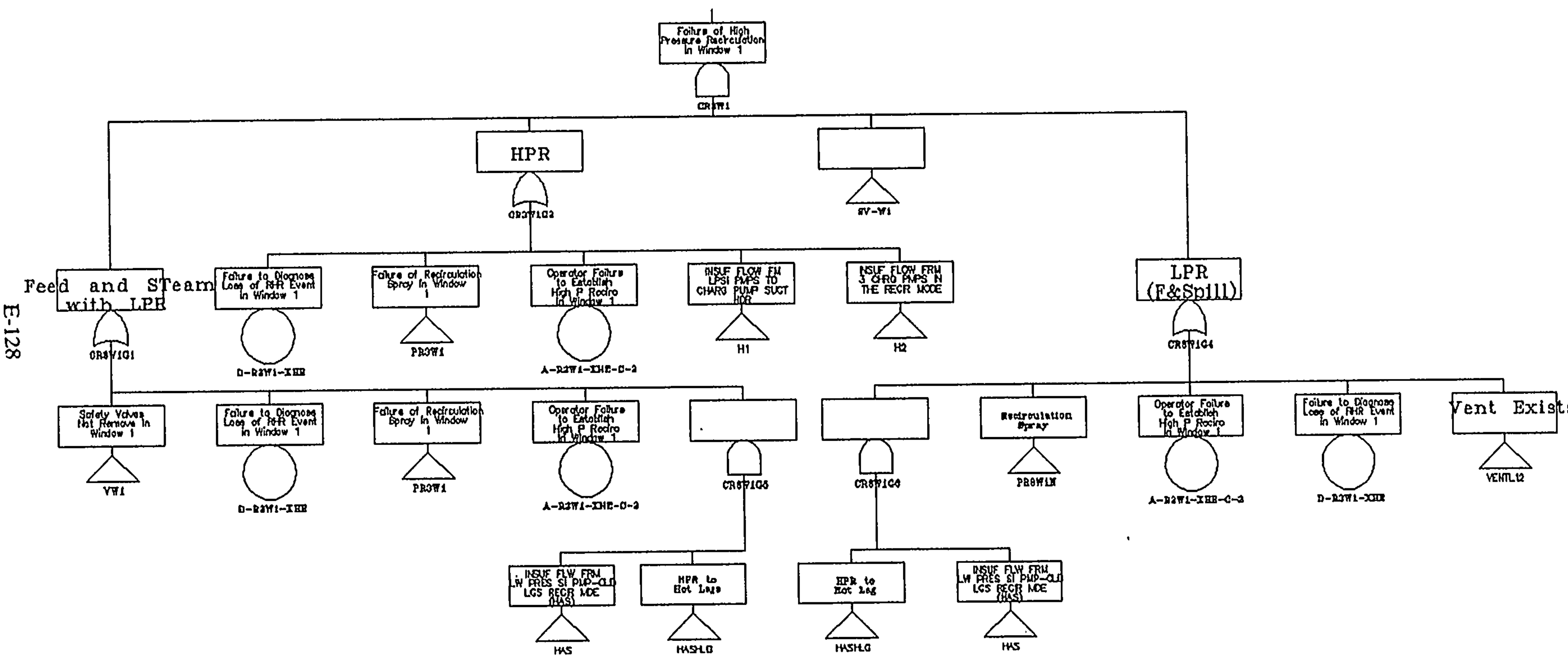
Feed and Bleed the RCS with V failed in RHR3, Window 1



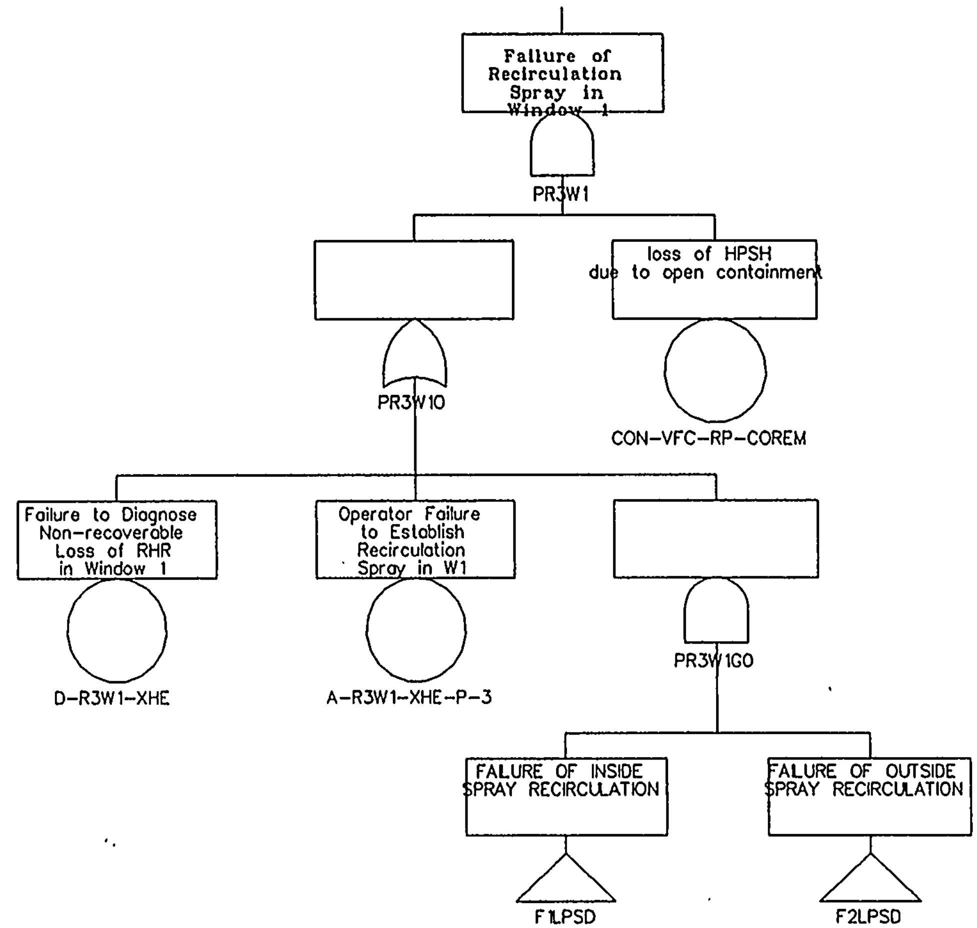
Gravity from RWST in RHR3, Window 1



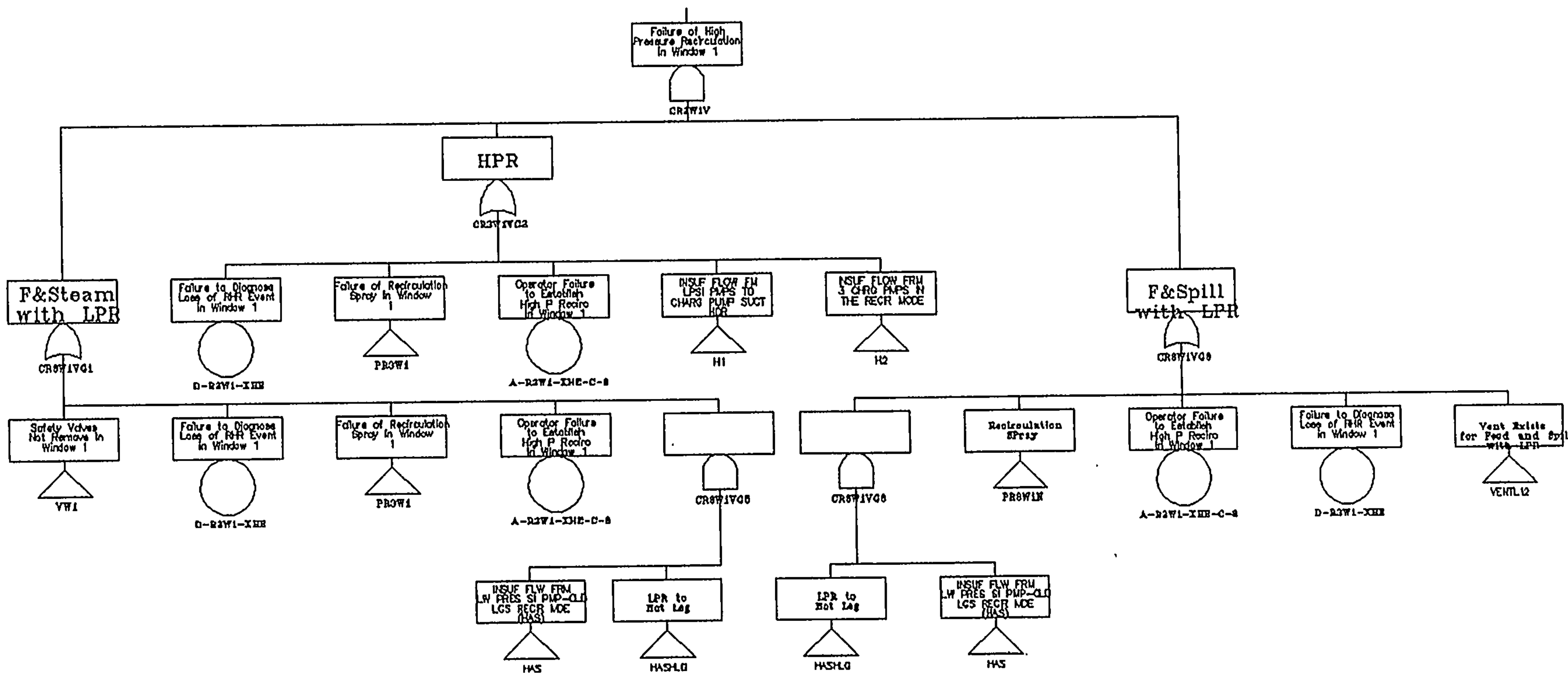
Failure of High Pressure Recirculation in Window 1

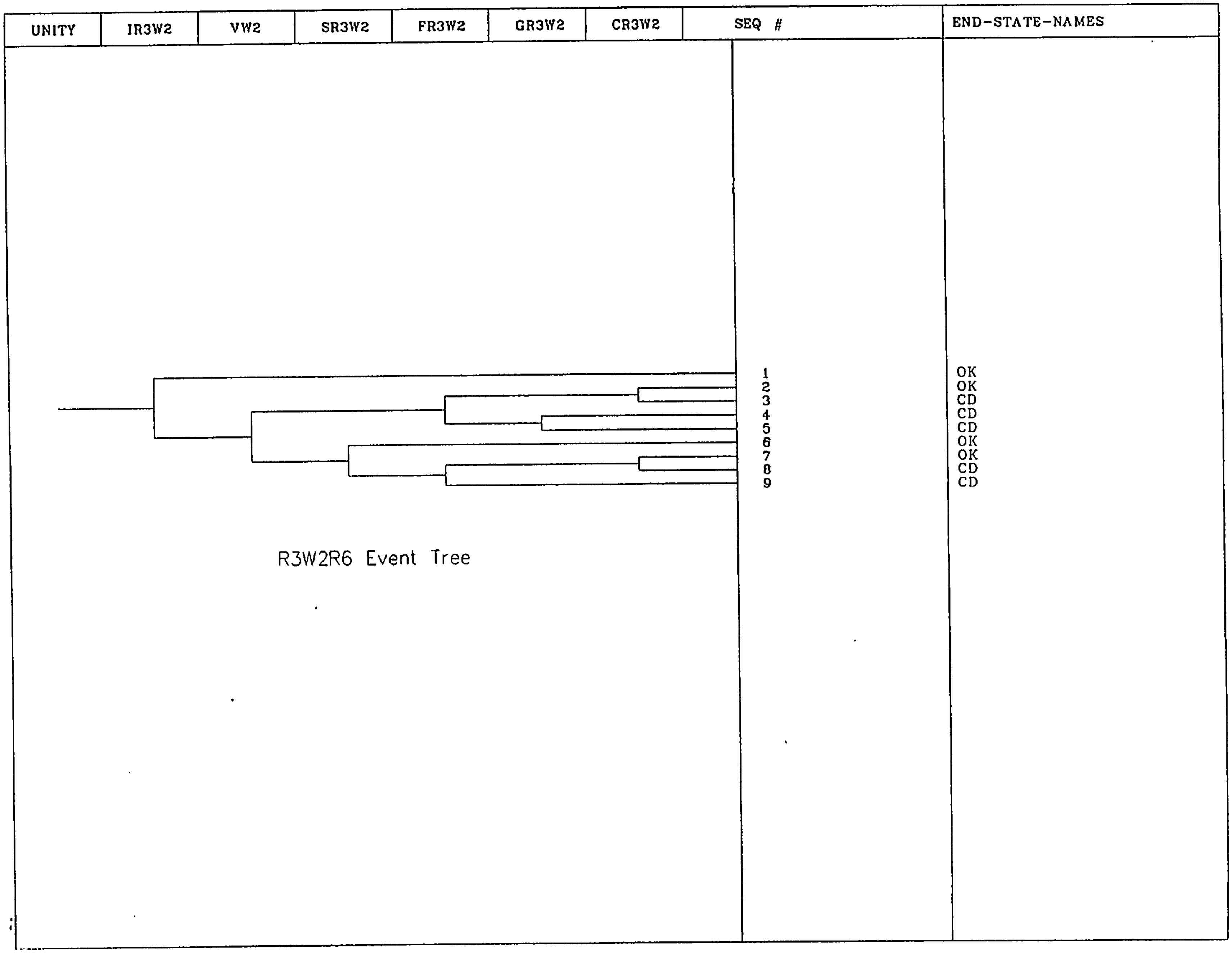


Failure of Recirculation Spray in Window 1-cause HPR failure

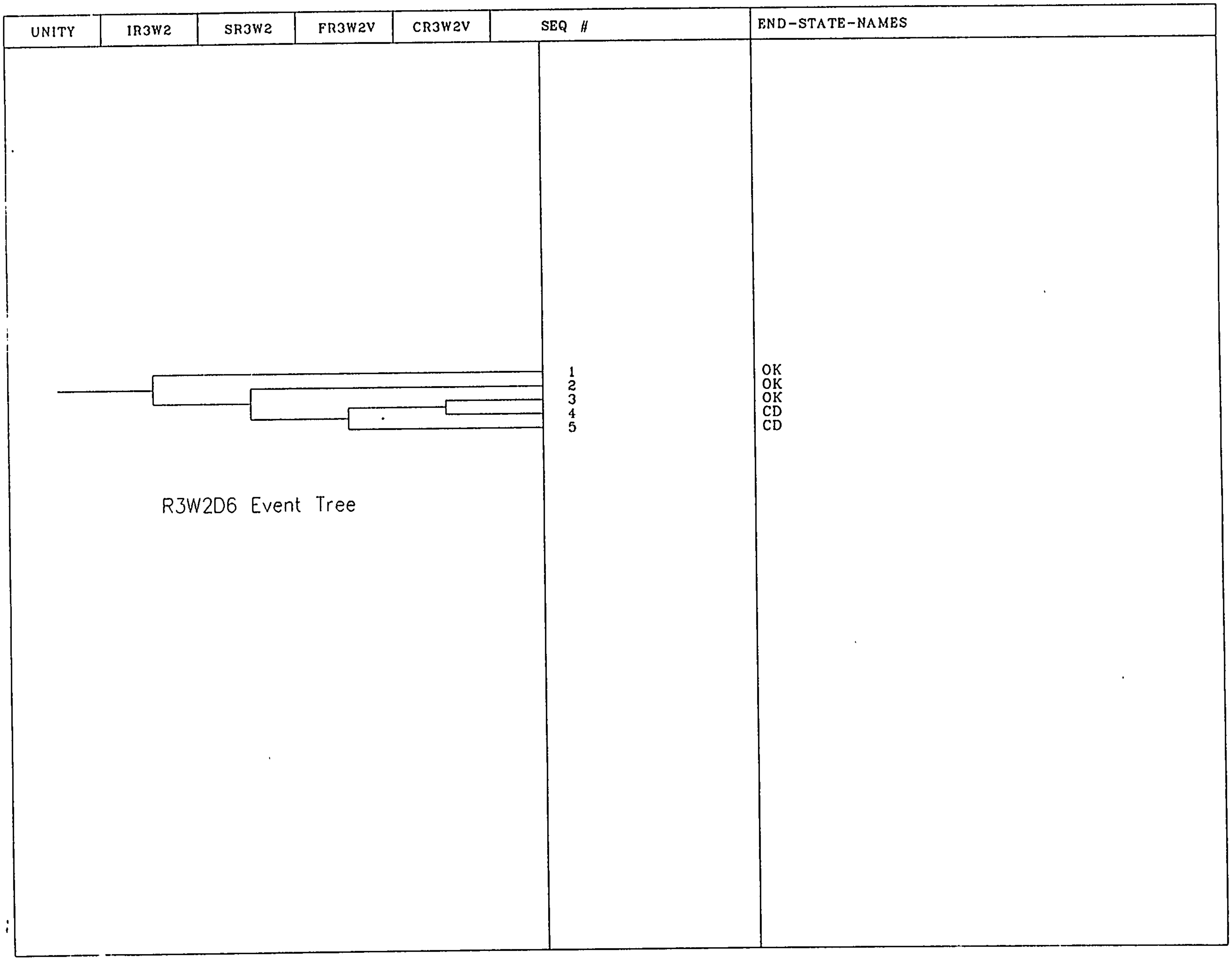


Failure of High Pressure Recirculation in Window 1



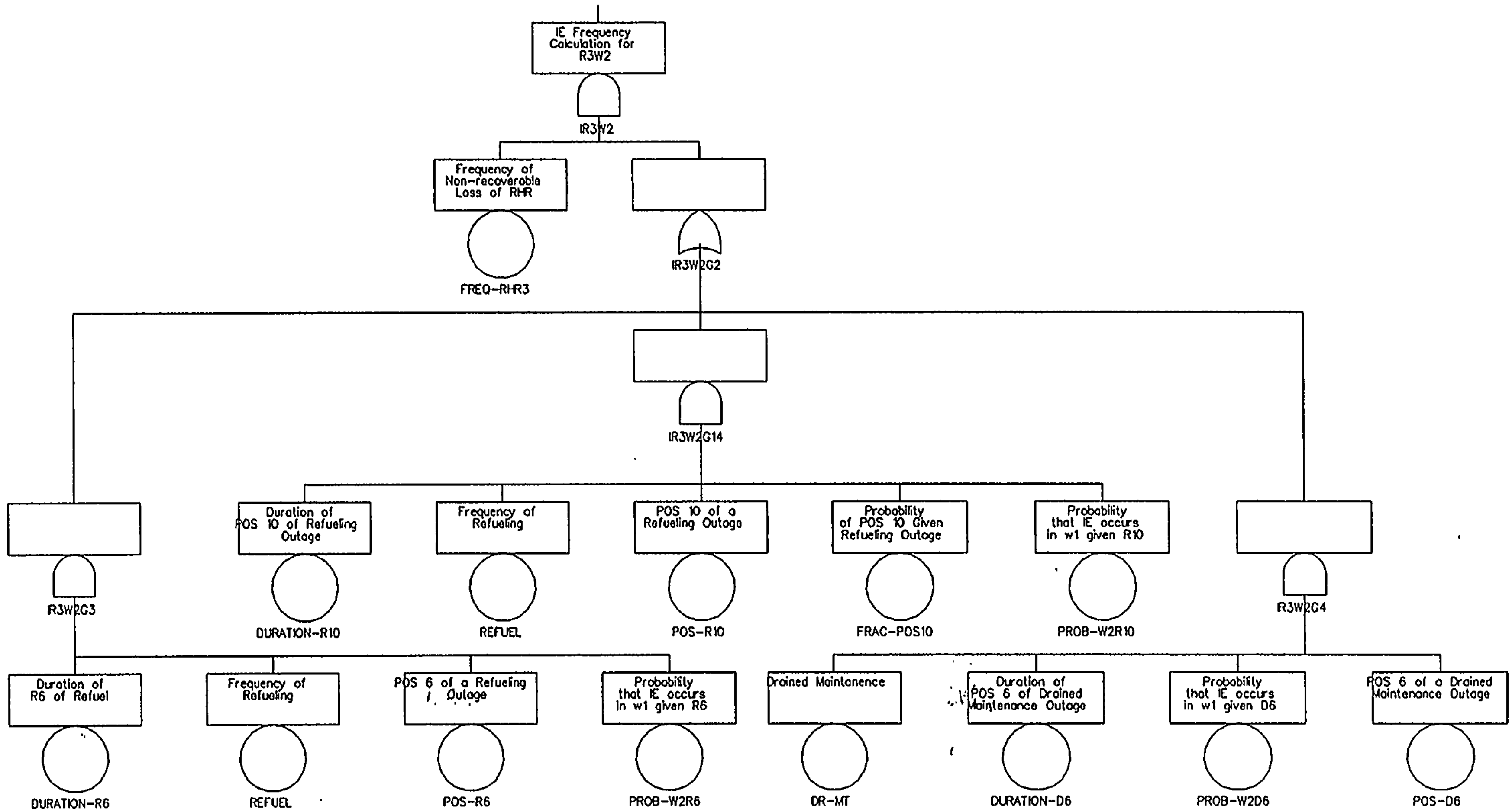


R3W2R6 Event Tree

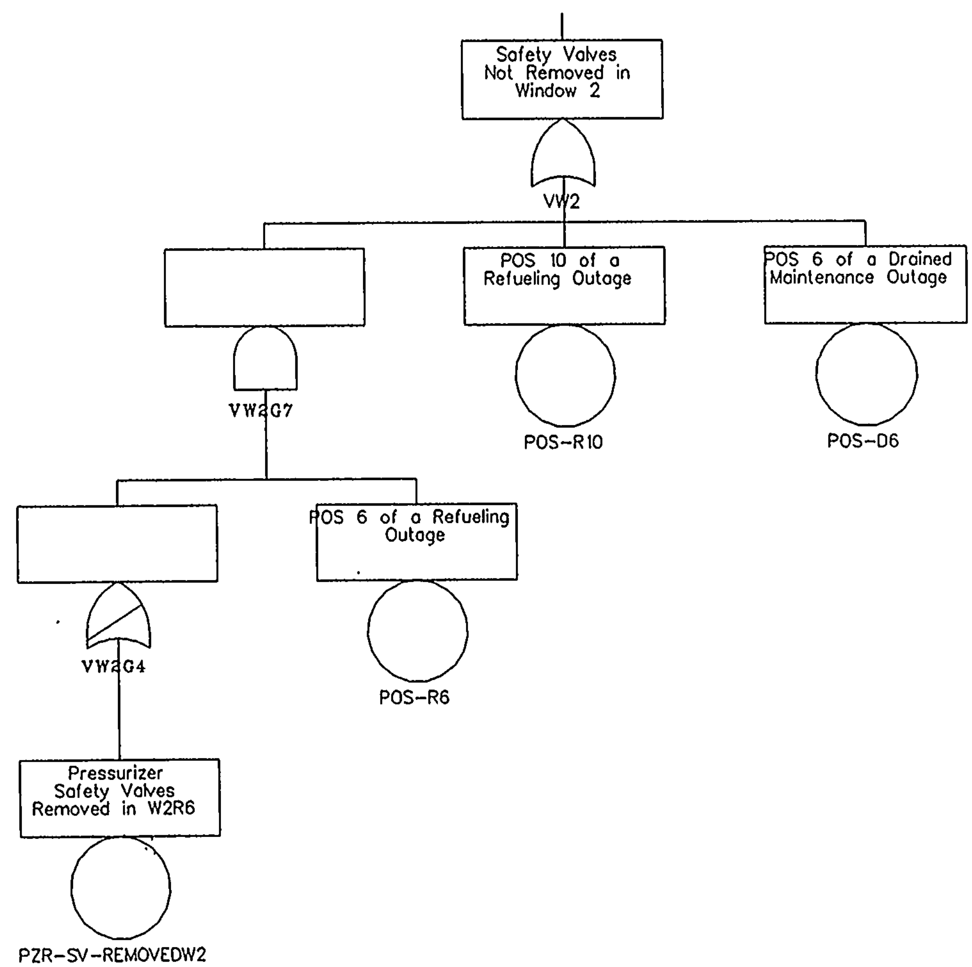


R3W2D6 Event Tree

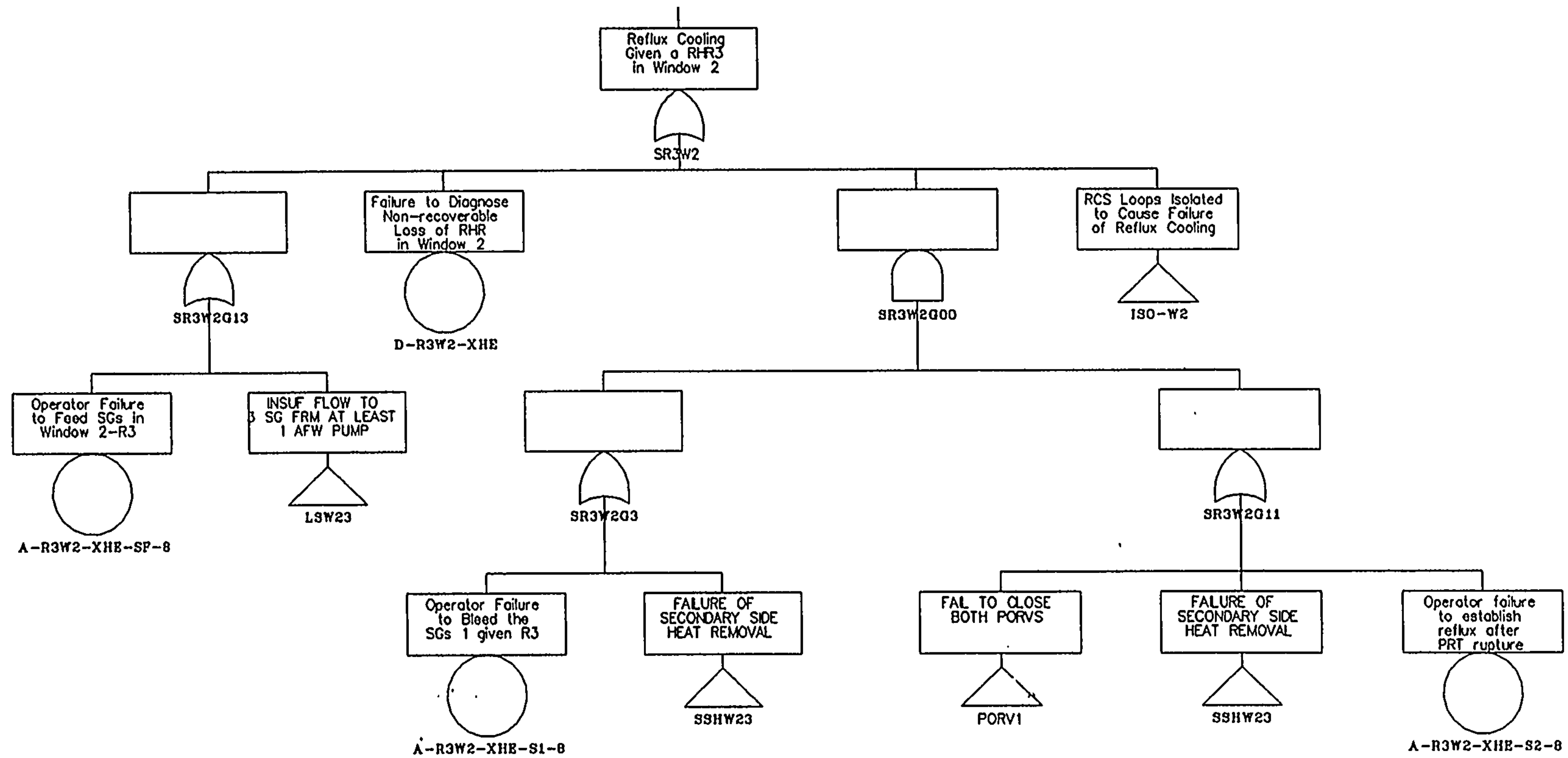
I Top Event for Loss of RHR- R3 in Window 2



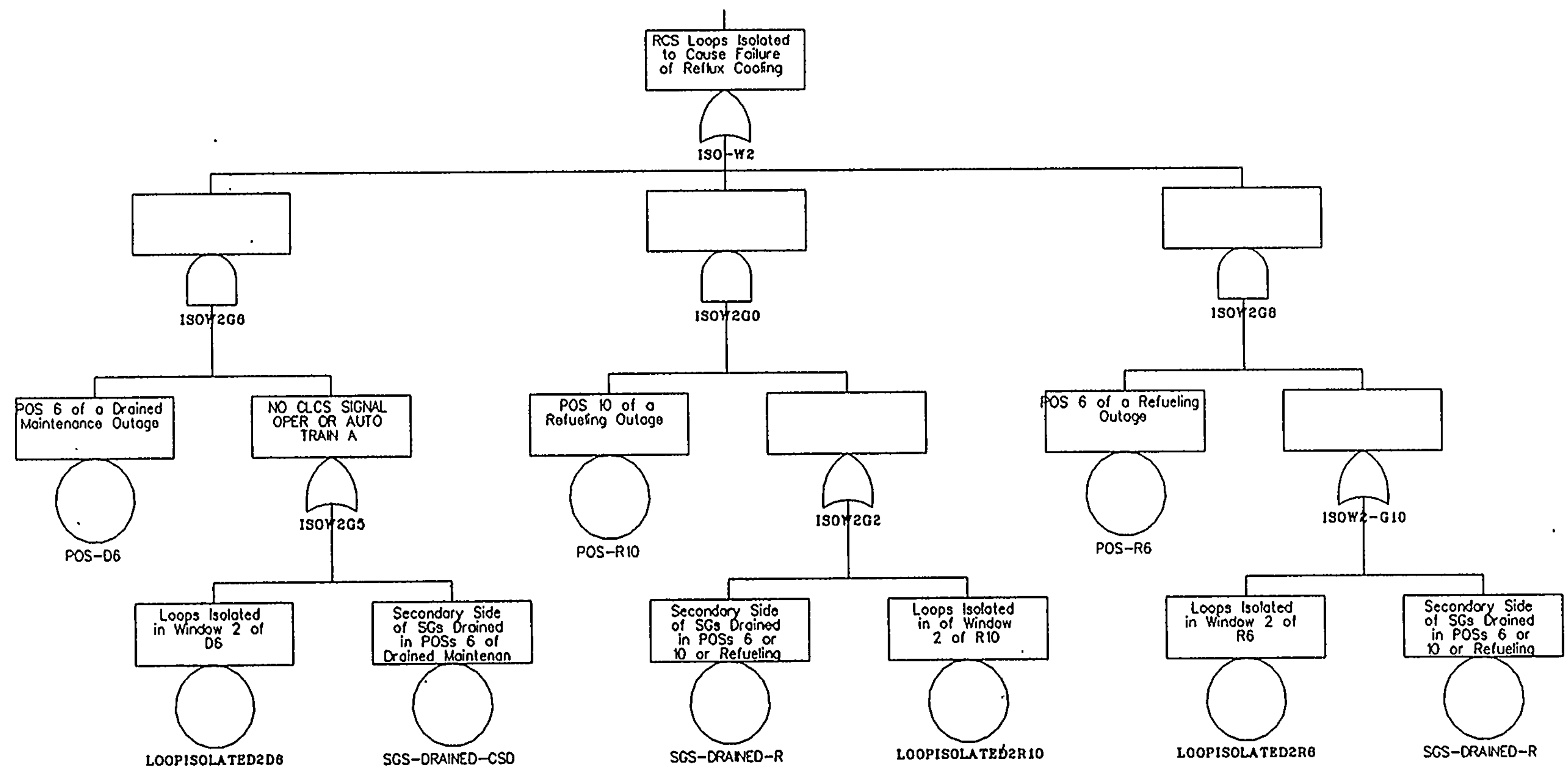
Safety Valves Not Removed in Window 2



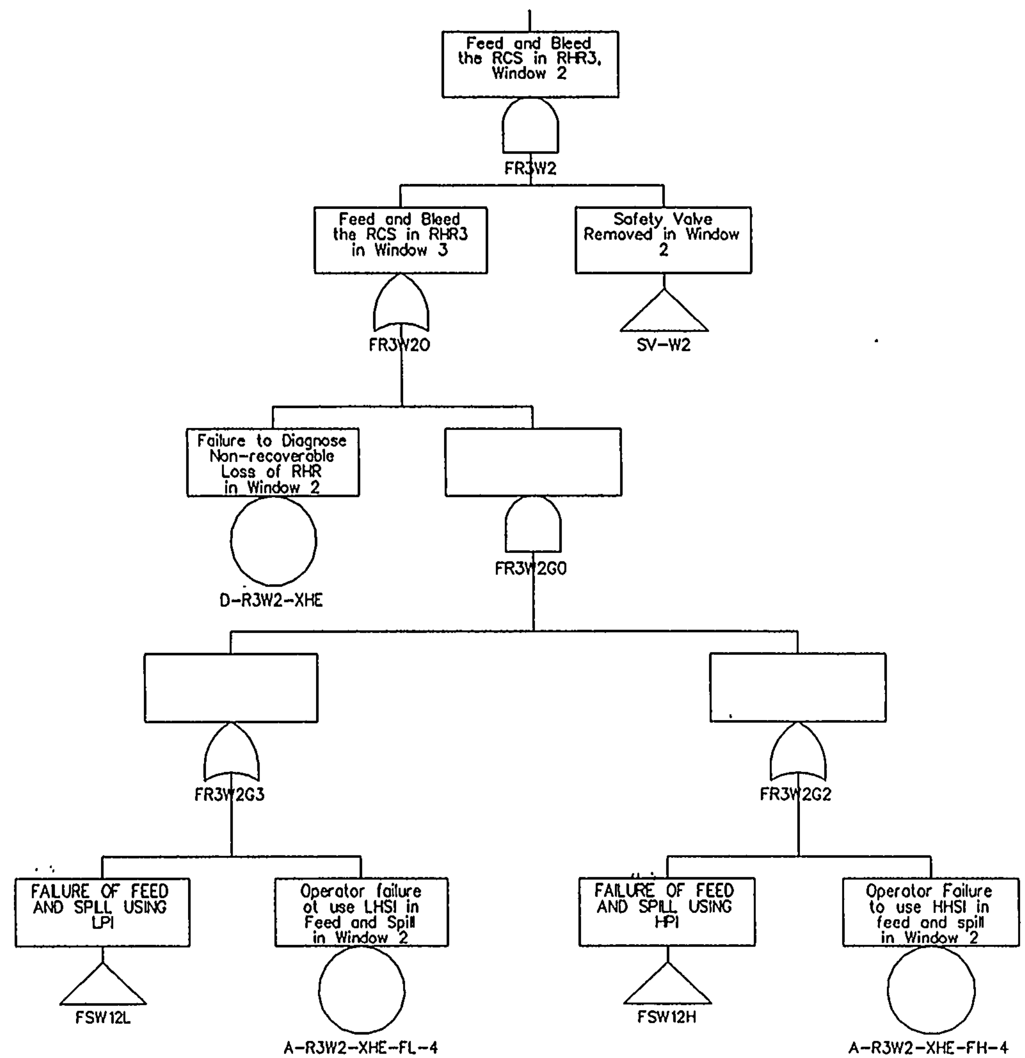
Reflux Cooling Given RHR3 in Window 2



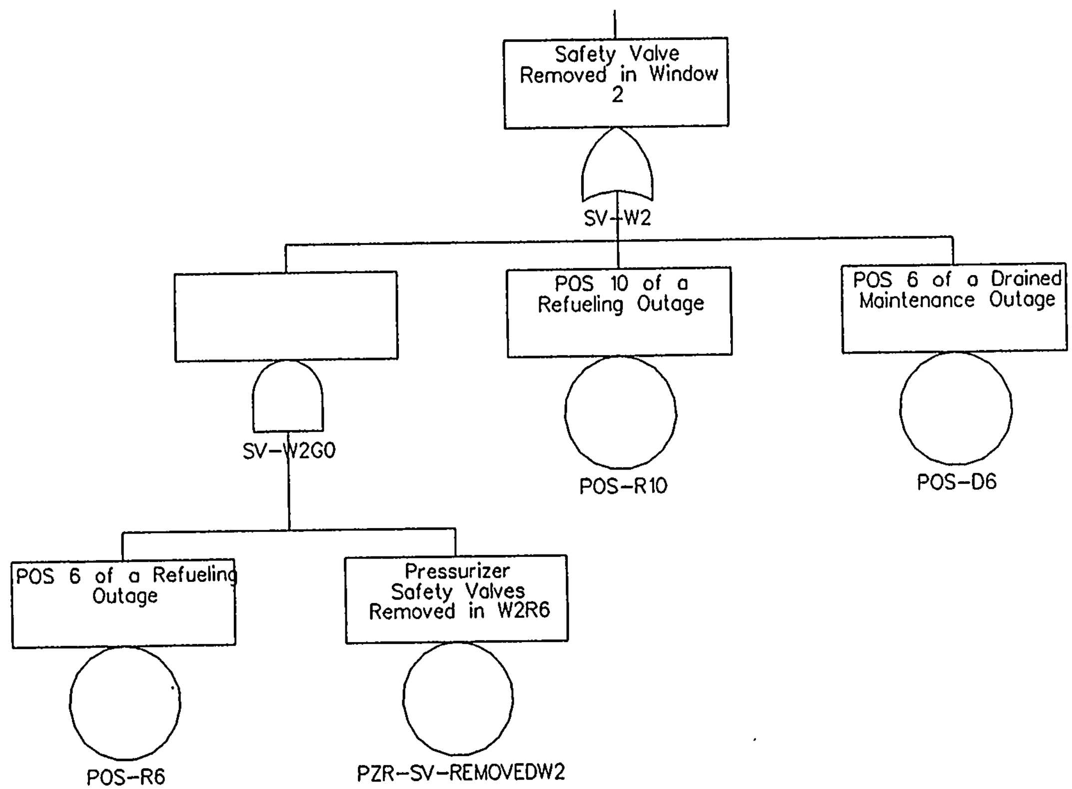
RCS Loops Isolated to Cause Failure of Reflux in Window 2



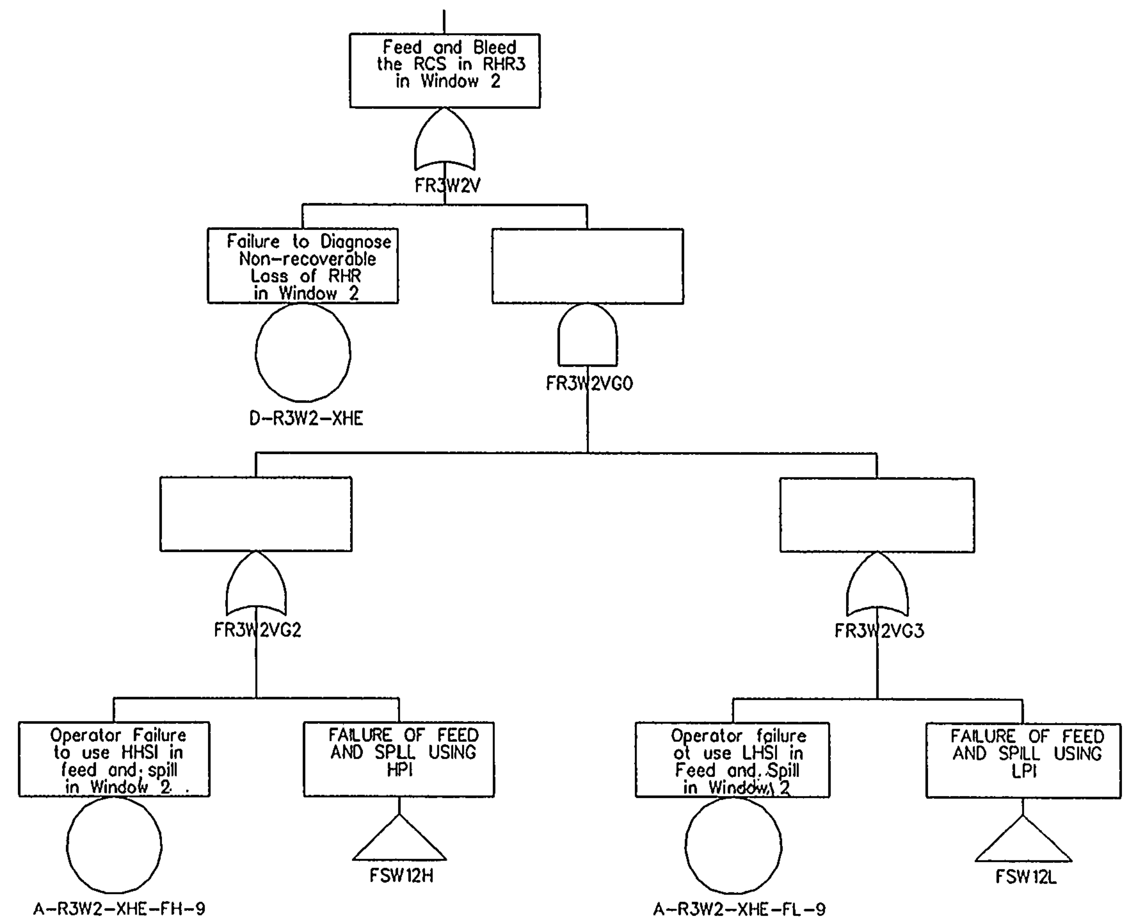
Feed and Bleed the RCS in RHR3, Window 2



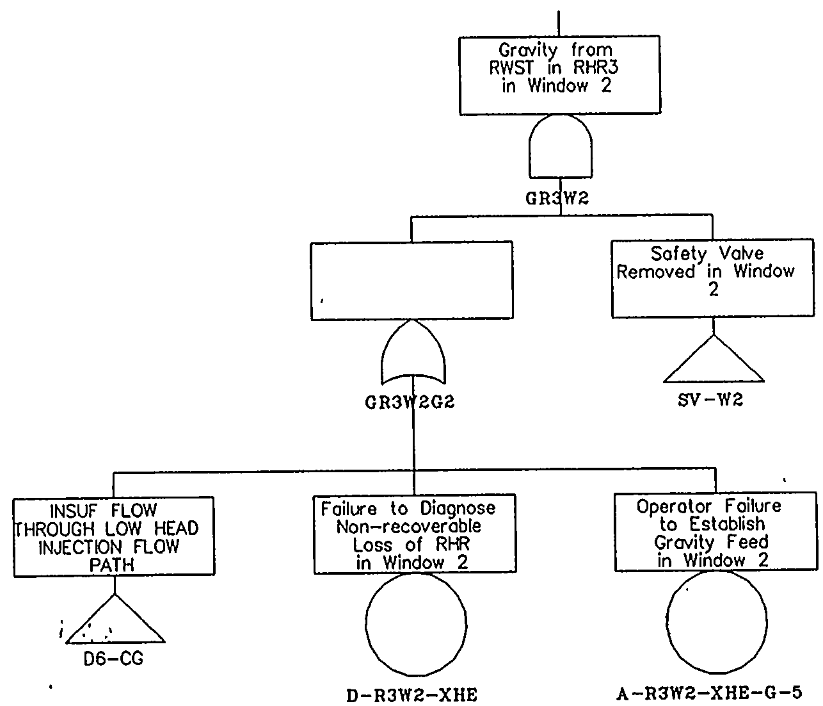
Safety Valves Removed in Window 2



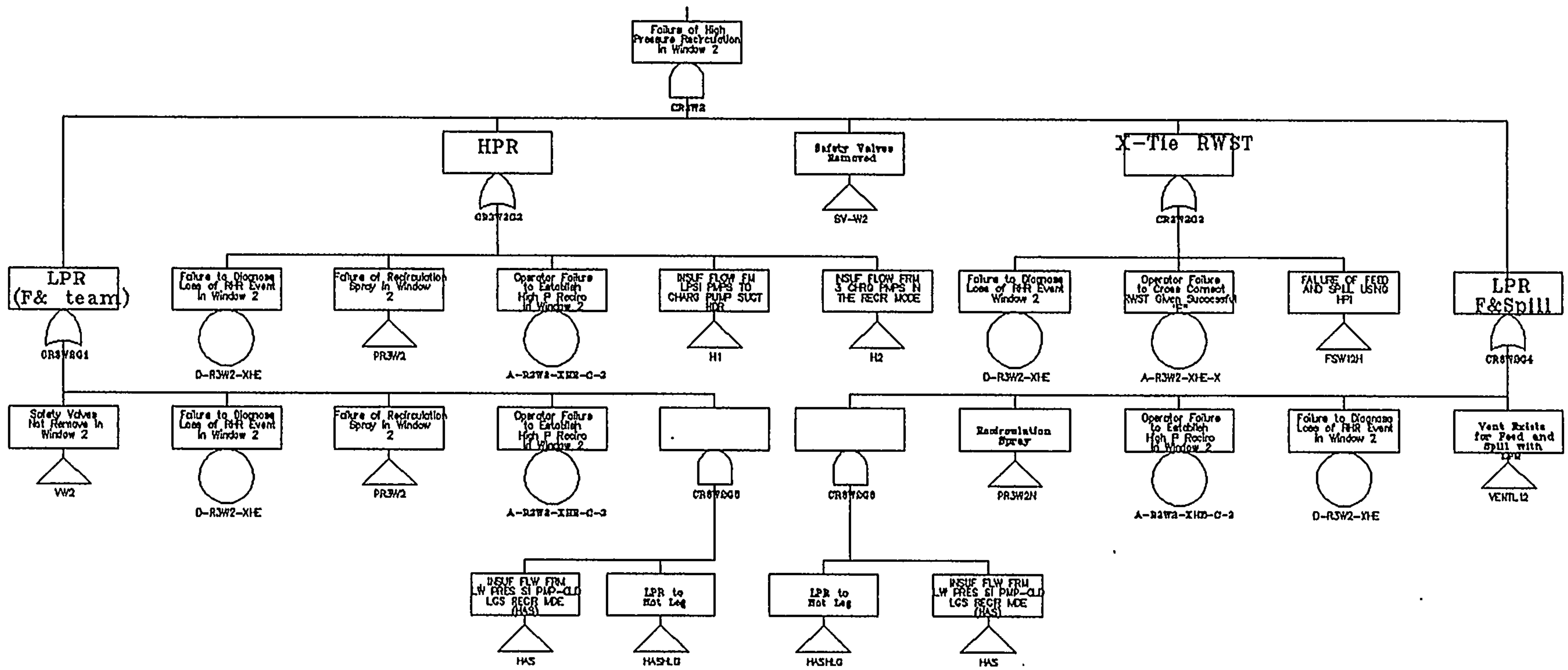
Feed and Bleed the RCS with V failed in RHR3, Window 2



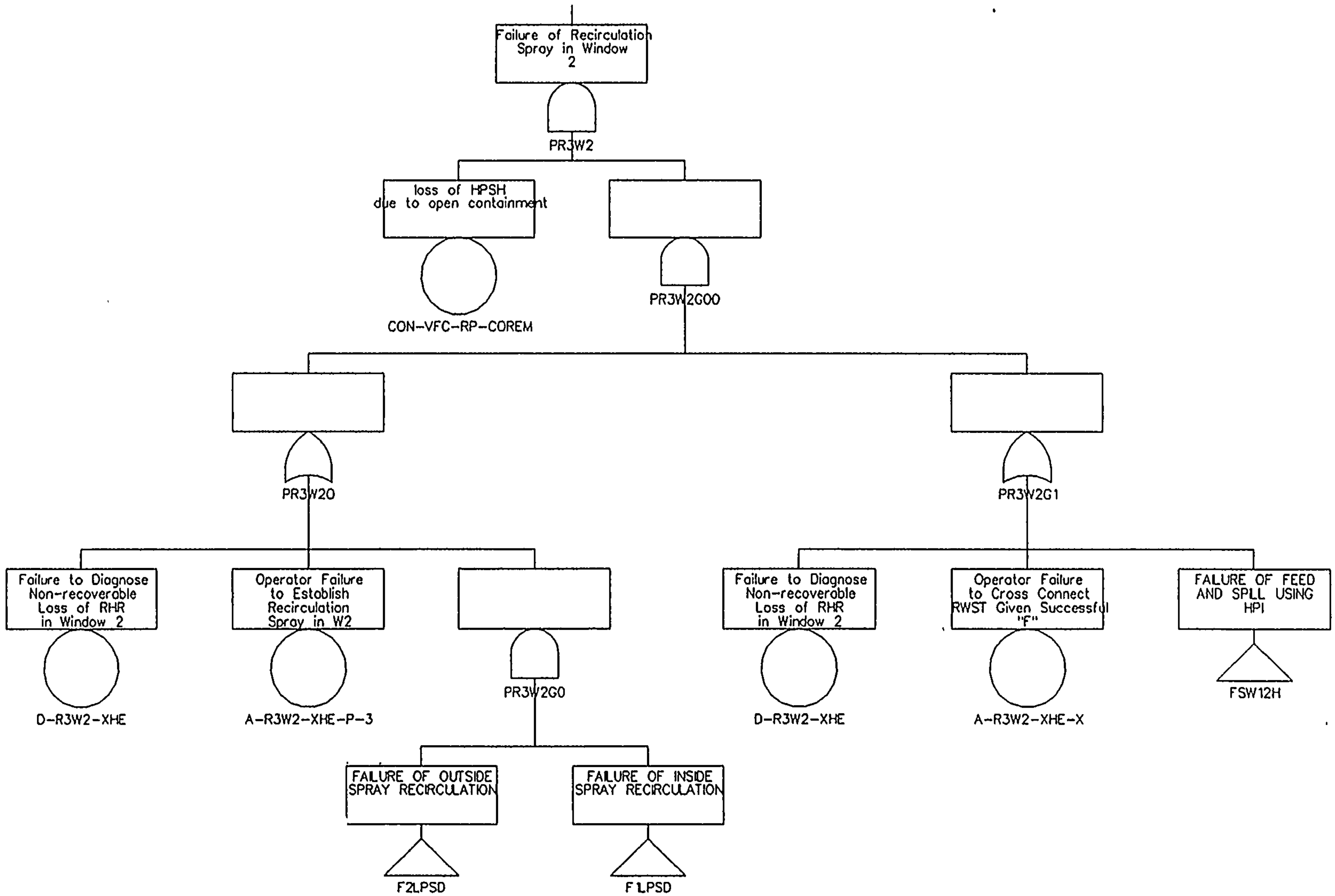
Gravity from RWST in RHR3, Window 2



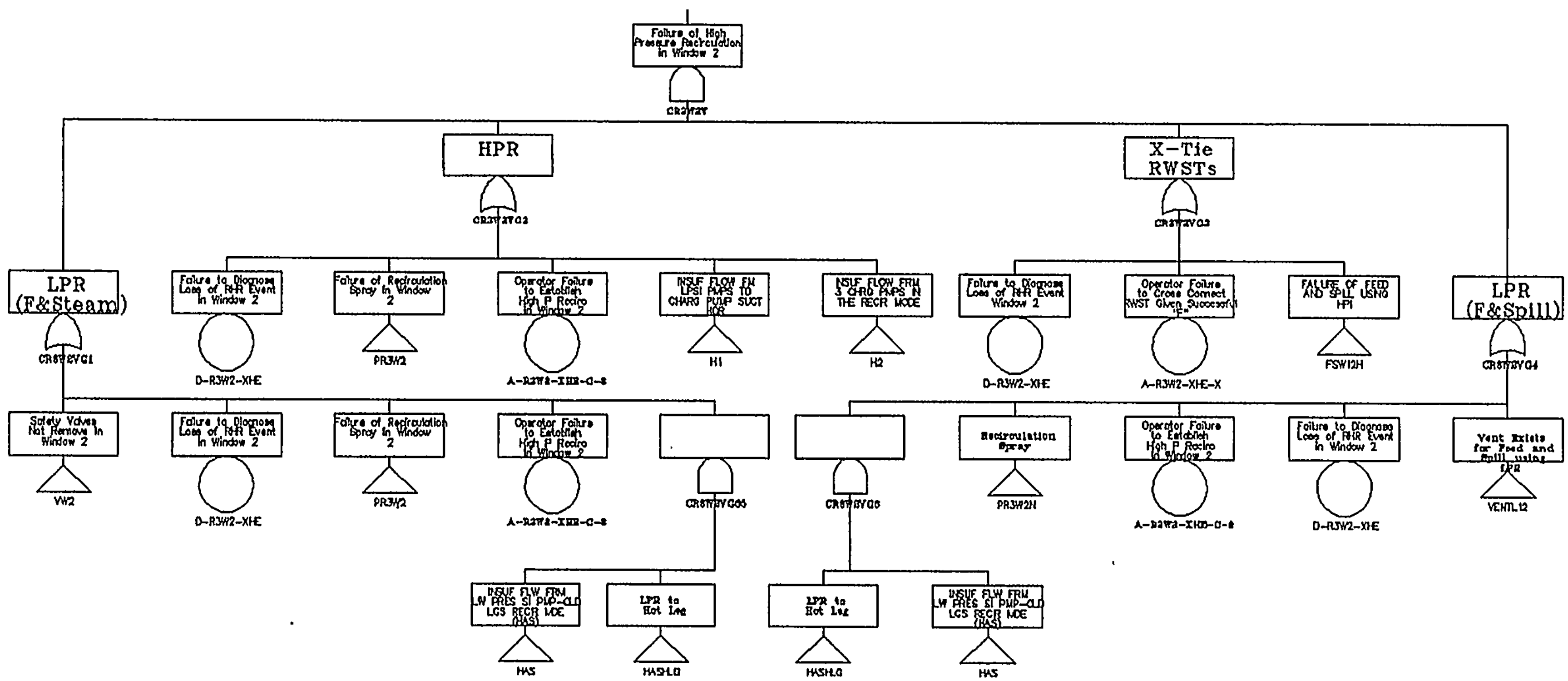
Failure of High Pressure Recirculation in Window 2

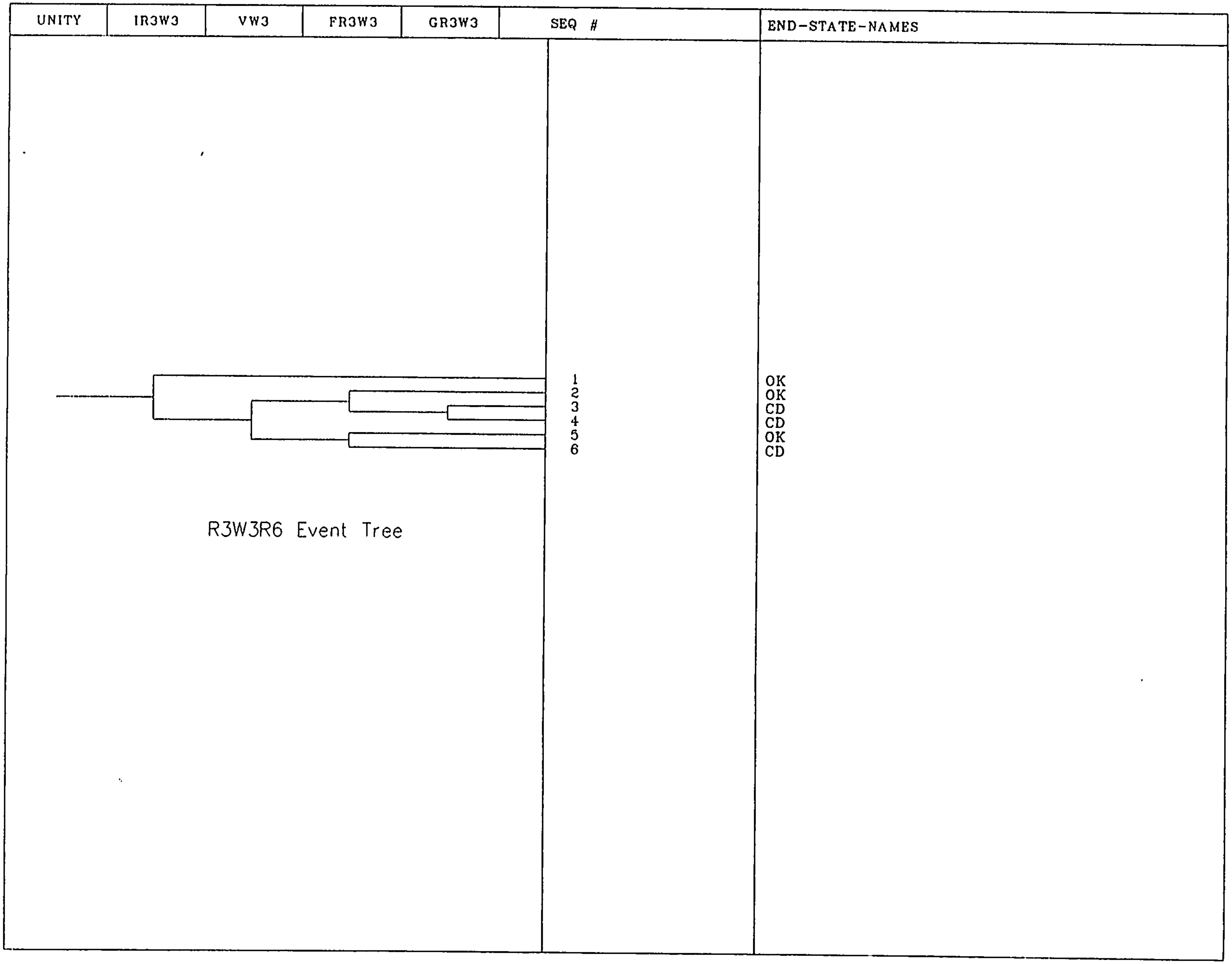


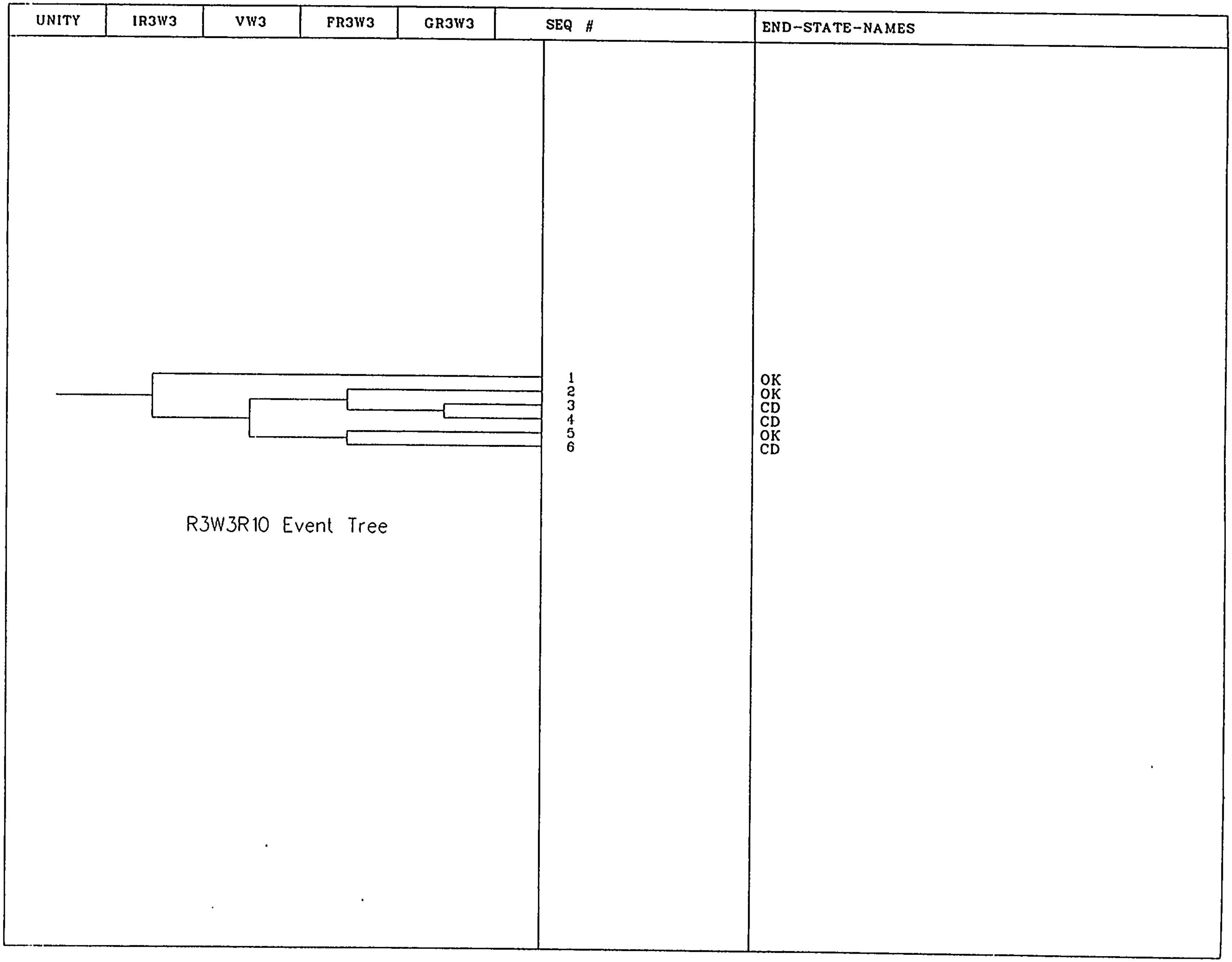
Failure of Recirculation Spray in Window 2-cause HPR failure for RHR3 Event

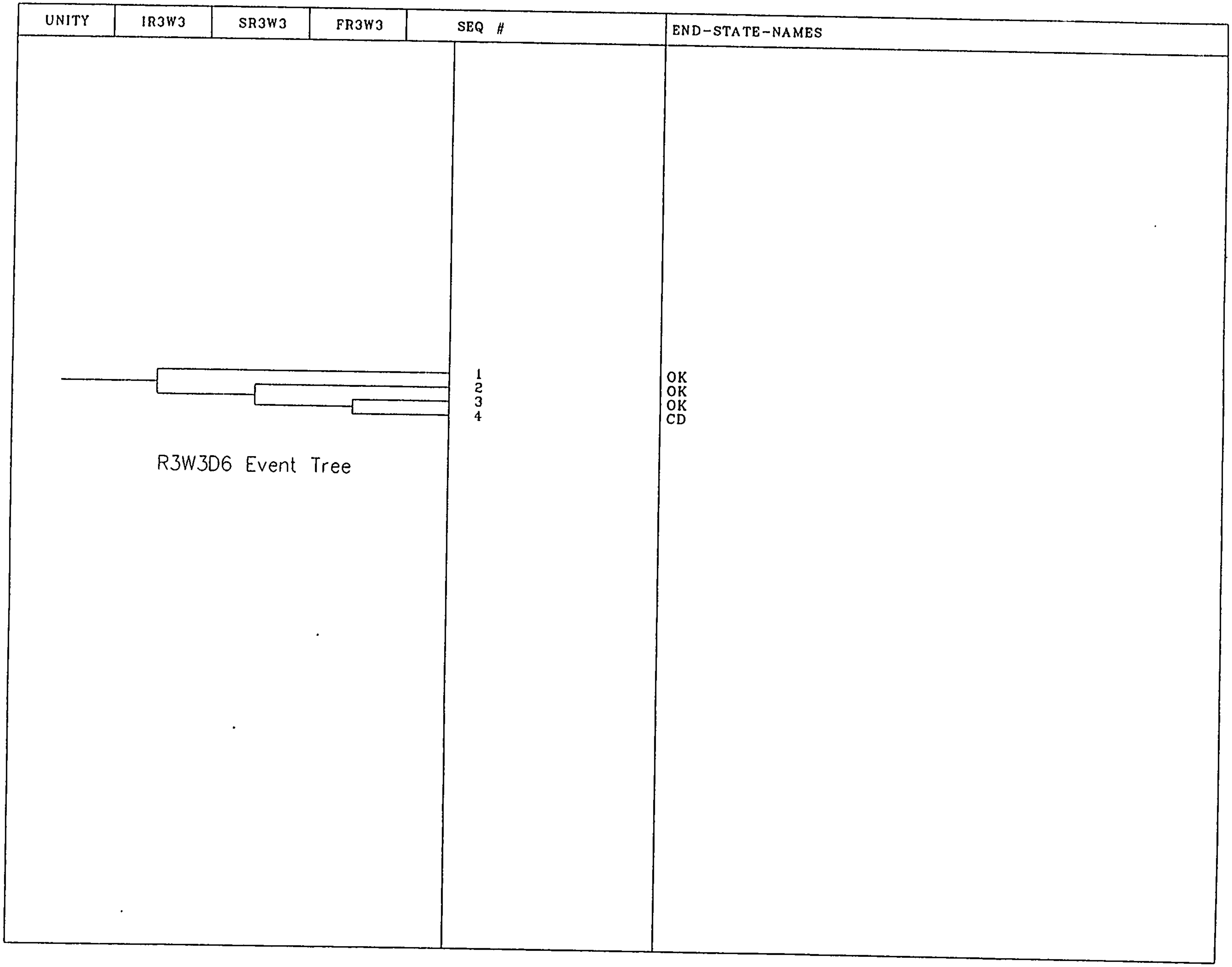


Failure of High Pressure Recirculation in Window 2



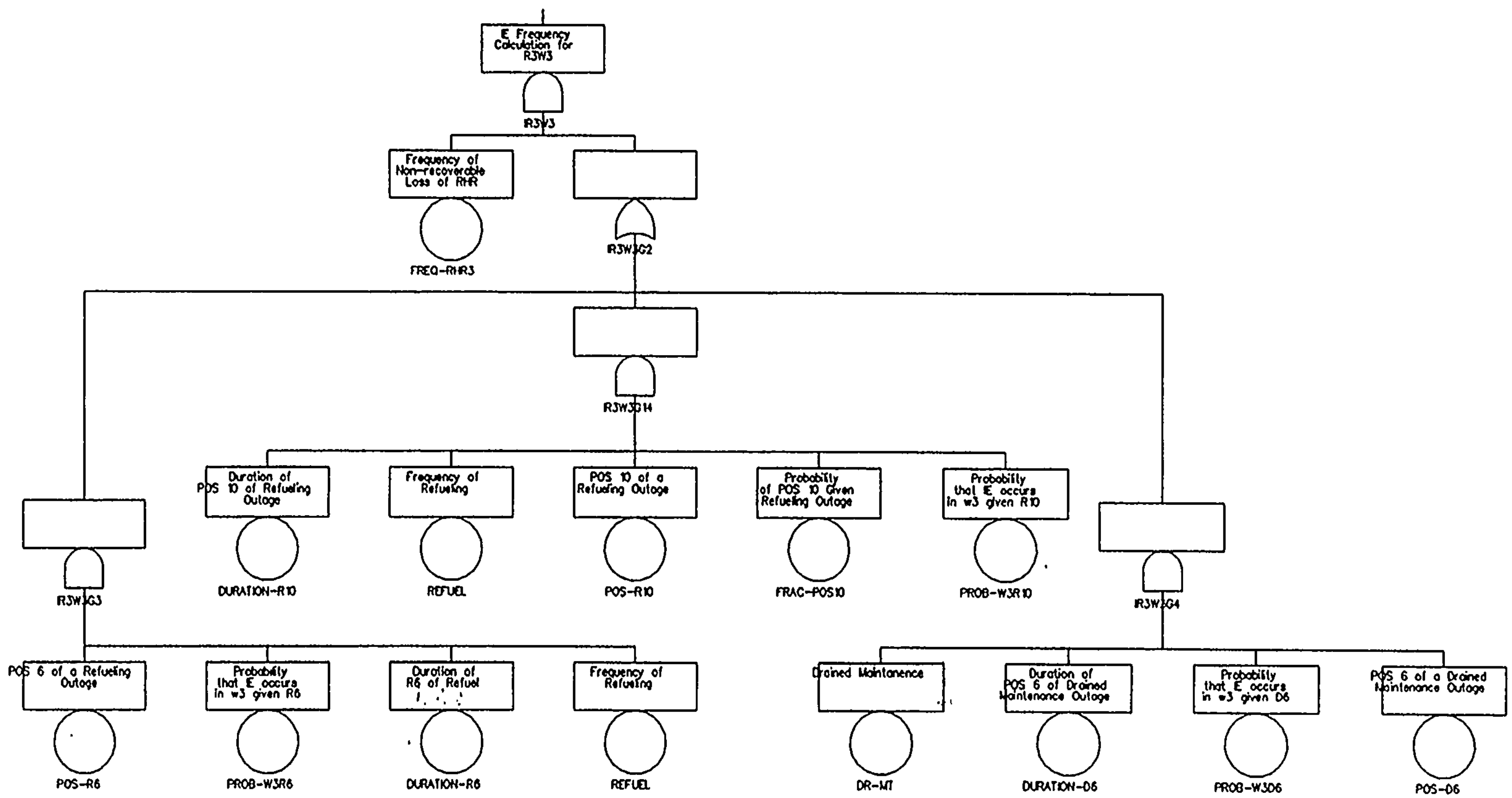

UNITY
IR3W3
VW3
FR3W3
GR3W3
SEQ #
END-STATE-NAMES
1 OK
2 OK
3 CD
4 CD
5 OK
6 CD
R3W3R6 Event Tree


UNITY
IR3W3
VW3
FR3W3
GR3W3
SEQ #
END-STATE-NAMES
1
2
3
4
5
6
OK
OK
CD
CD
OK
CD
R3W3R10 Event Tree

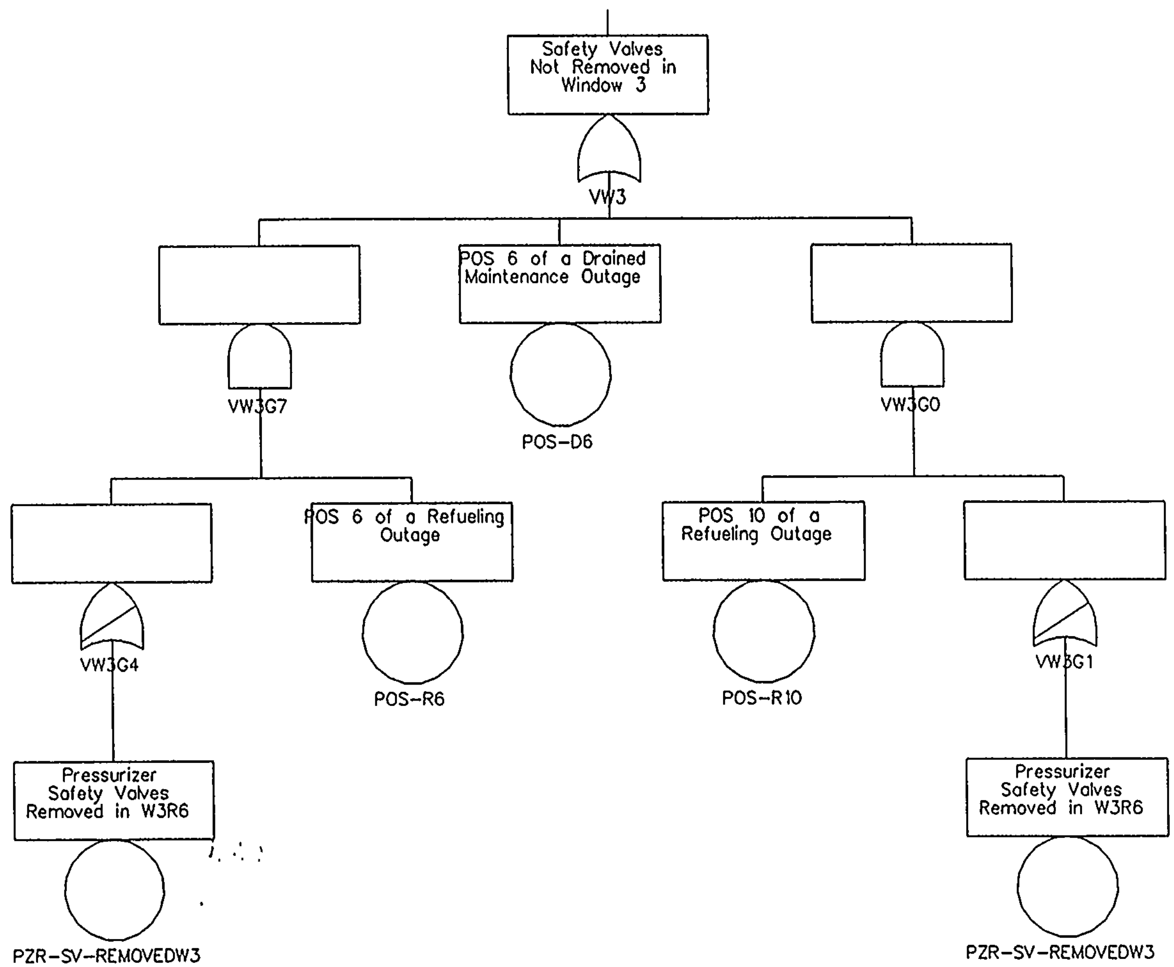


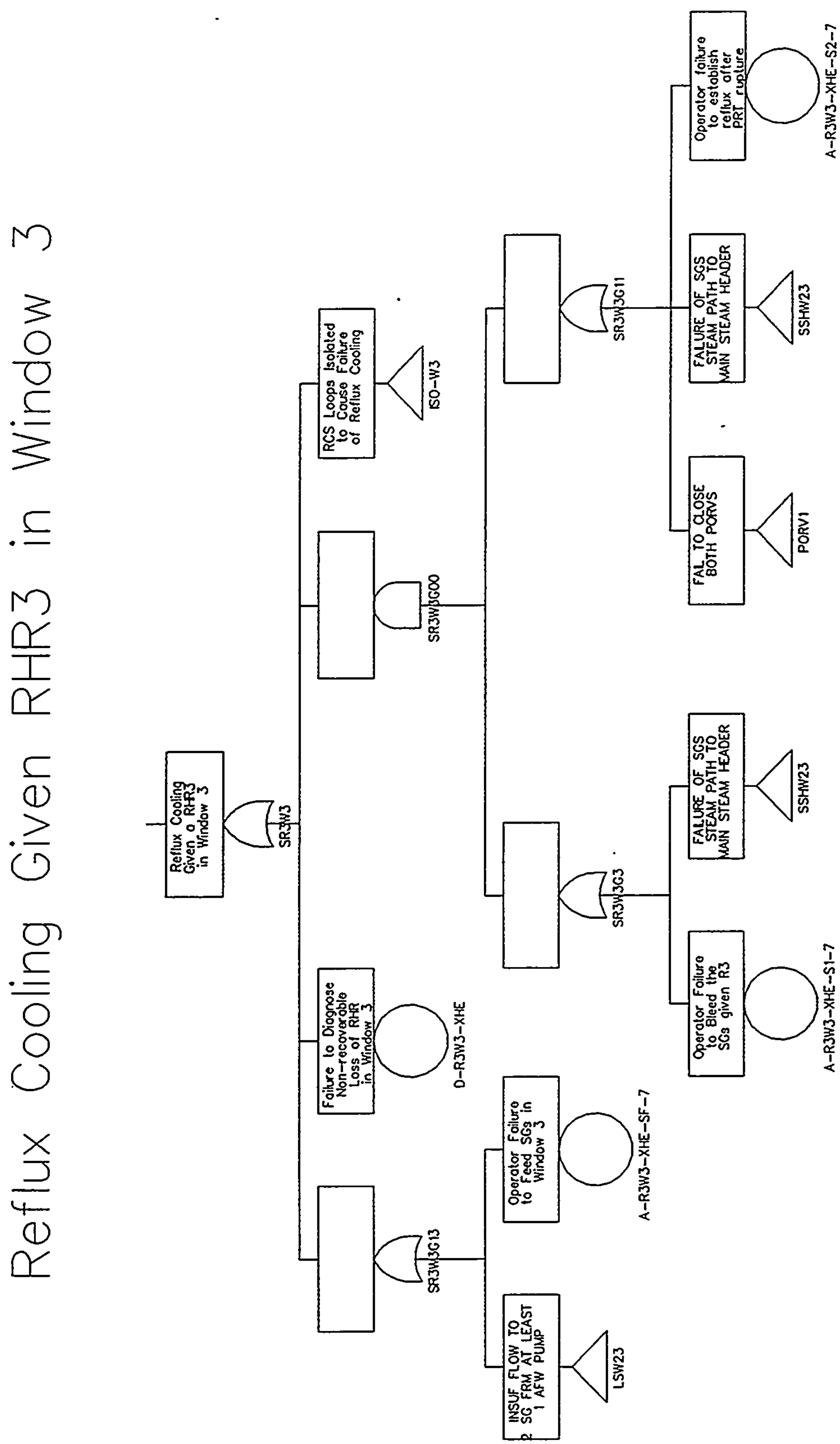
R3W3D6 Event Tree

I Top Event for Loss of RHR– R3 in Window 3

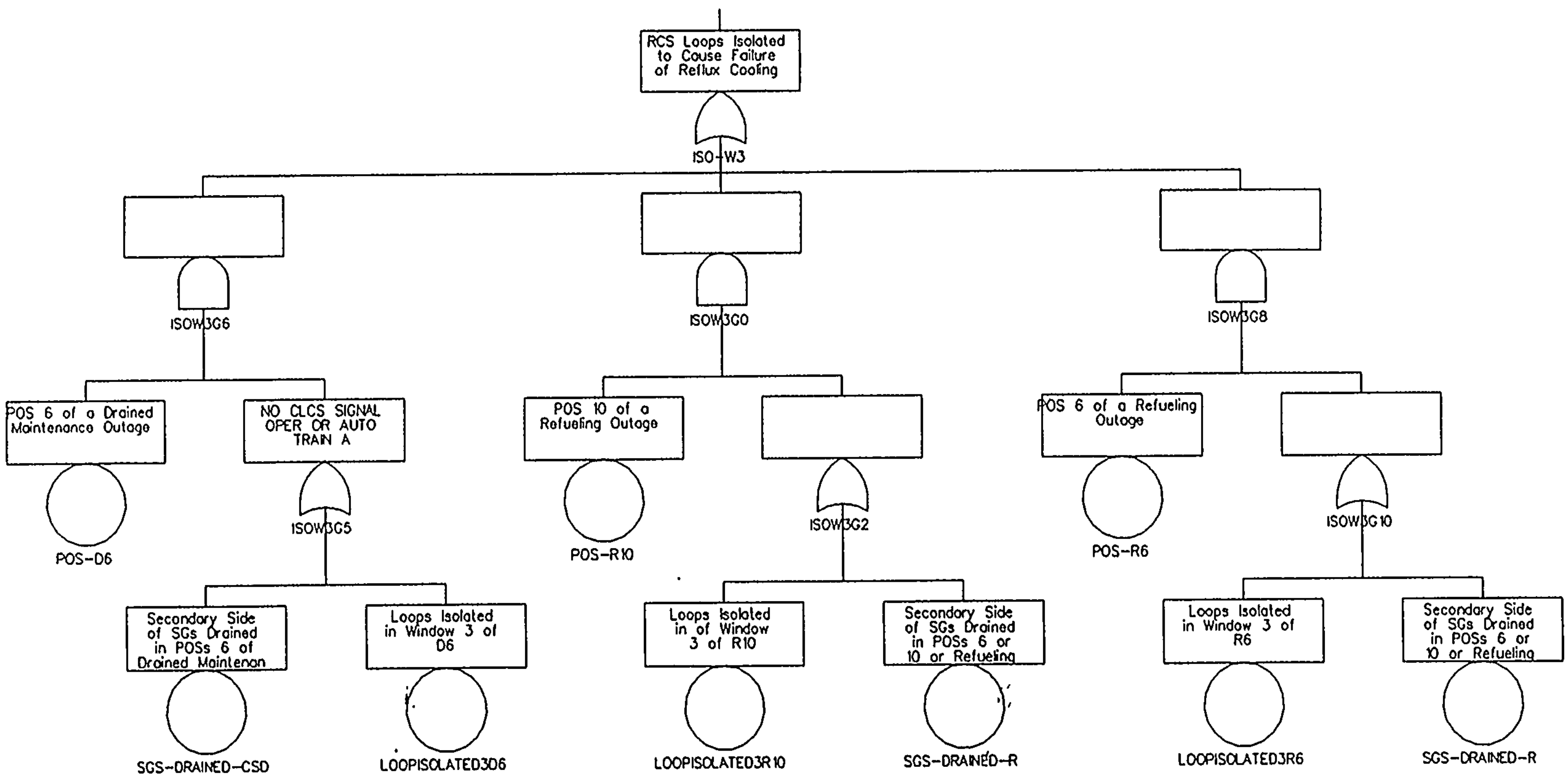


Safety Valves Not Removed in Window 3

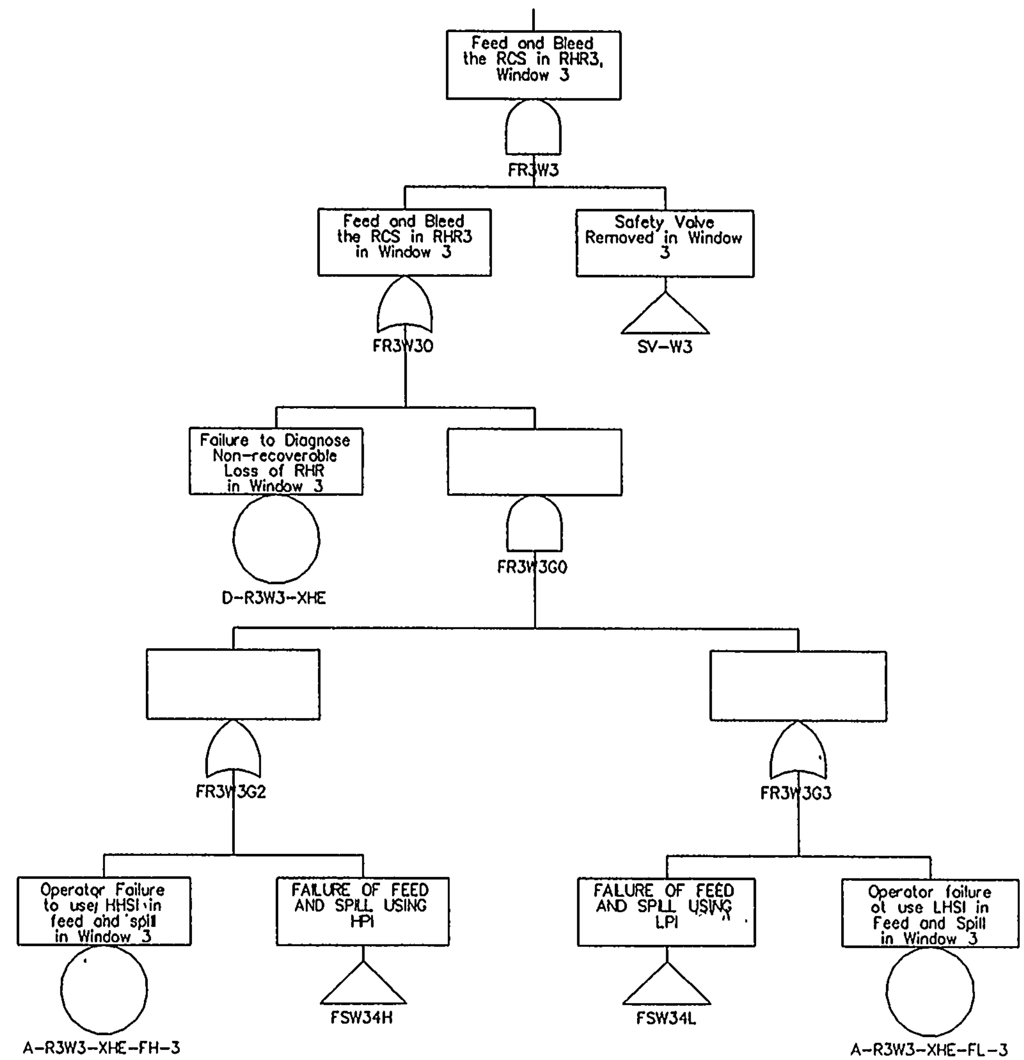



Reflux Cooling Given RHR3 in Window 3
Reflux Cooling Given a RHR3 in Window 3
SR3W3
SR3W3G13
Failure to Diagnose Non-recoverable Loss of RHR in Window 3
D-R3W3-XHE
SR3W3G00
RCS Loops Isolated to Cause Failure of Reflux Cooling
ISO-W3
INSUF FLOW TO SG FRM AT LEAST 1 AFW PUMP
LSW23
Operator Failure to Feed SGs in Window 3
A-R3W3-XHE-SF-7
SR3W3G3
SR3W3G11
Operator Failure to Bleed the SGs given R3
A-R3W3-XHE-S1-7
FALURE OF SGS STEAM PATH TO MAIN STEAM HEADER
SSHW23
FAL TO CLOSE BOTH PORVS
PORV1
FALURE OF SGS STEAM PATH TO MAIN STEAM HEADER
SSHW23
Operator failure to establish reflux after PRT rupture
A-R3W3-XHE-S2-7

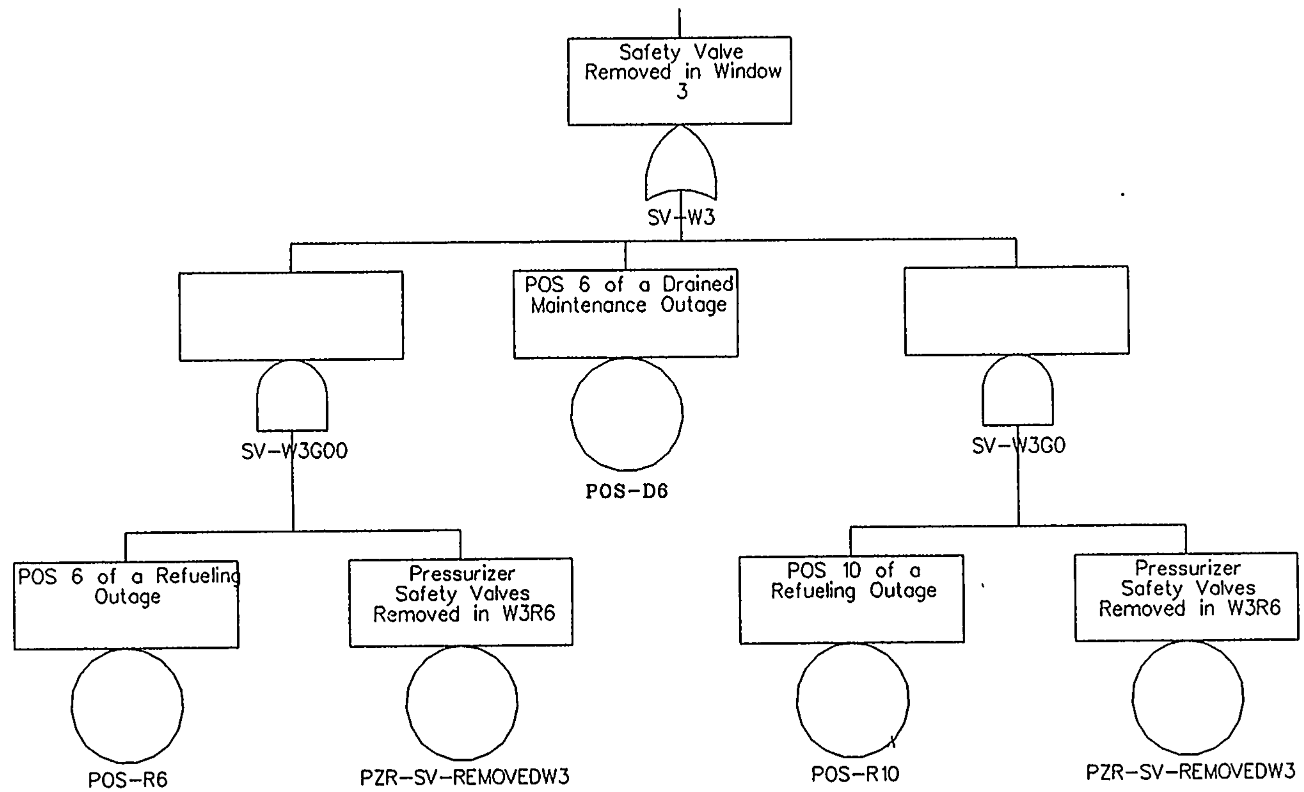
RCS Loops Isolated to Cause Failure of Reflux in Window 3



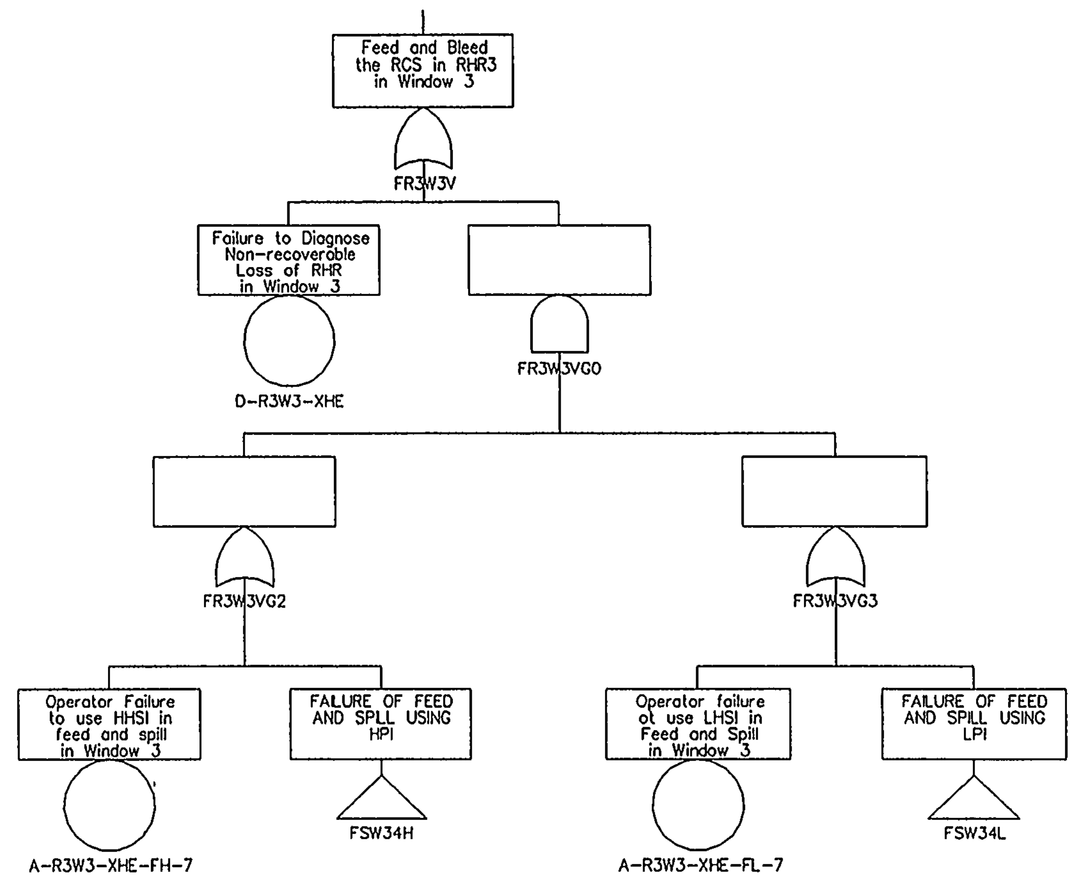
Feed and Bleed the RCS in RHR3, Window 3



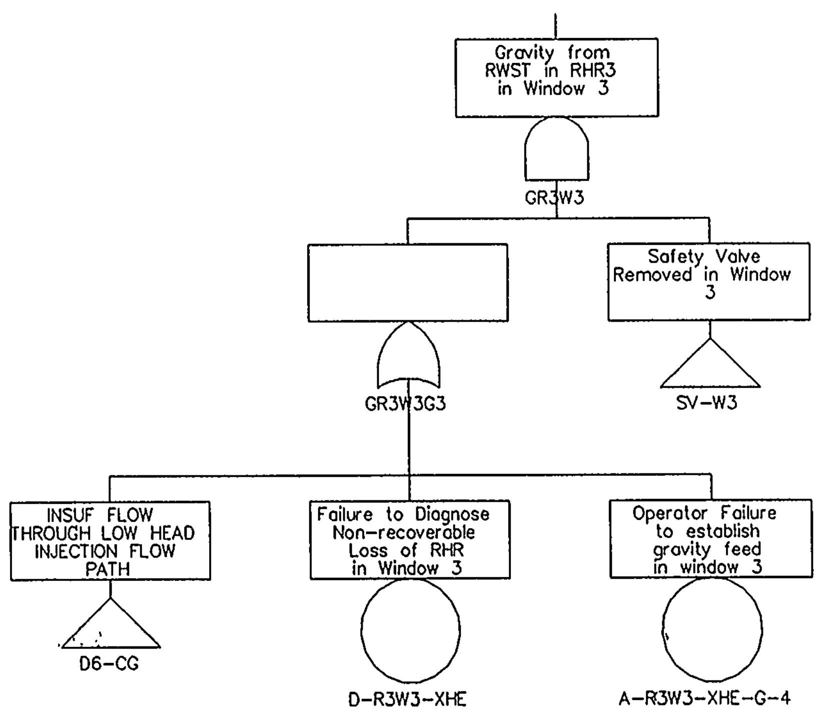
Safety Valves Removed in Window 3

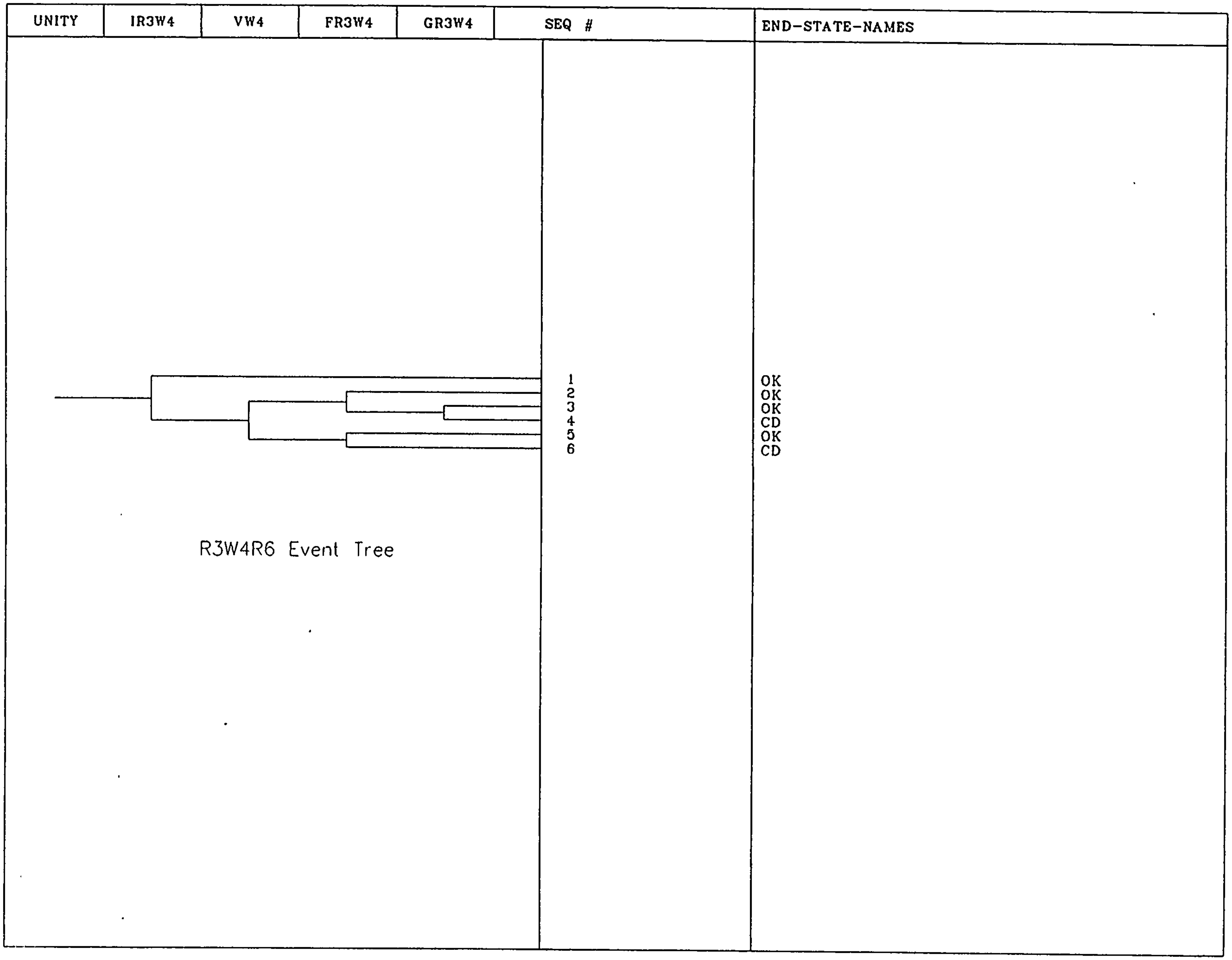


Feed and Bleed the RCS with V failed in RHR3, Window 3

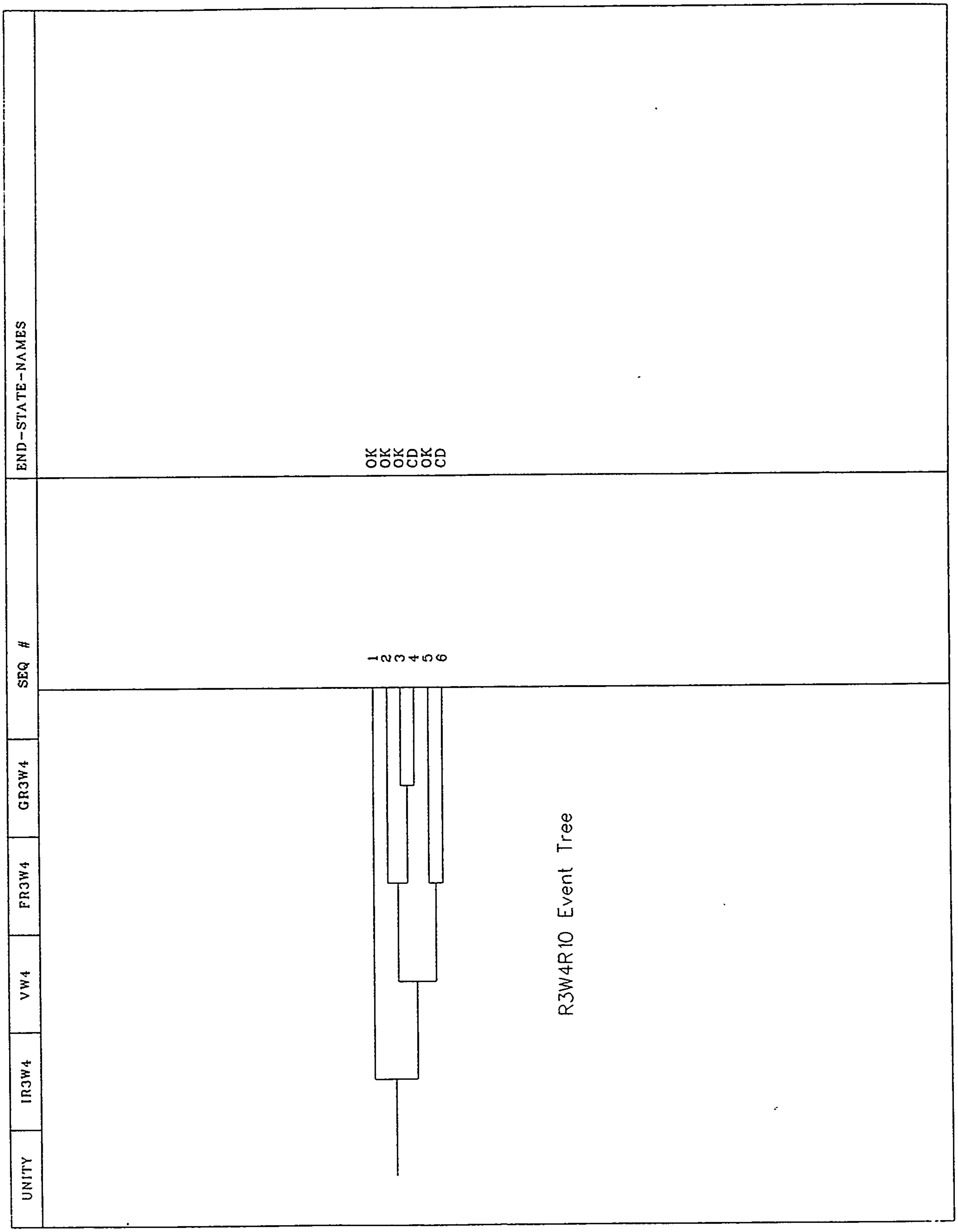


Gravity from RWST in RHR3, Window 3

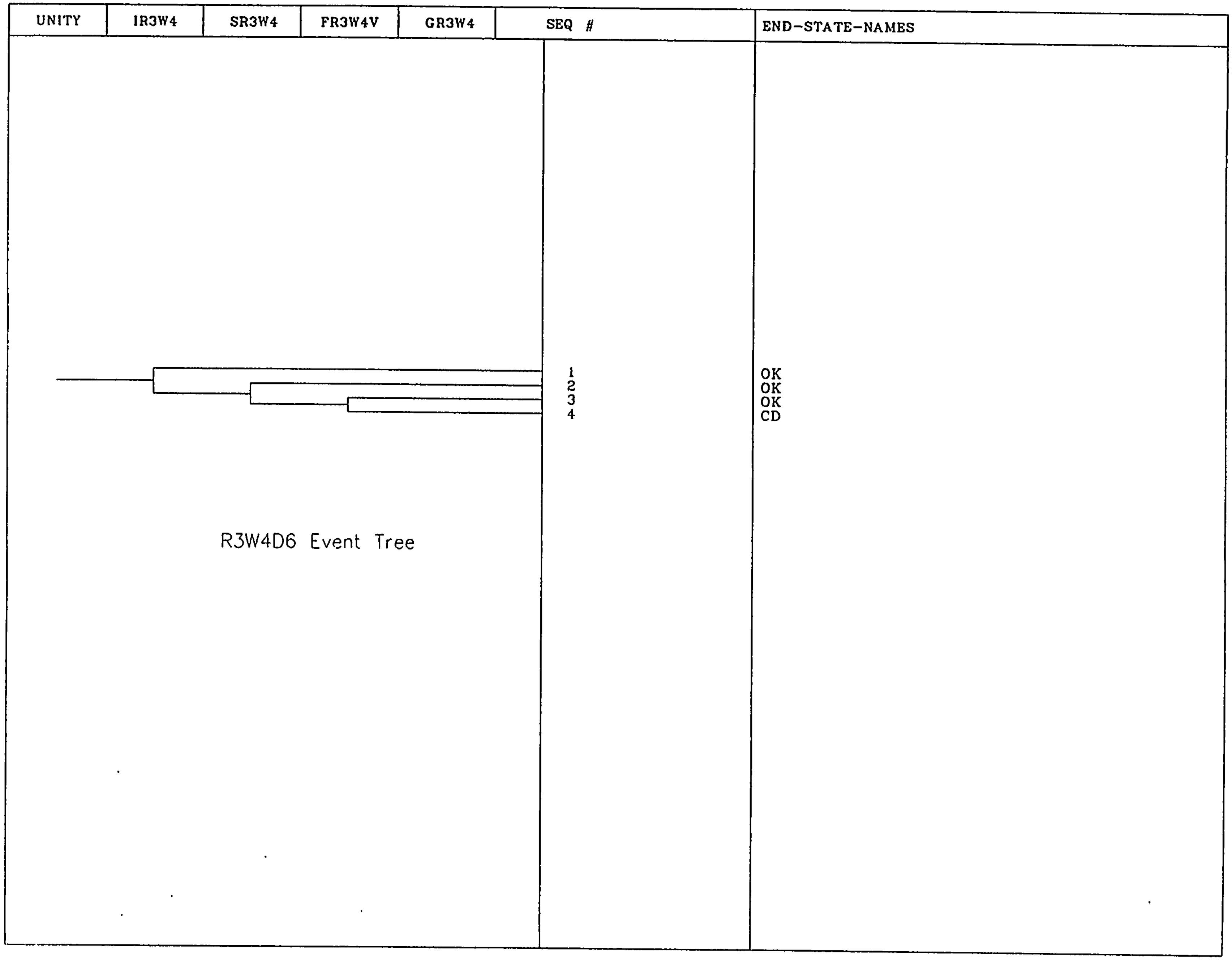




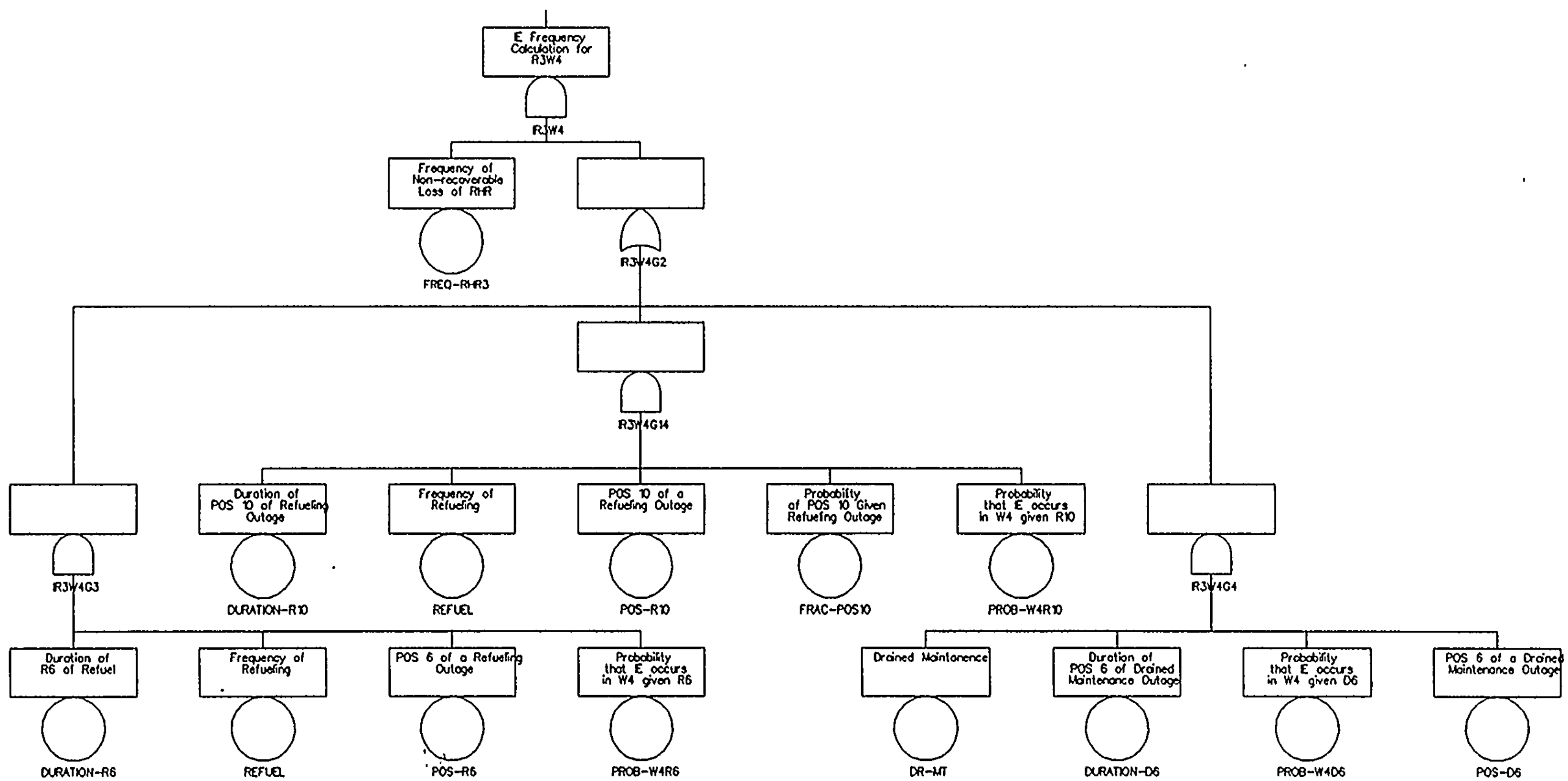
UNITY
IR3W4
VW4
FR3W4
GR3W4
SEQ #
END-STATE-NAMES
1
2
3
4
5
6
OK
OK
OK
CD
OK
CD
R3W4R6 Event Tree



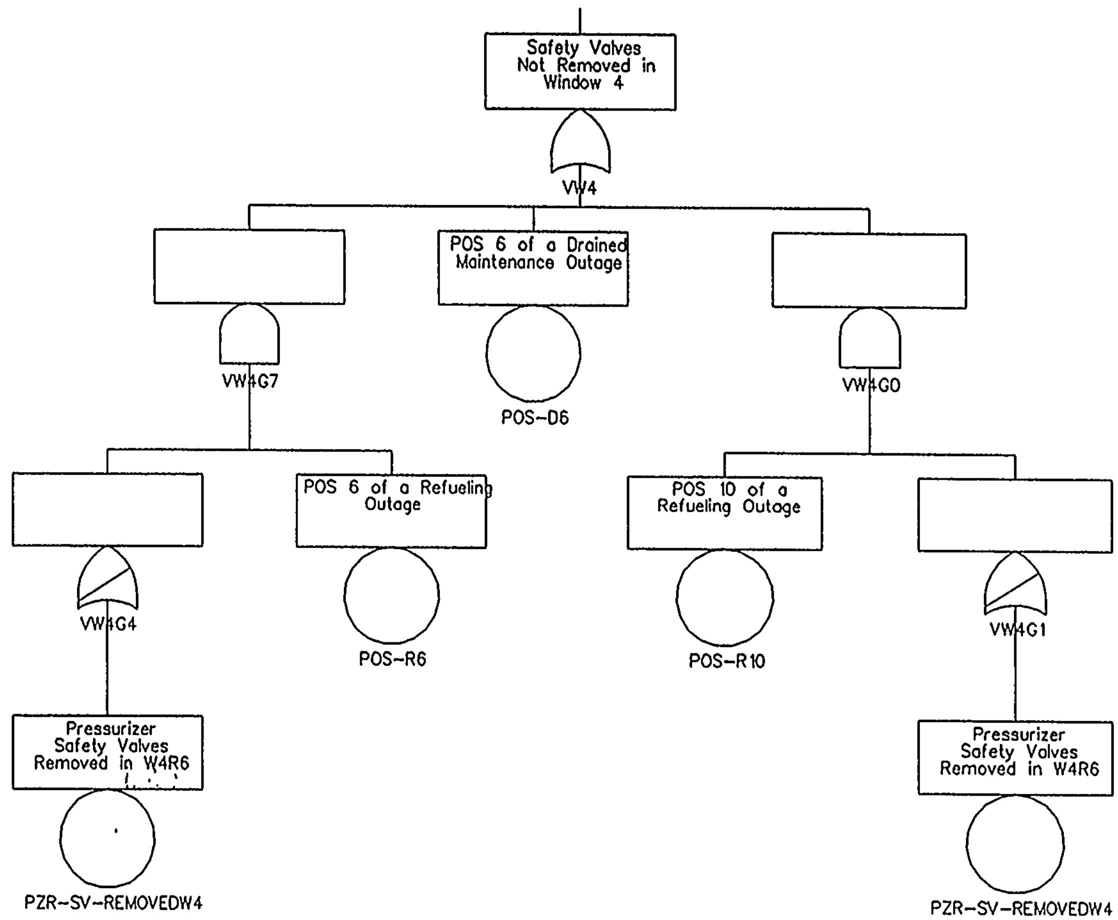
UNITY
IR3W4
VW4
FR3W4
GR3W4
SEQ #
END-STATE-NAMES
1 OK
2 OK
3 OK
4 CD
5 OK
6 CD
R3W4R10 Event Tree


UNITY
IR3W4
SR3W4
FR3W4V
GR3W4
SEQ #
END-STATE-NAMES
1
2
3
4
OK
OK
OK
CD
R3W4D6 Event Tree

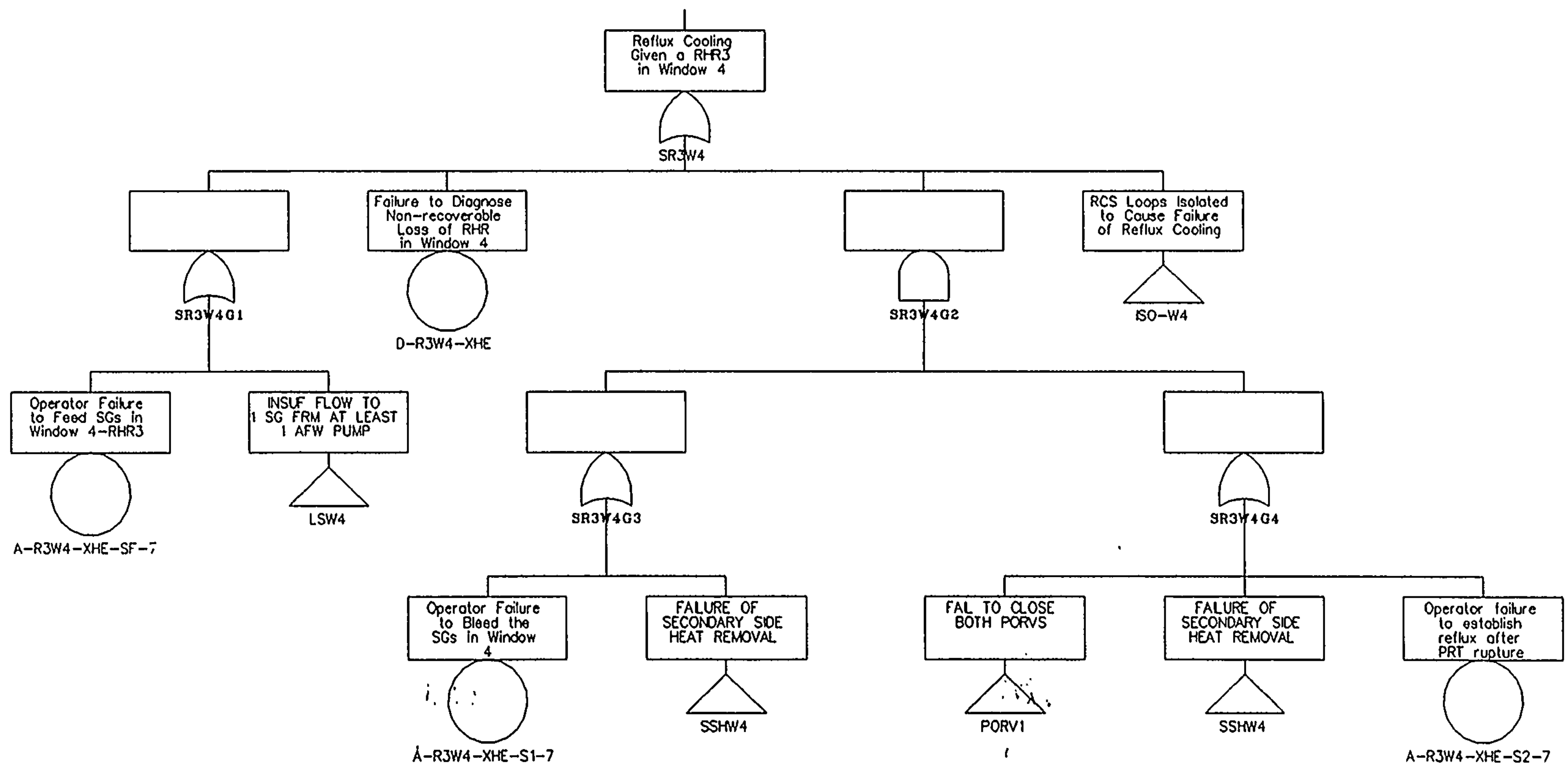
I Top Event for Loss of RHR- R3 in Window 4



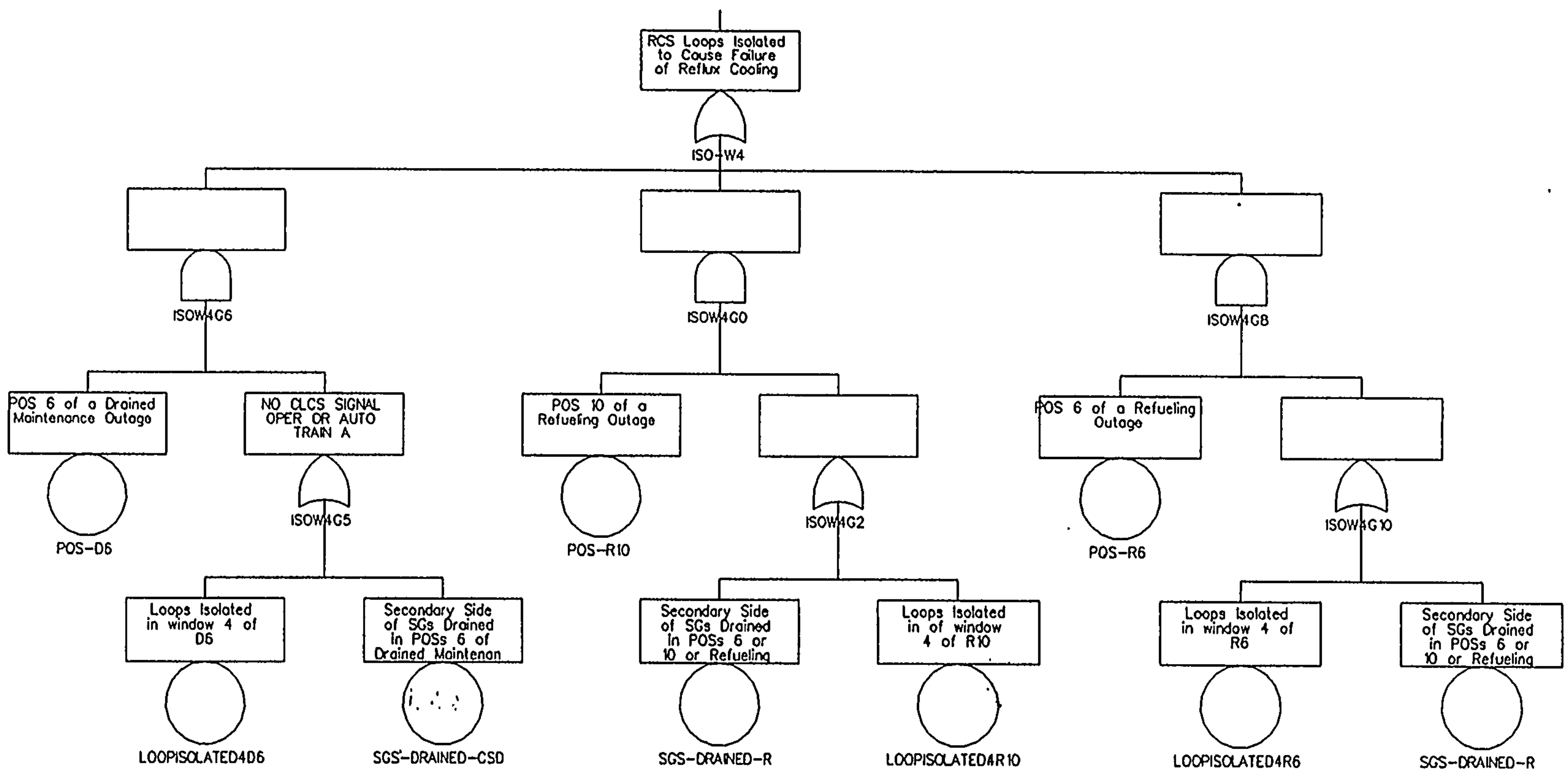
Safety Valves Not Removed in Window 4



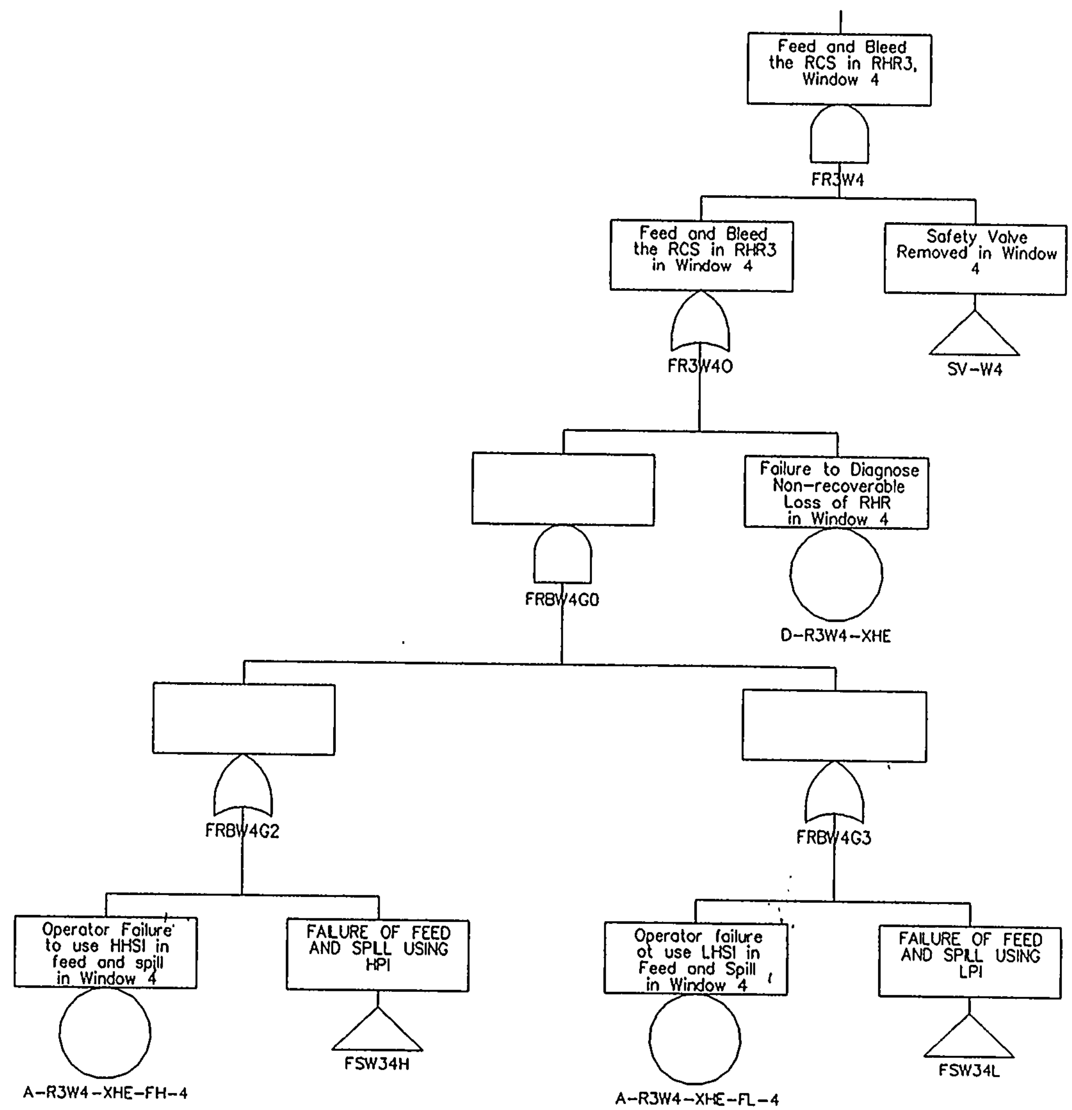
Reflux Cooling Given RHR3 in Window 4



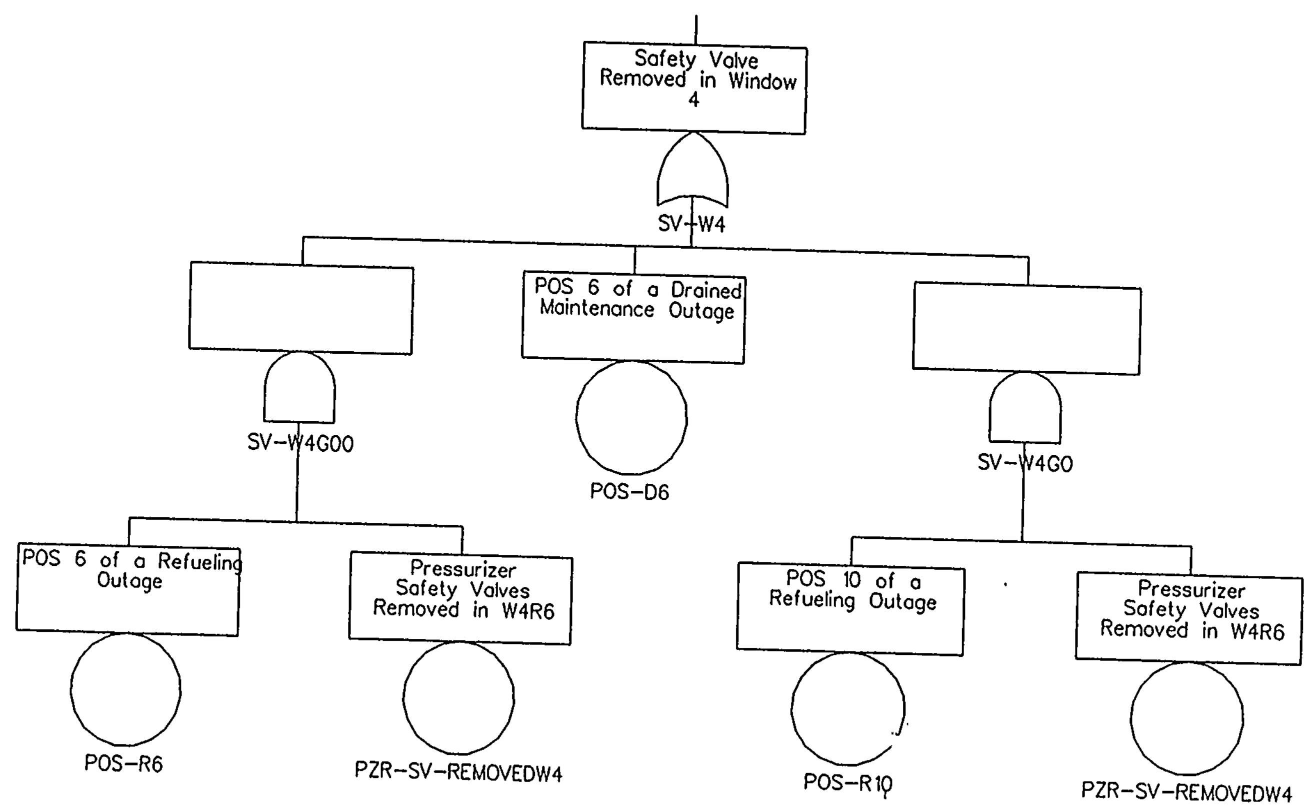
RCS Loops Isolated to Cause Failure of Reflux in Window 4



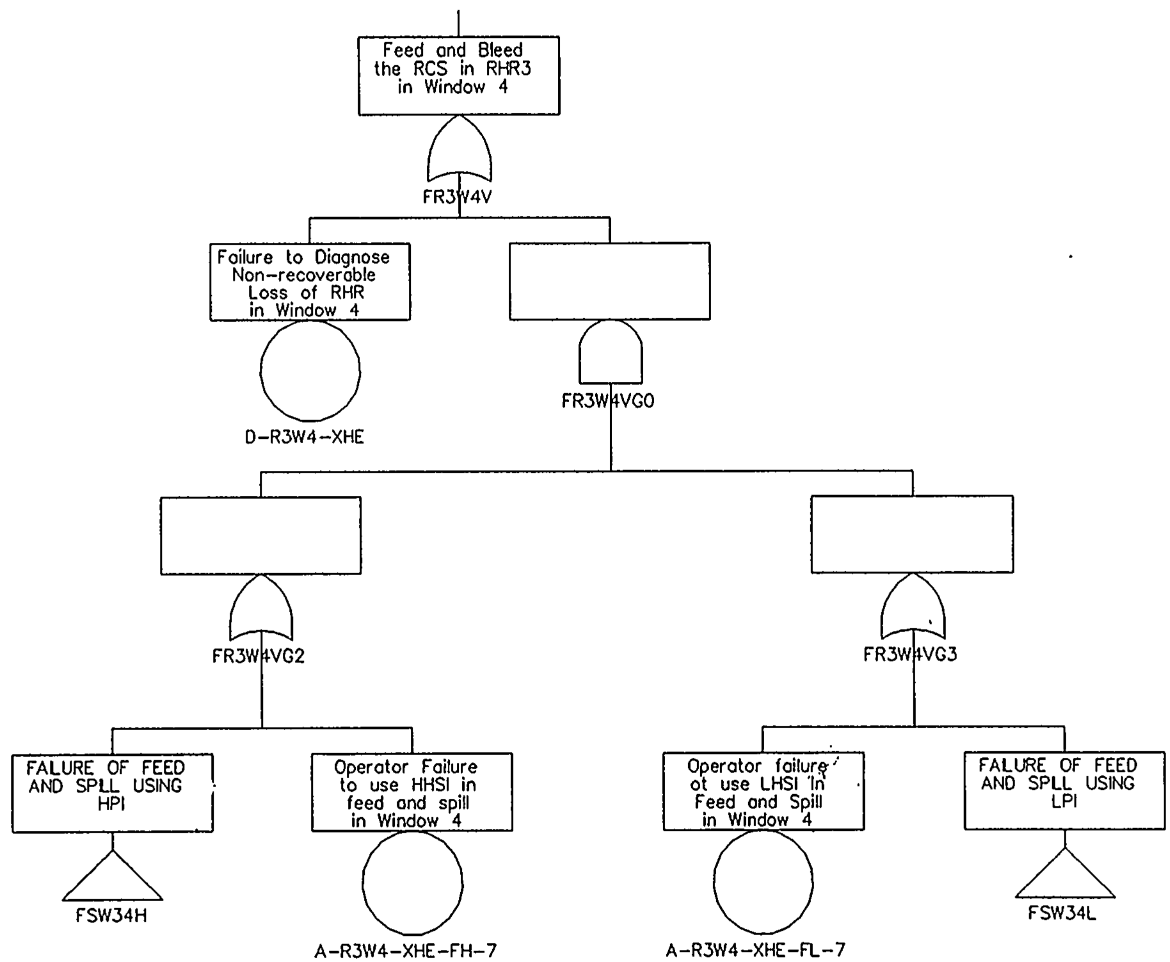
Feed and Bleed the RCS in RHR3, Window 4



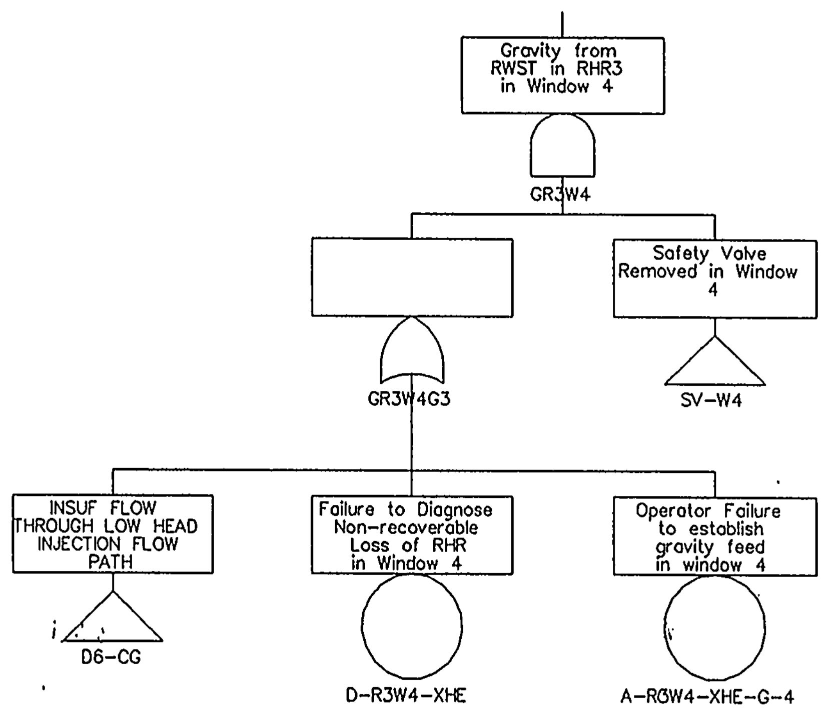
Safety Valves Removed in Window 4



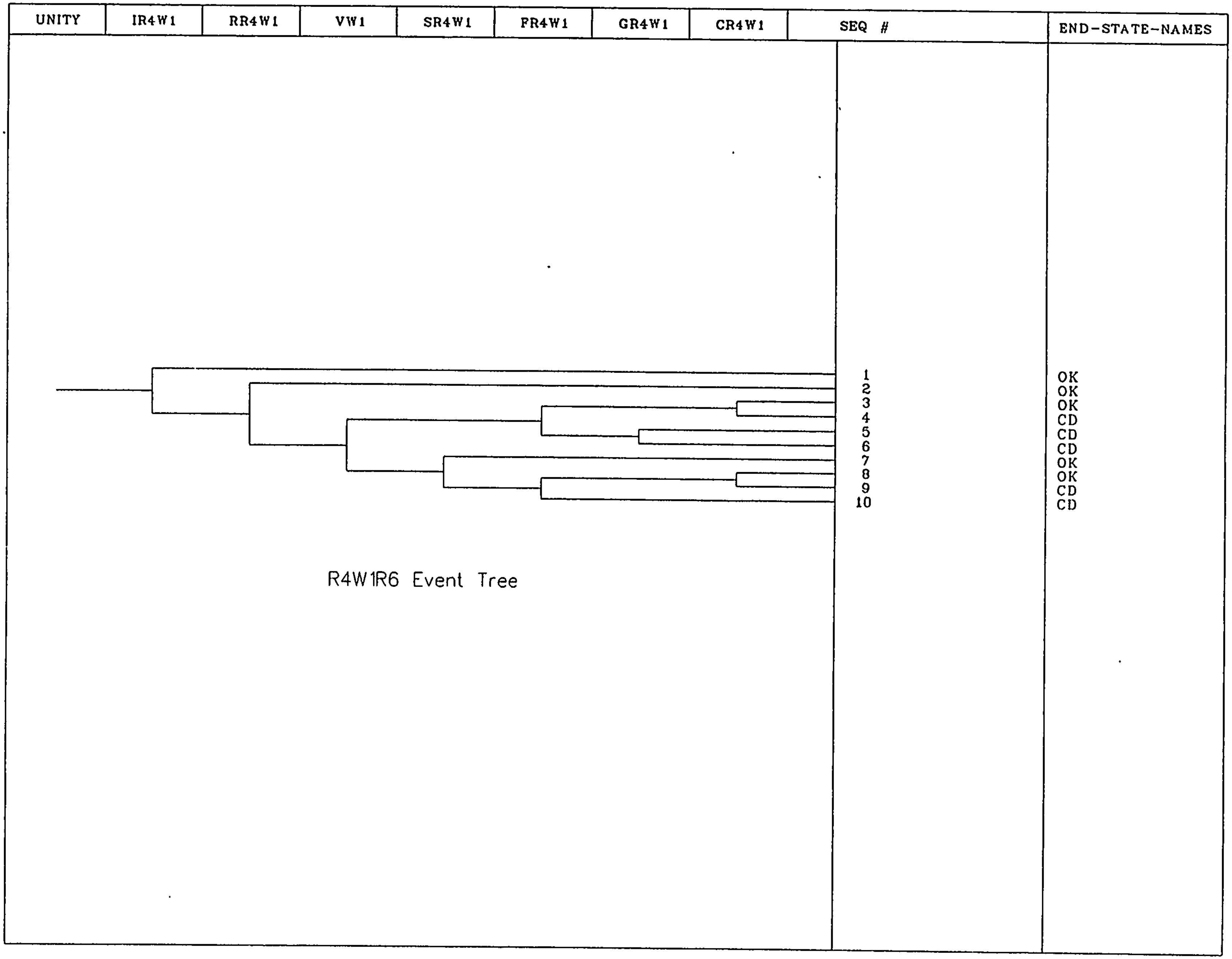
Feed and Bleed the RCS with V failed in RHR3, Window 4

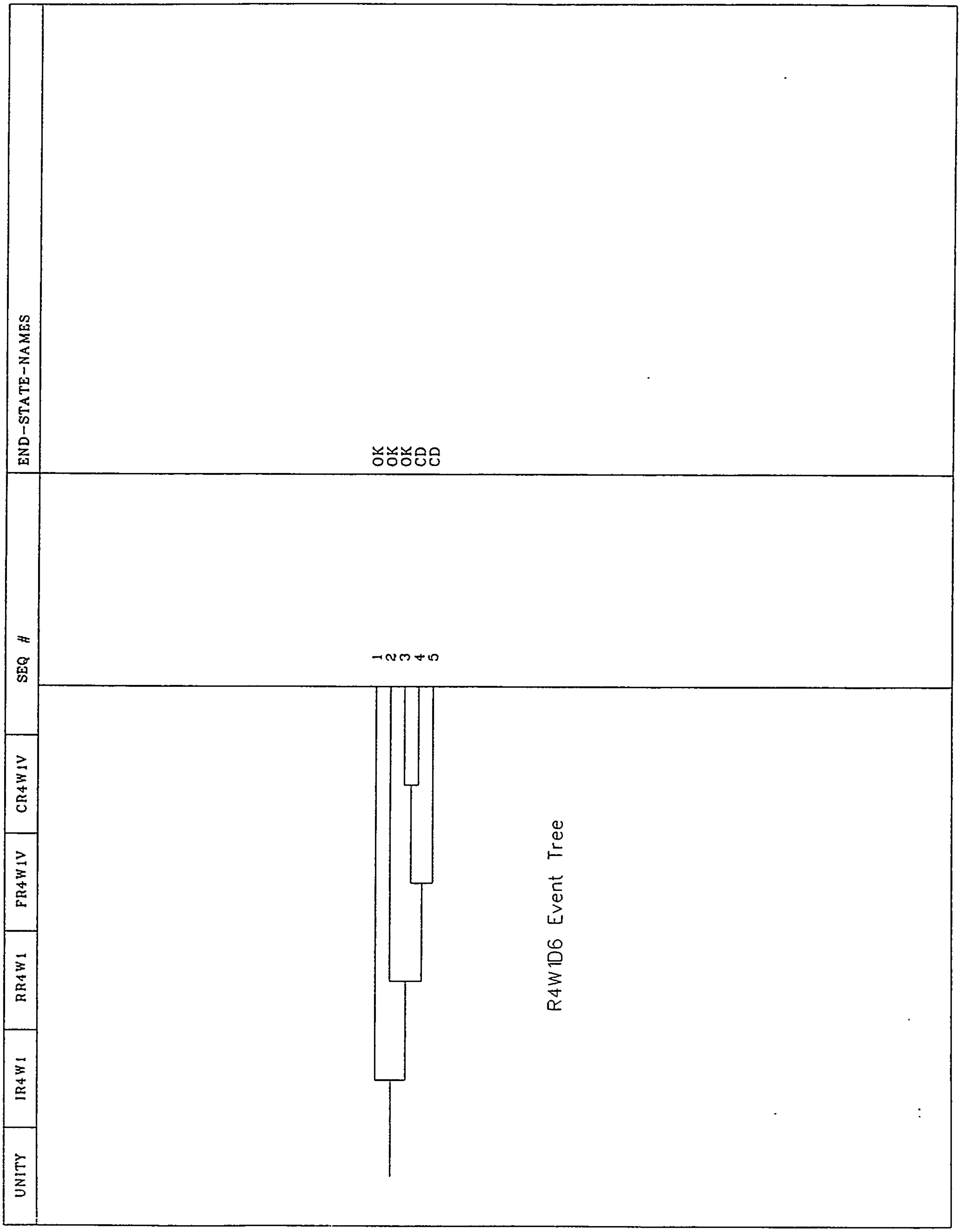


Gravity from RWST in RHR3, Window 4



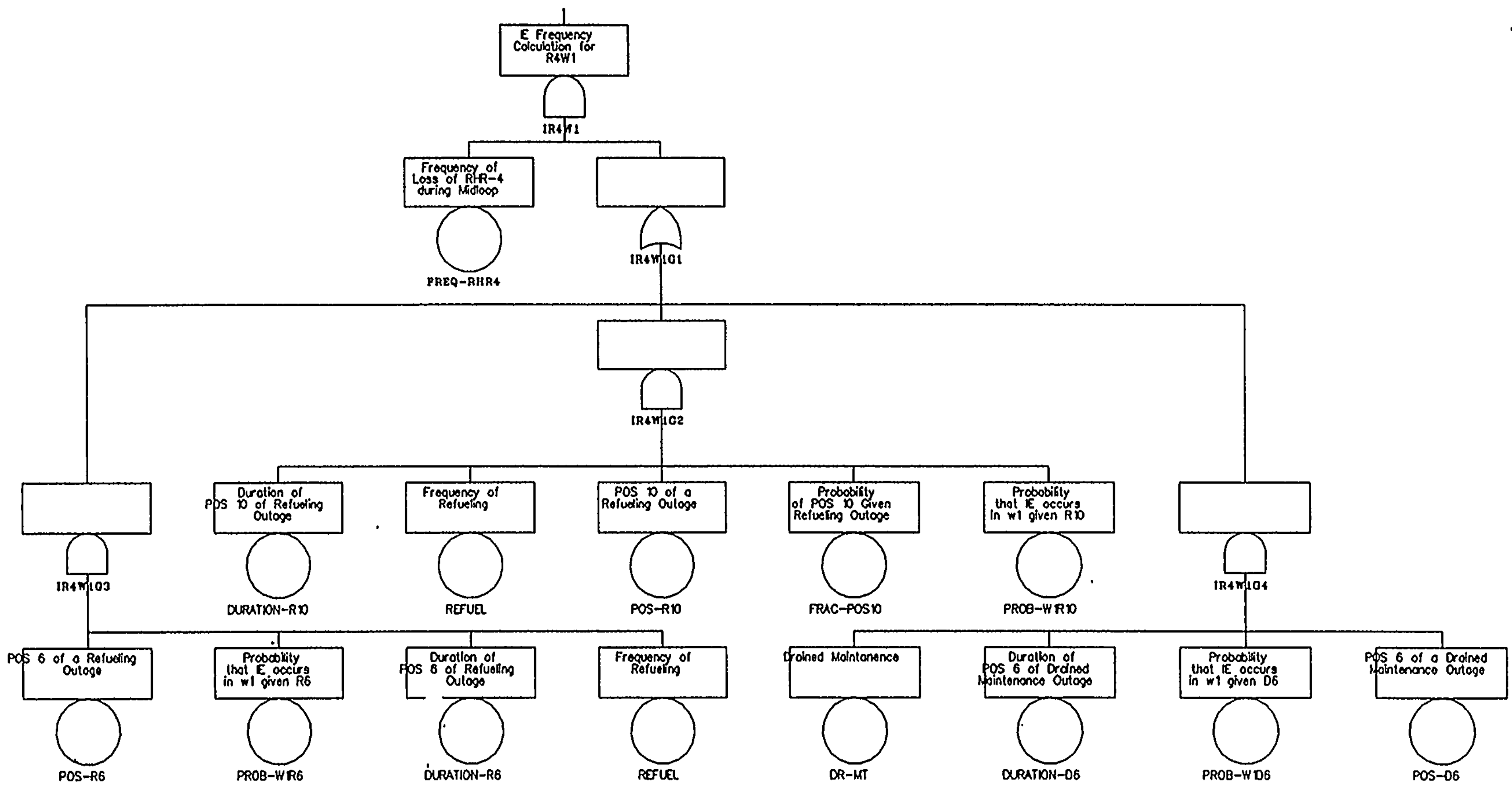
Appendix E.4 Event Trees and High Level Fault Trees for Loss of Operation Train of RHR(RHR4)


UNITY
IR4W1
RR4W1
VW1
SR4W1
FR4W1
GR4W1
CR4W1
SEQ #
END-STATE-NAMES
1 OK
2 OK
3 OK
4 CD
5 CD
6 CD
7 OK
8 OK
9 CD
10 CD
R4W1R6 Event Tree

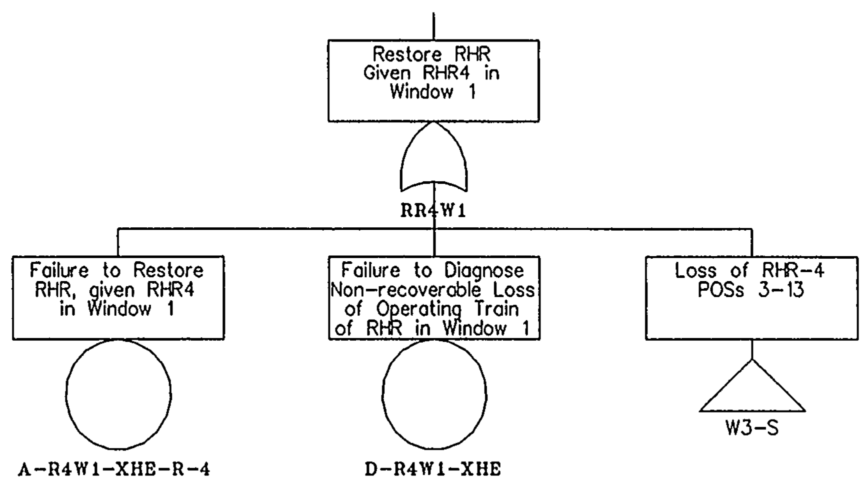


UNITY
IR4W1
RR4W1
FR4W1V
CR4W1V
SEQ #
END-STATE-NAMES
1 OK
2 OK
3 OK
4 CD
5 CD
R4W1D6 Event Tree

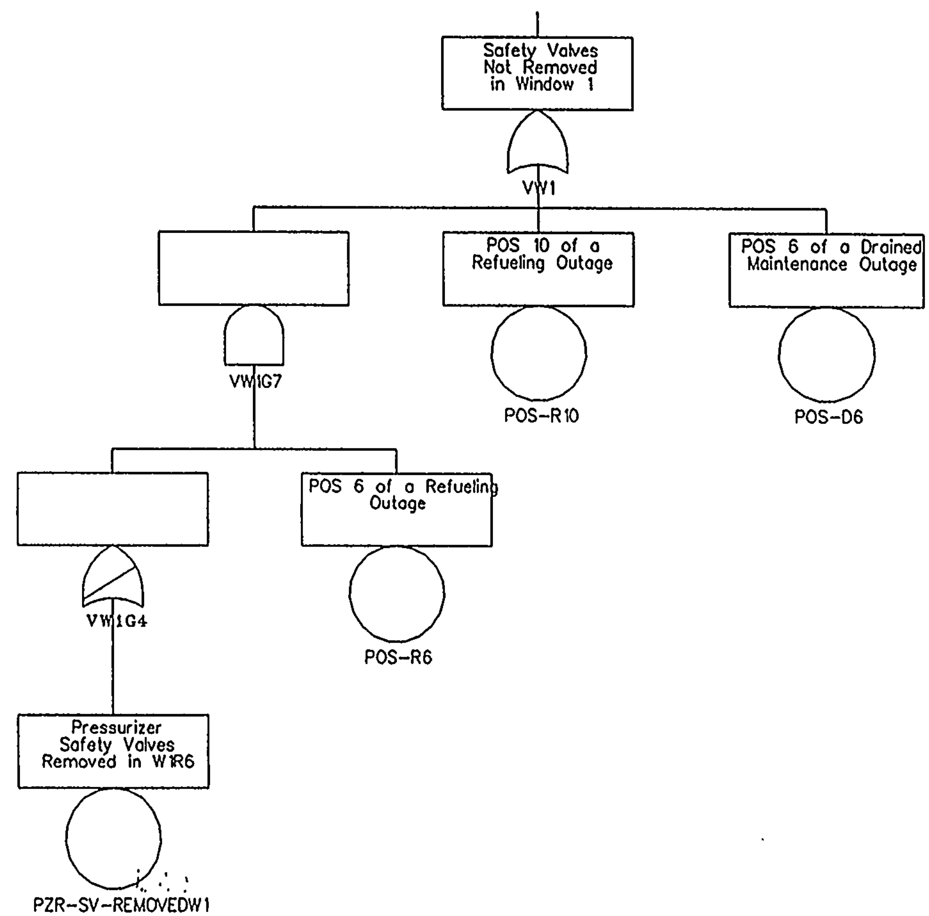
I top event for loss of RHR- R4 in Window 1



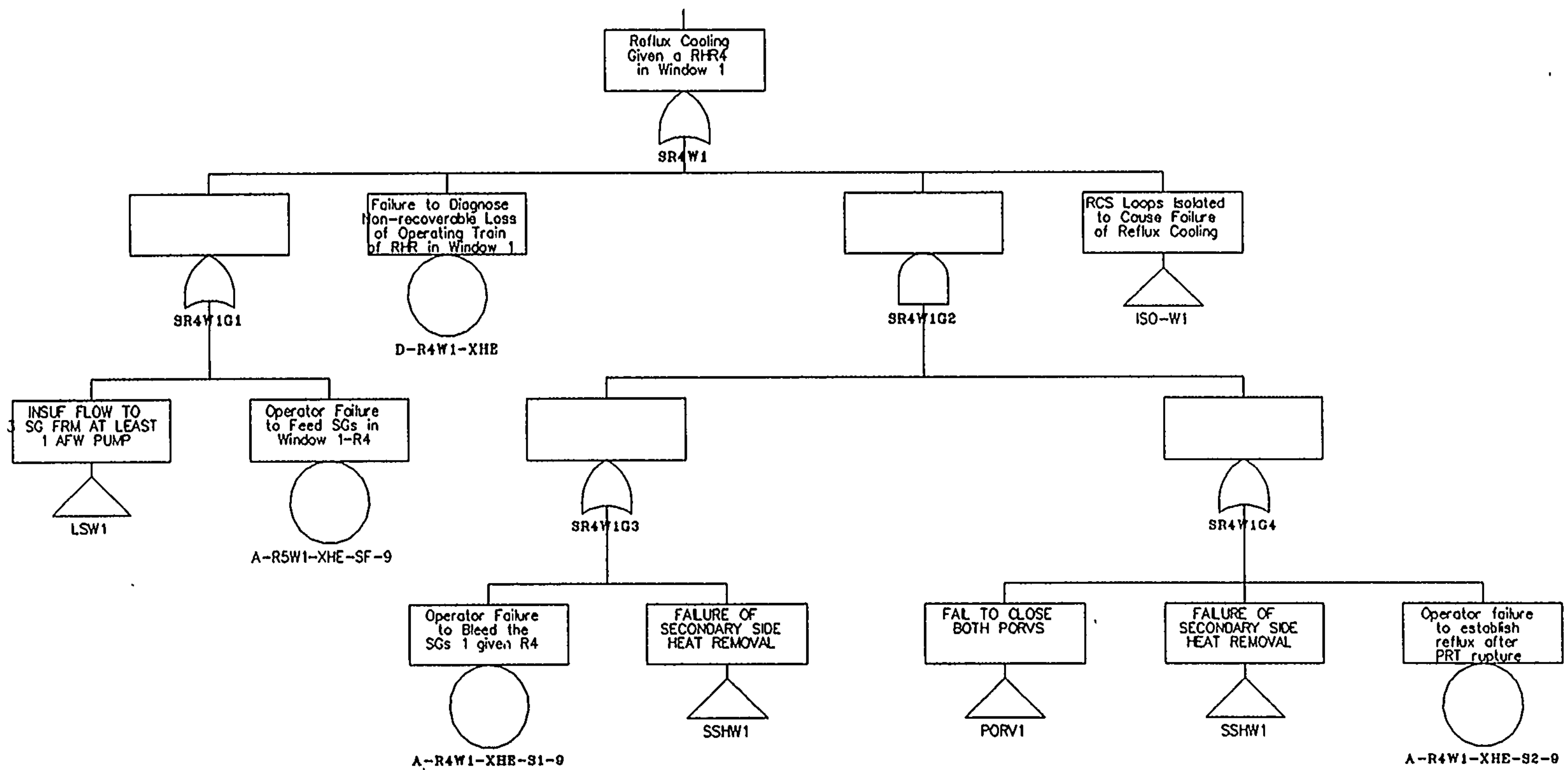
Restore RHR given RHR4 in Window 1



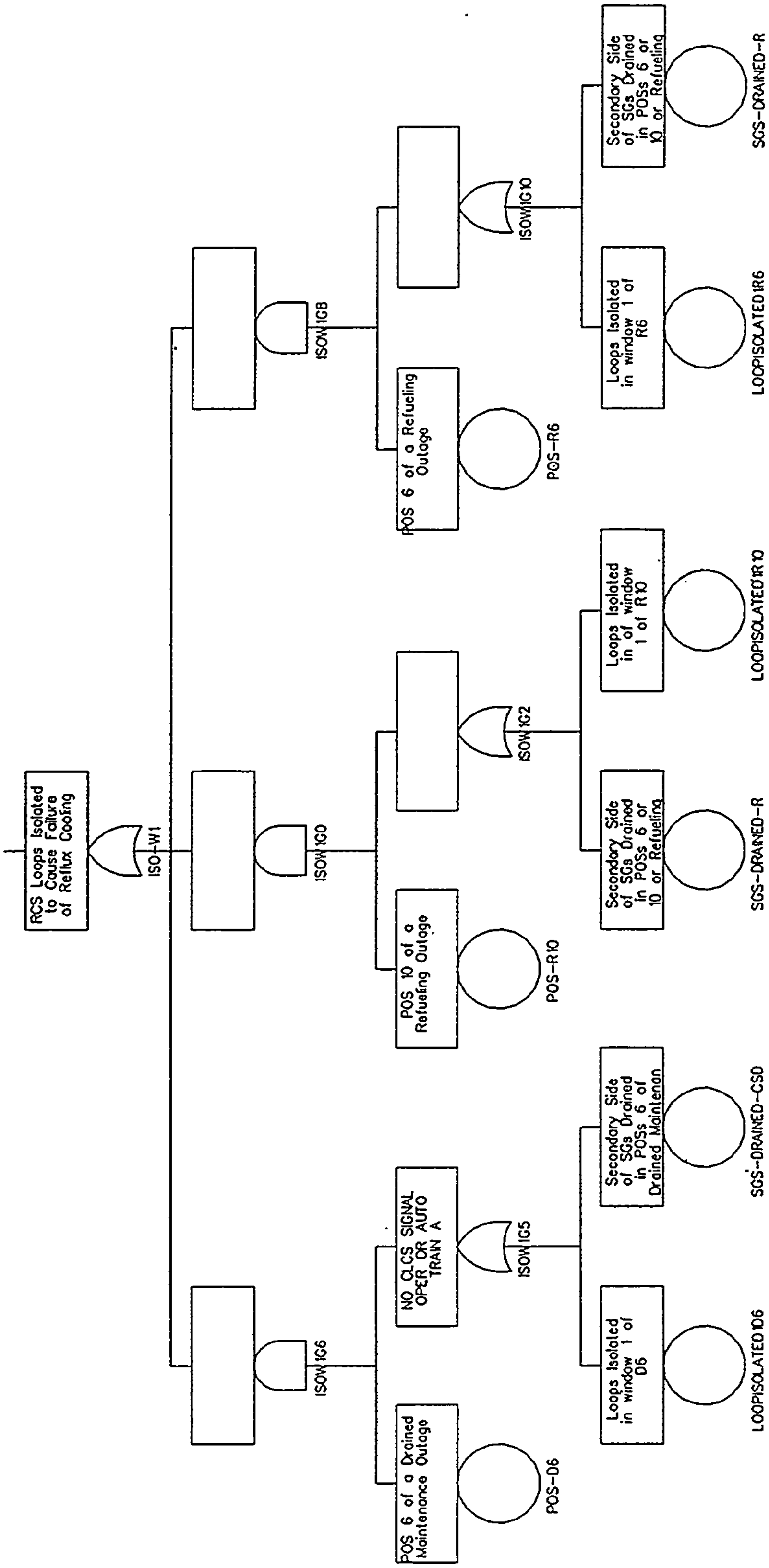
Safety Valves Not Removed in Window 1



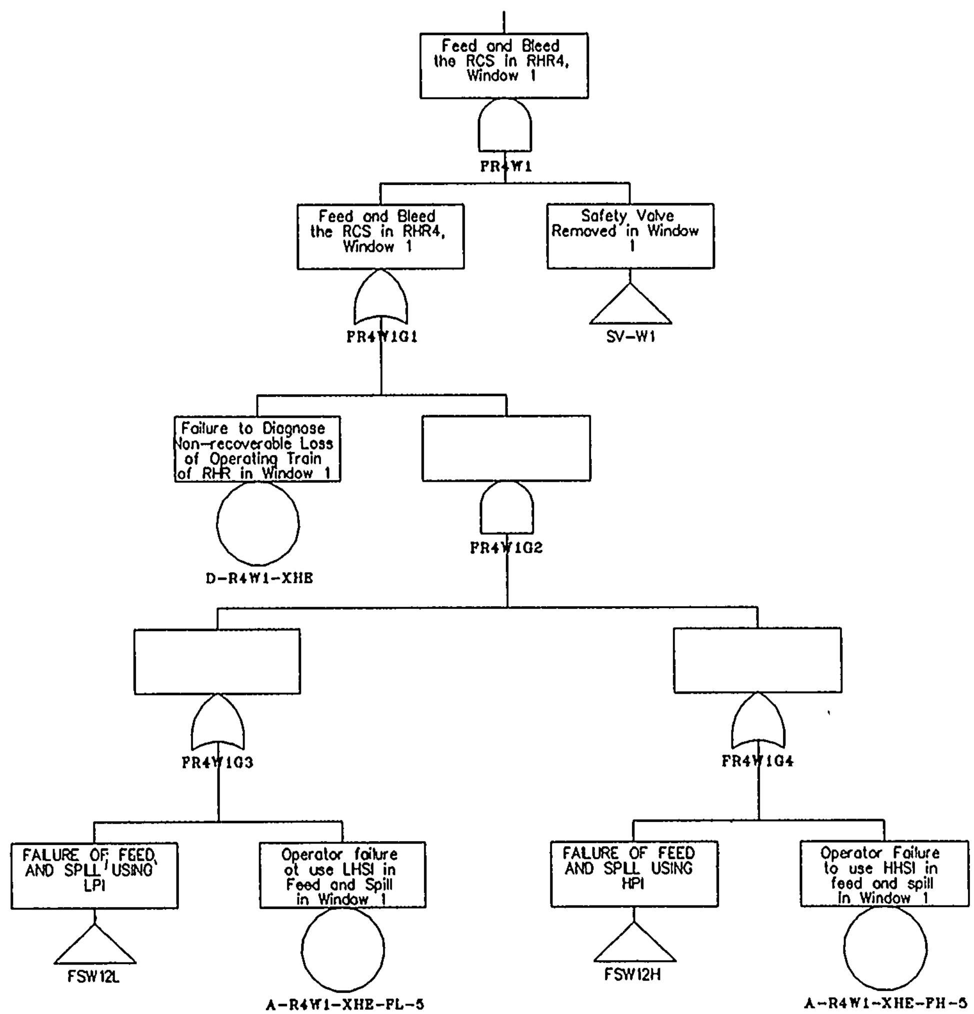
Reflux Cooling in Window 1



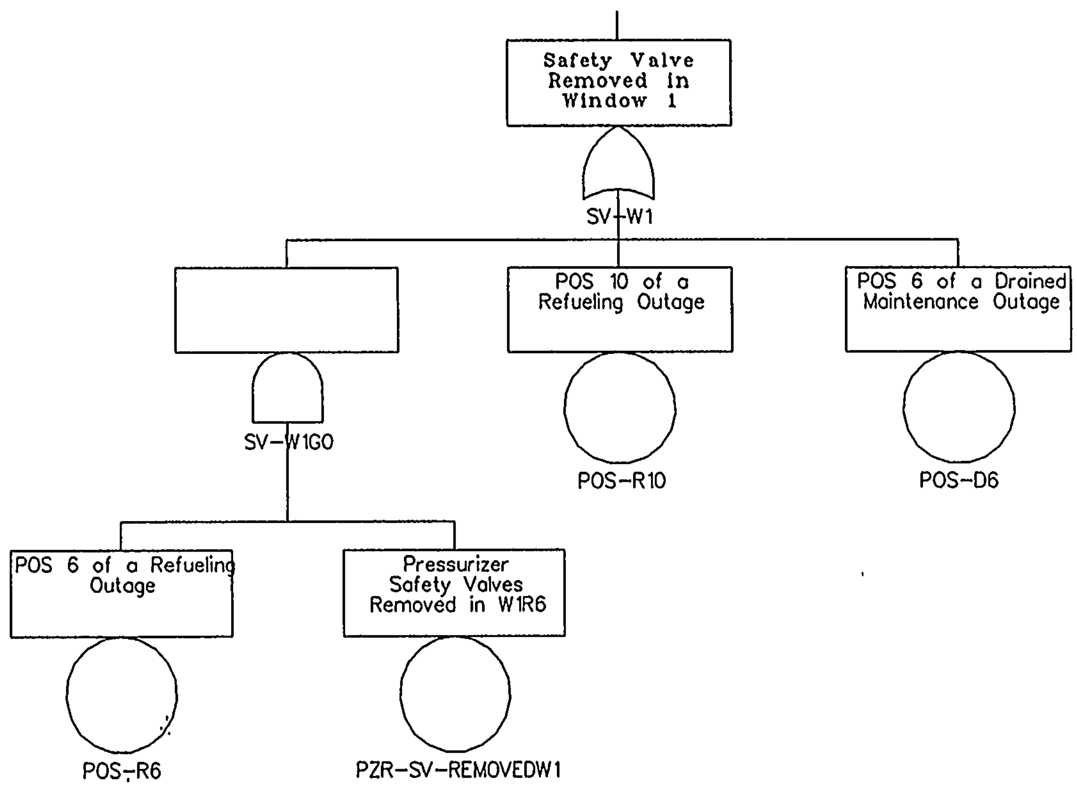
RCS Loops Isolated to Cause Failure of Reflux in Window 1



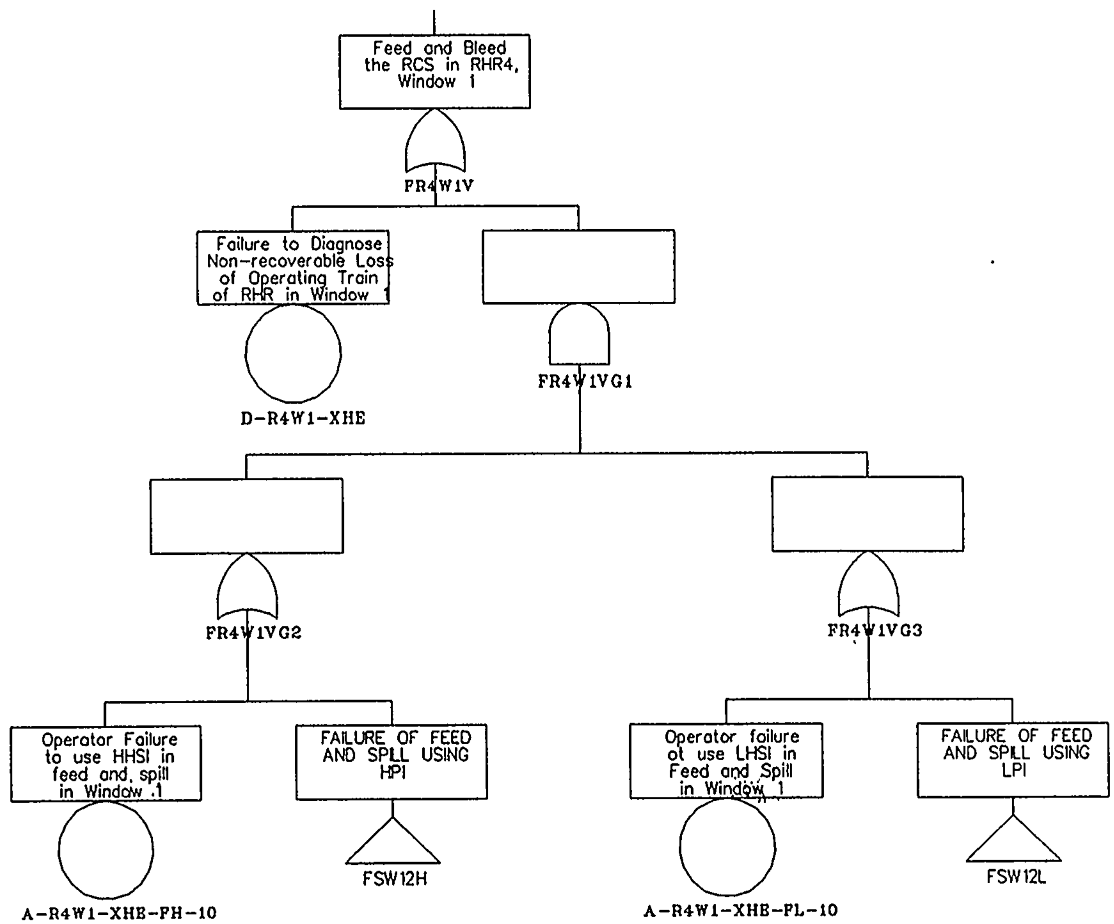
Feed and Bleed the RCS in RHR4, Window 1



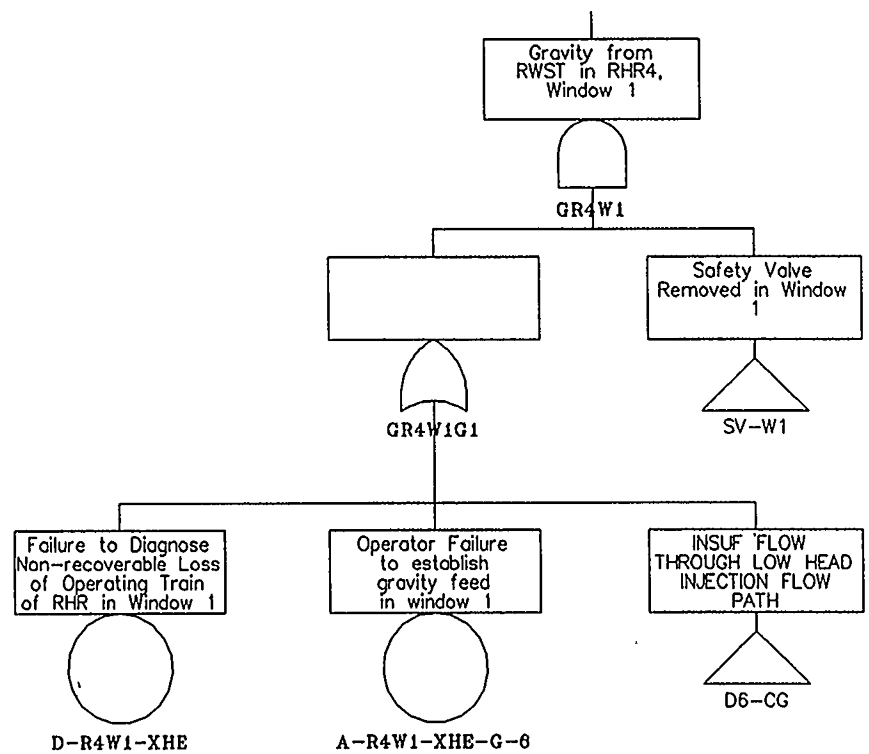
Safety Valves Removed in Window 1



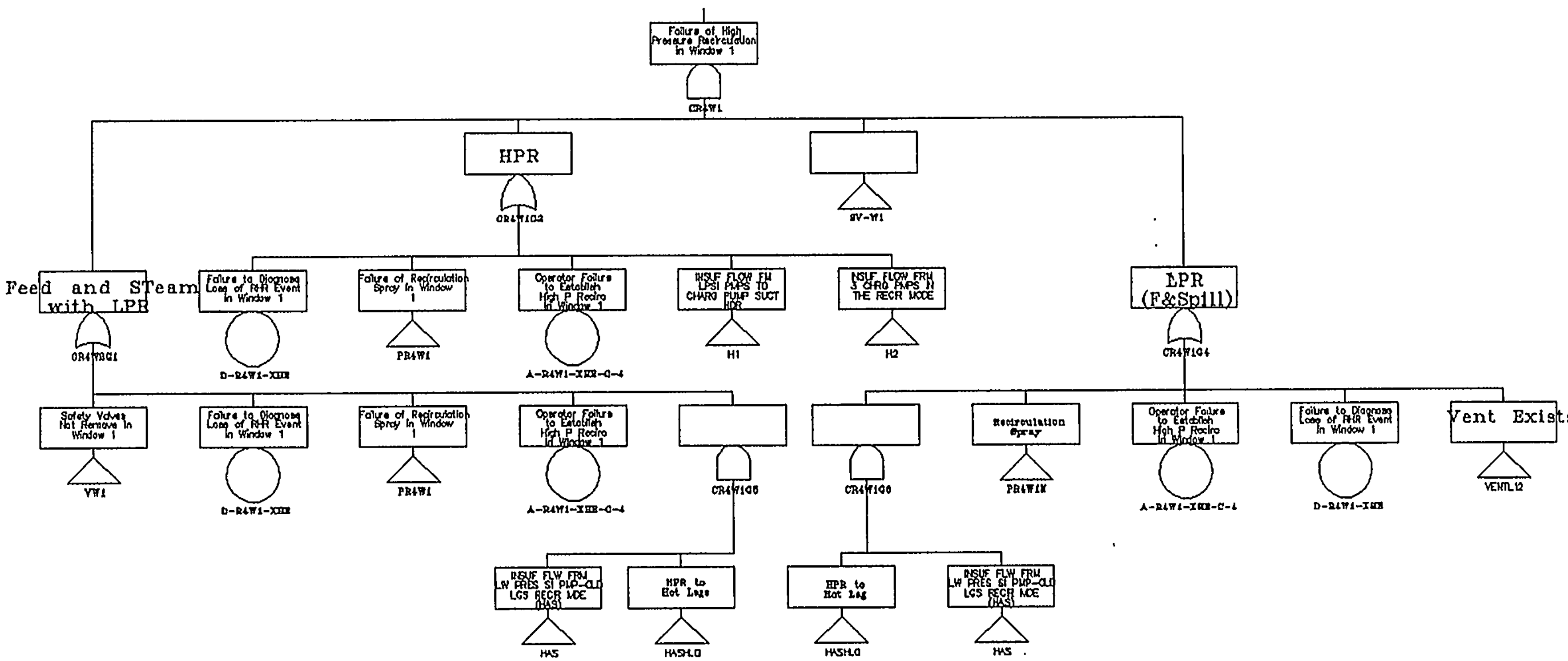
Feed and Bleed the RCS with V failed in RHR4, Window 1



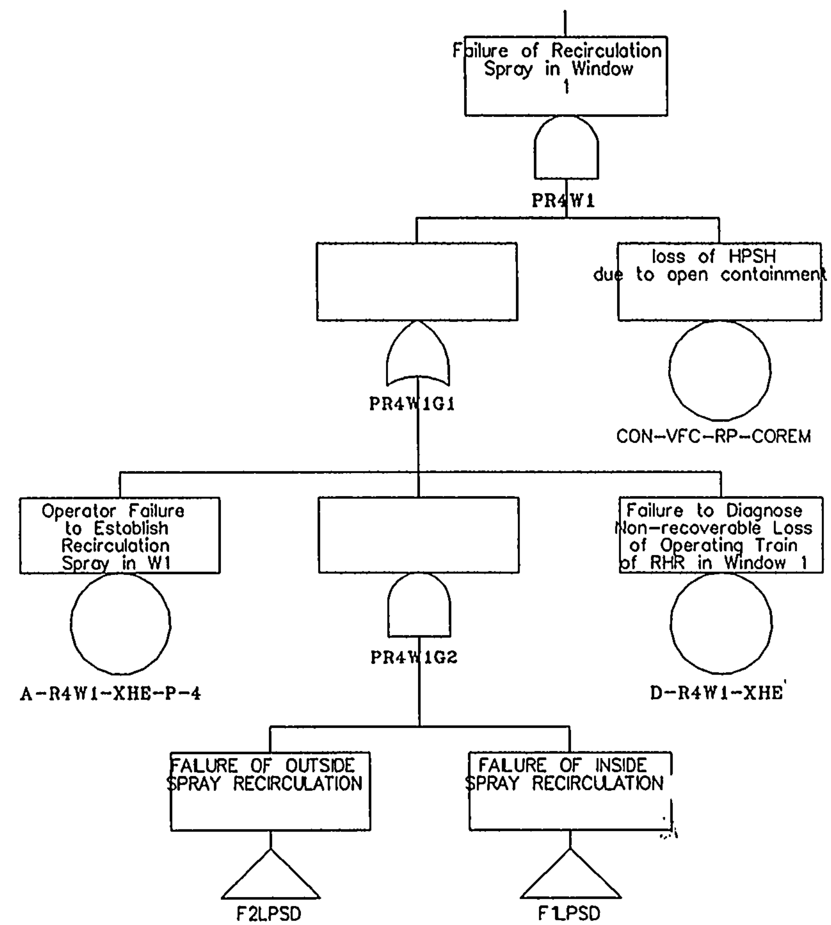
Gravity from RWST in RHR4, Window 1



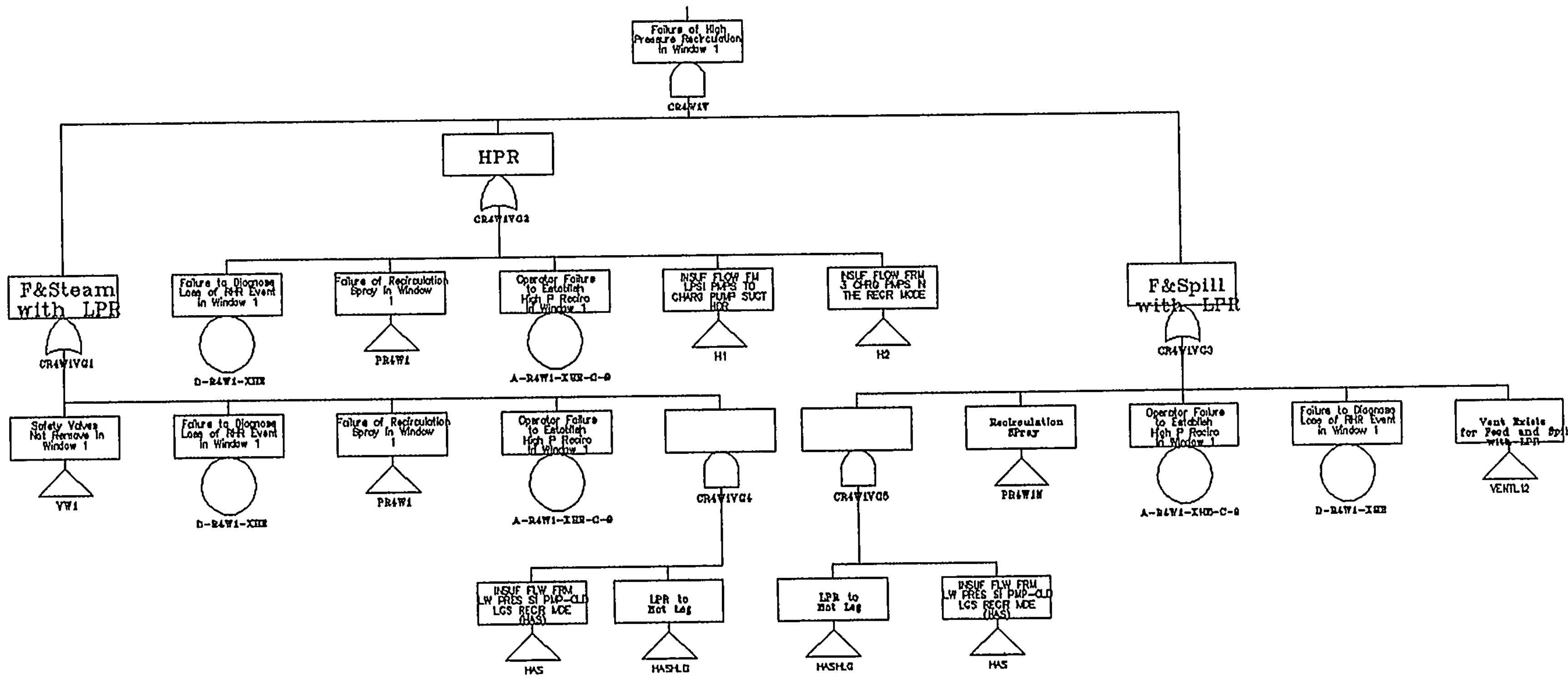
Failure of High Pressure Recirculation in Window 1

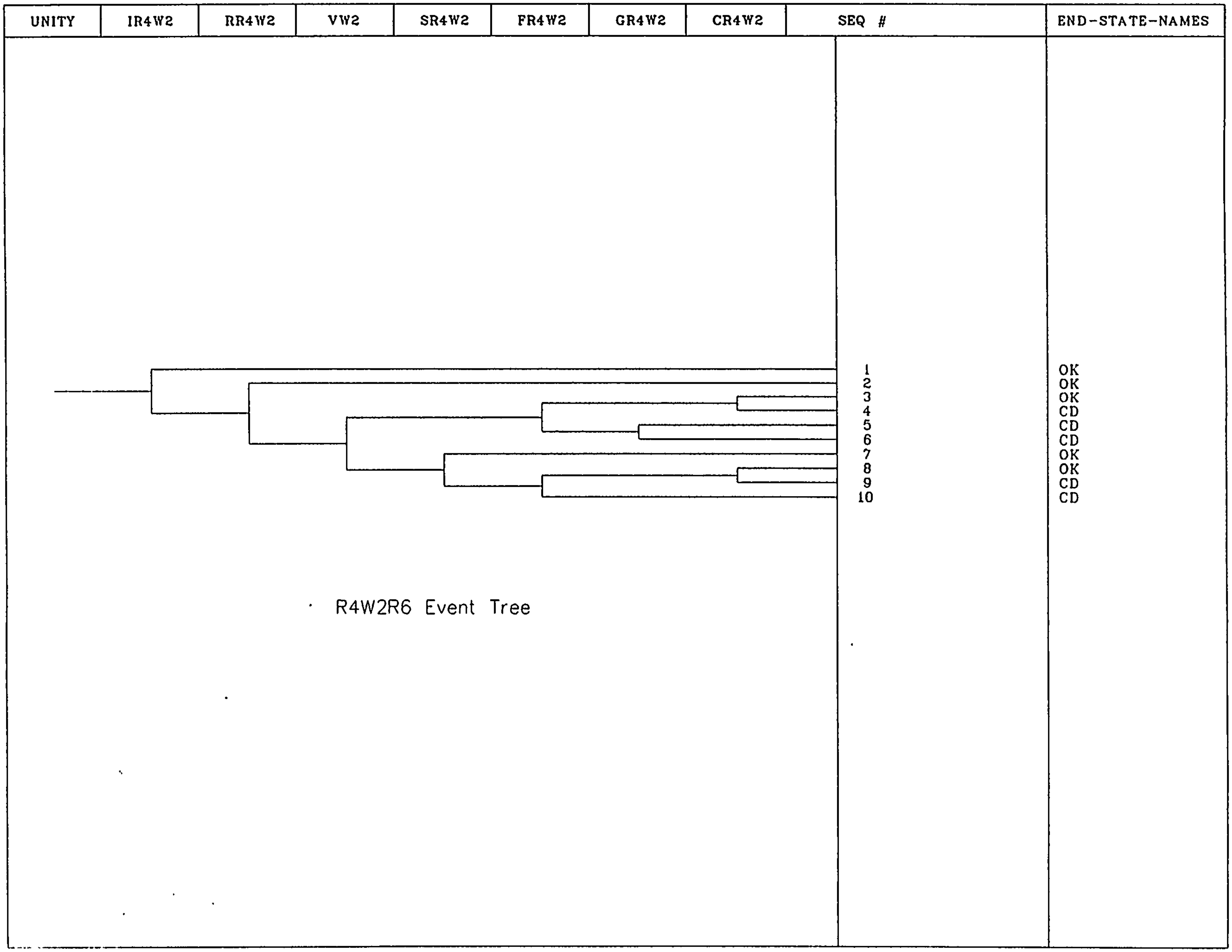


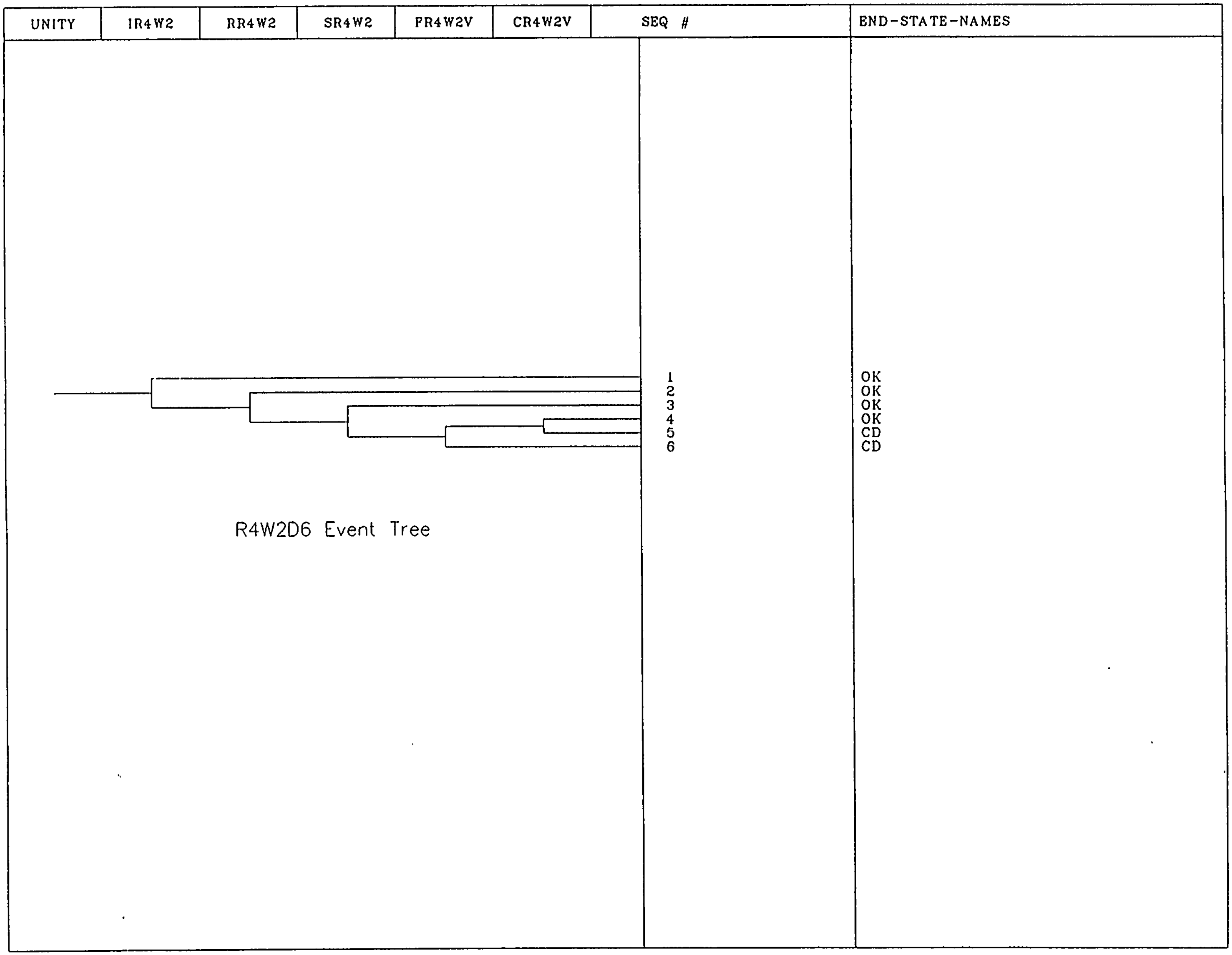
Failure of Recirculation Spray in Window 1–cause HPR failure



Failure of High Pressure Recirculation in Window 1

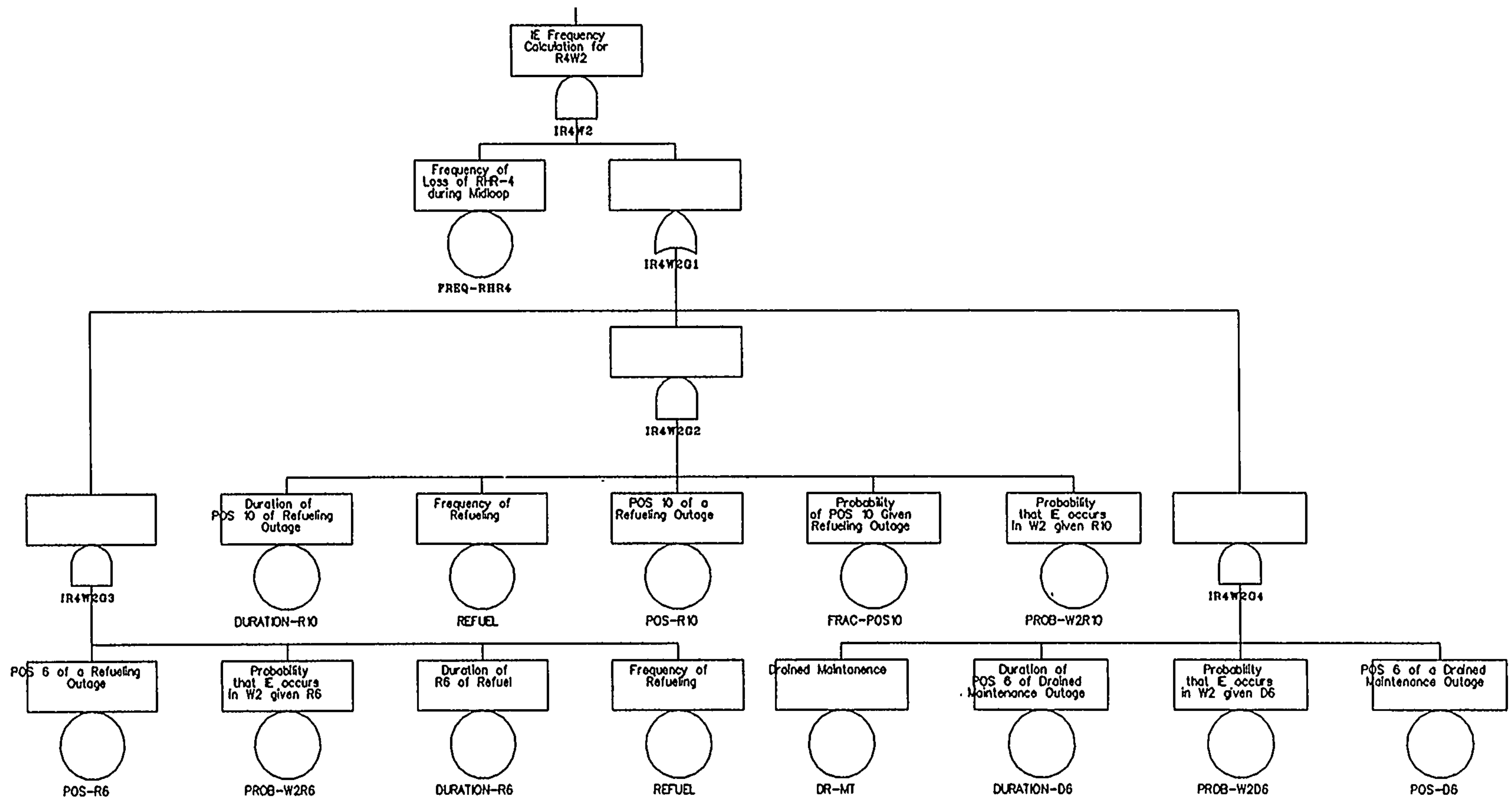



UNITY
IR4W2
RR4W2
VW2
SR4W2
FR4W2
GR4W2
CR4W2
SEQ #
END-STATE-NAMES
1 OK
2 OK
3 OK
4 CD
5 CD
6 CD
7 OK
8 OK
9 CD
10 CD
R4W2R6 Event Tree

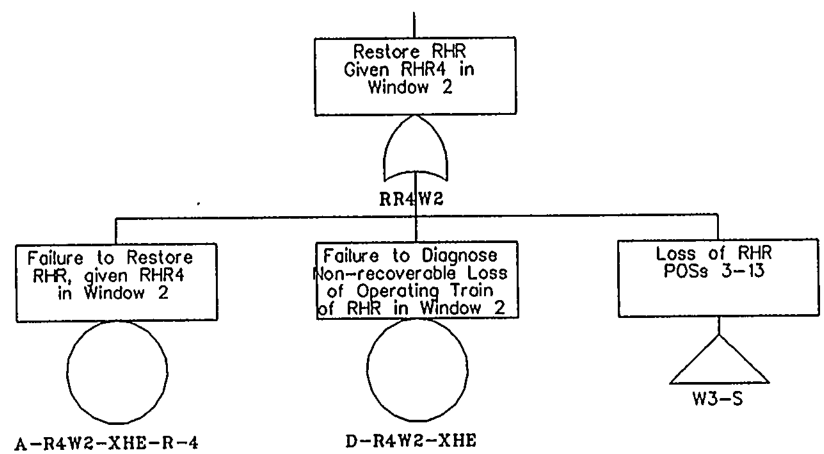


UNITY
IR4W2
RR4W2
SR4W2
PR4W2V
CR4W2V
SEQ #
END-STATE-NAMES
1 OK
2 OK
3 OK
4 OK
5 CD
6 CD
R4W2D6 Event Tree

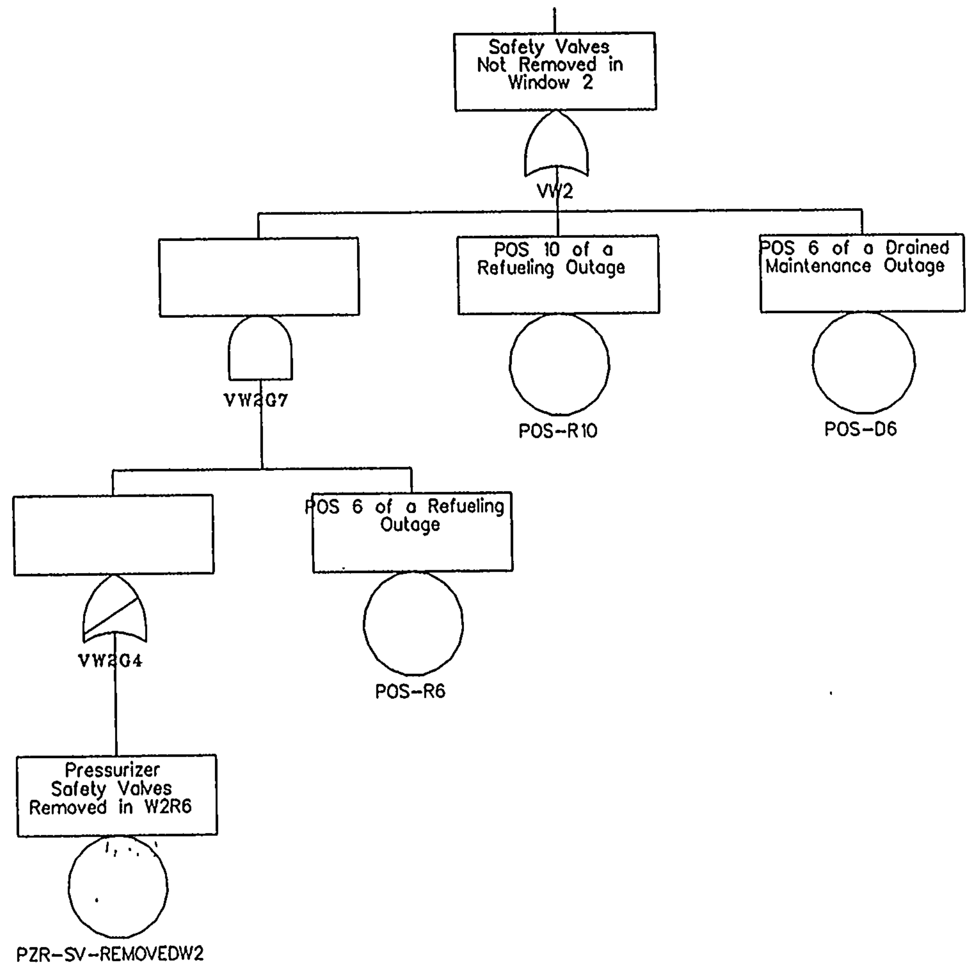
I Top Event for Loss of RHR– R4 in Window 2



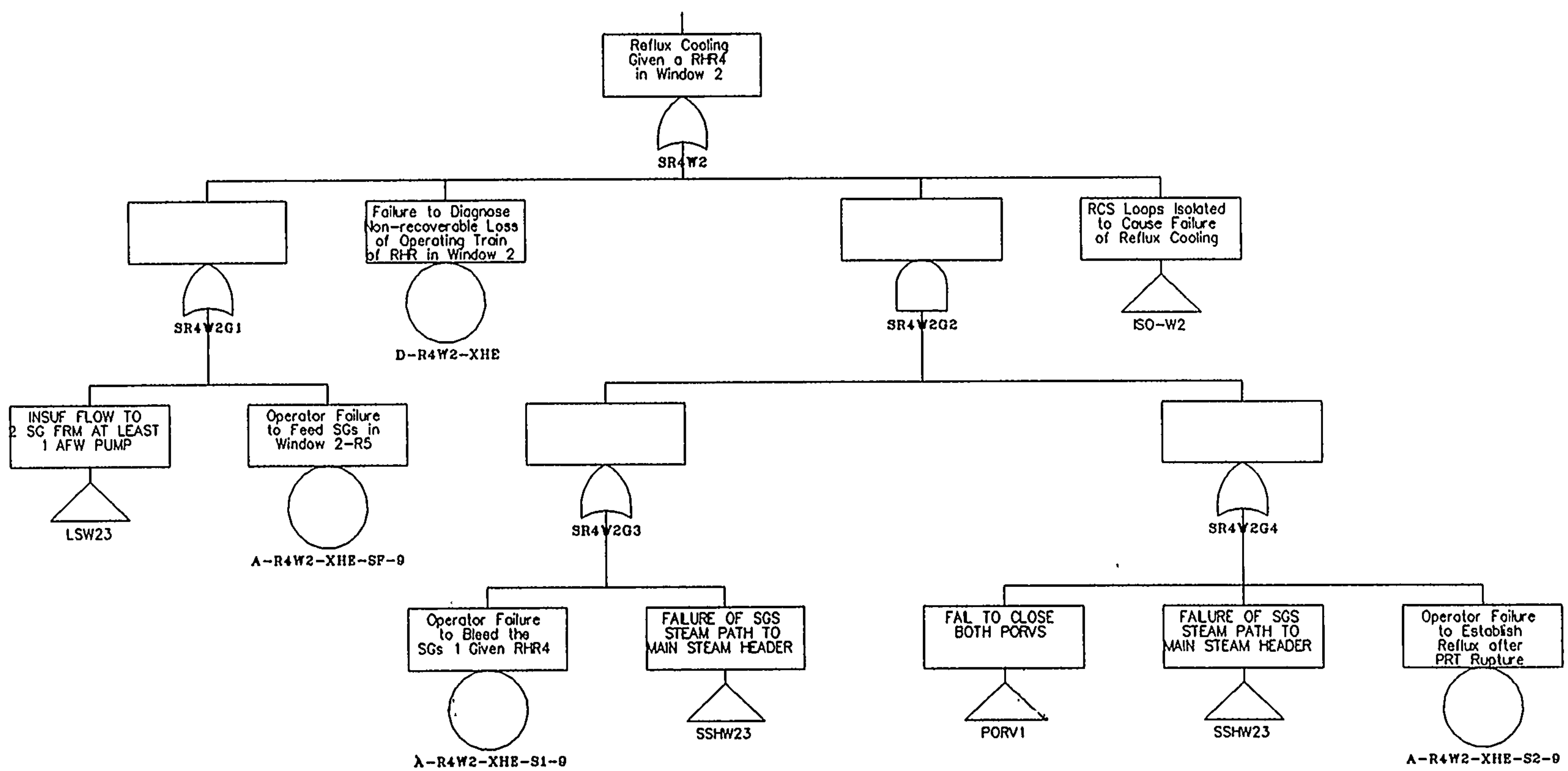
Restore RHR given RHR4 in Window 2



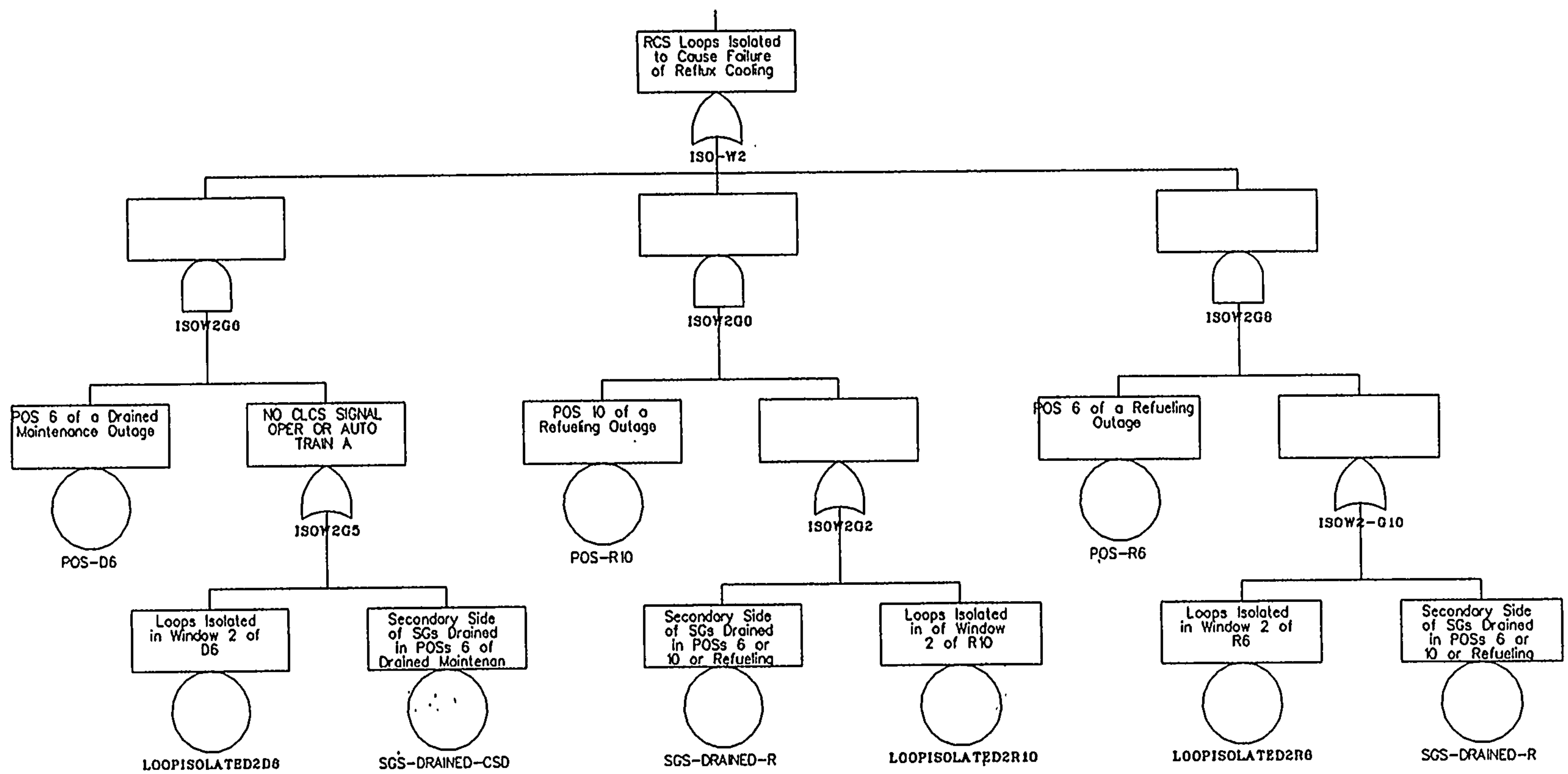
Safety Valves Not Removed in Window 2



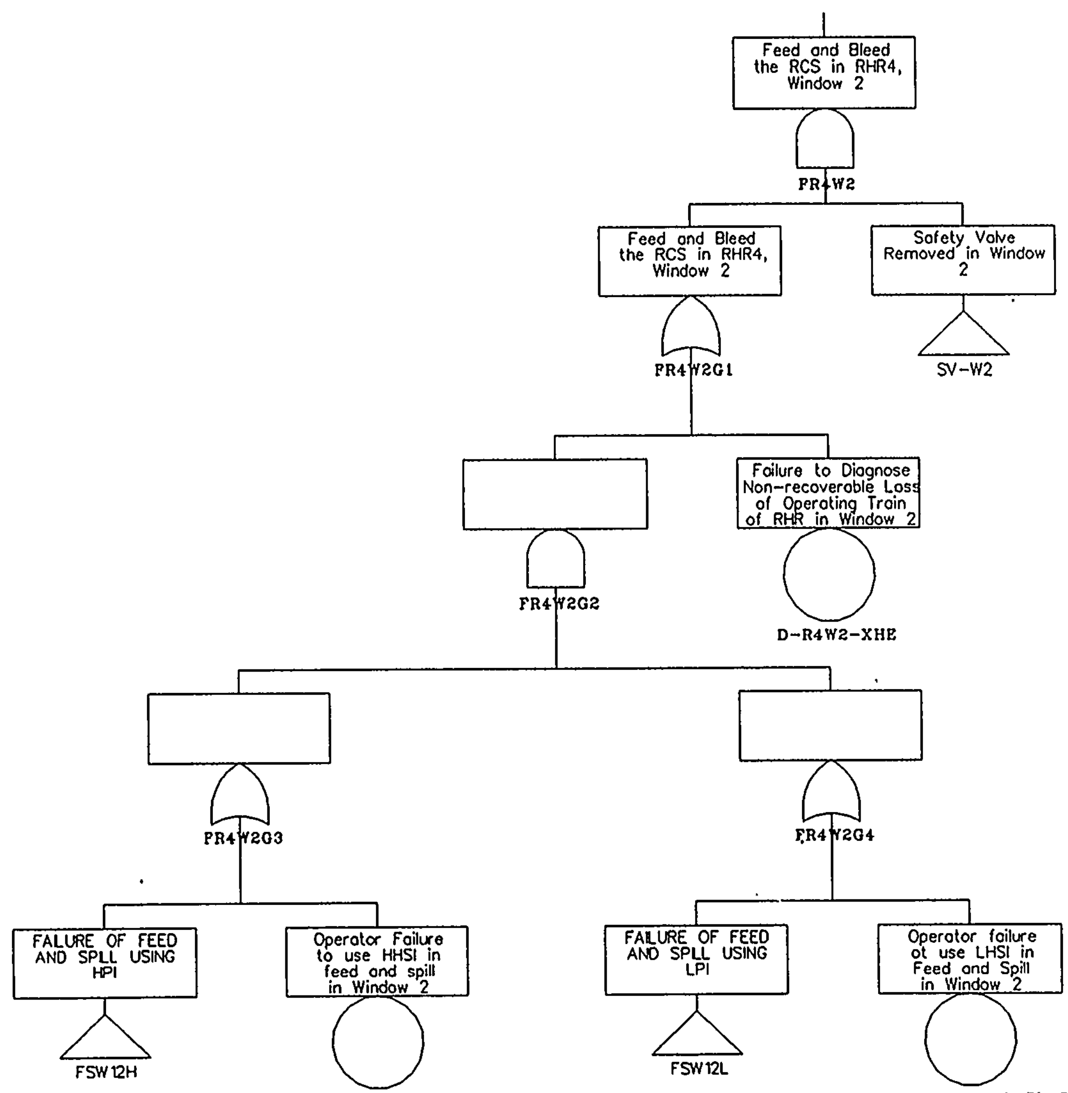
Reflux Cooling in Window 2



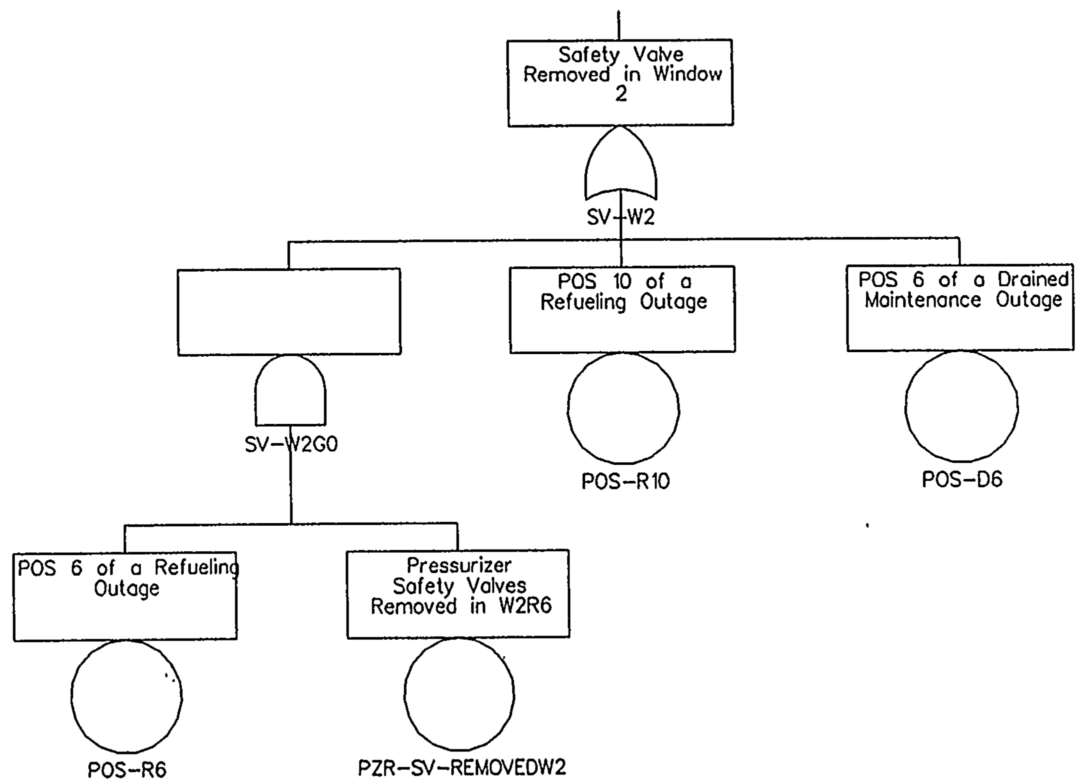
RCS Loops Isolated to Cause Failure of Reflux in Window 2



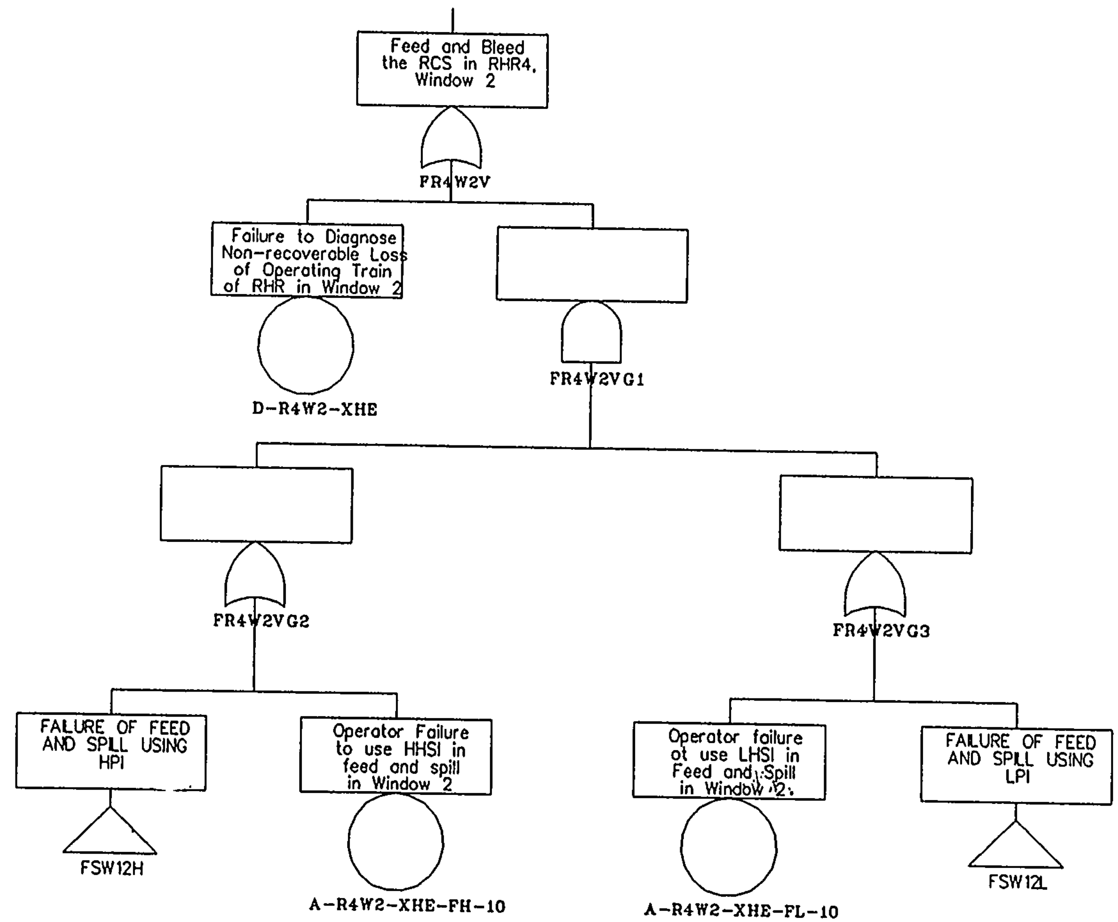
Feed and Bleed the RCS in RHR4, Window 2



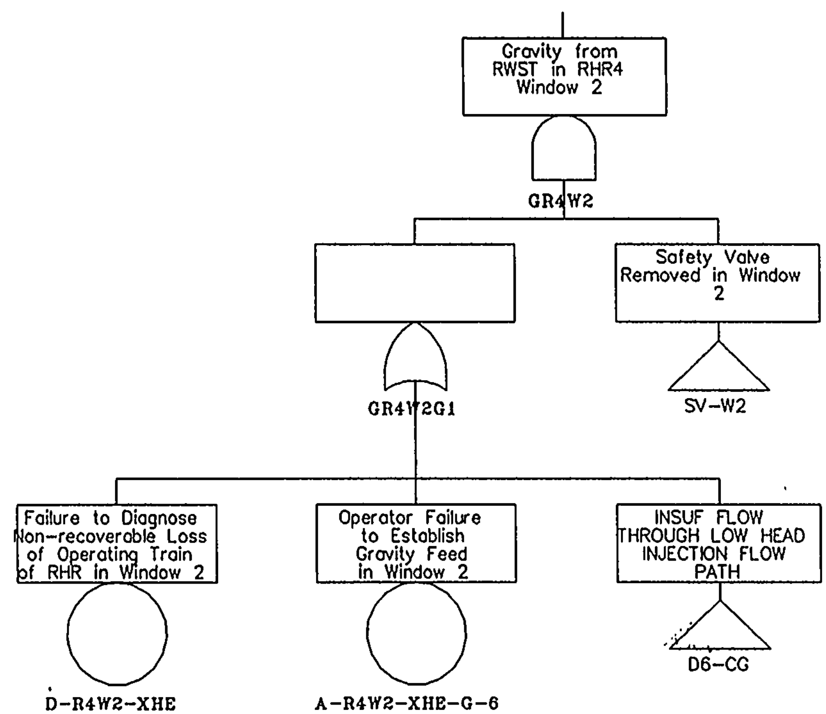
Safety Valves Removed in Window 2



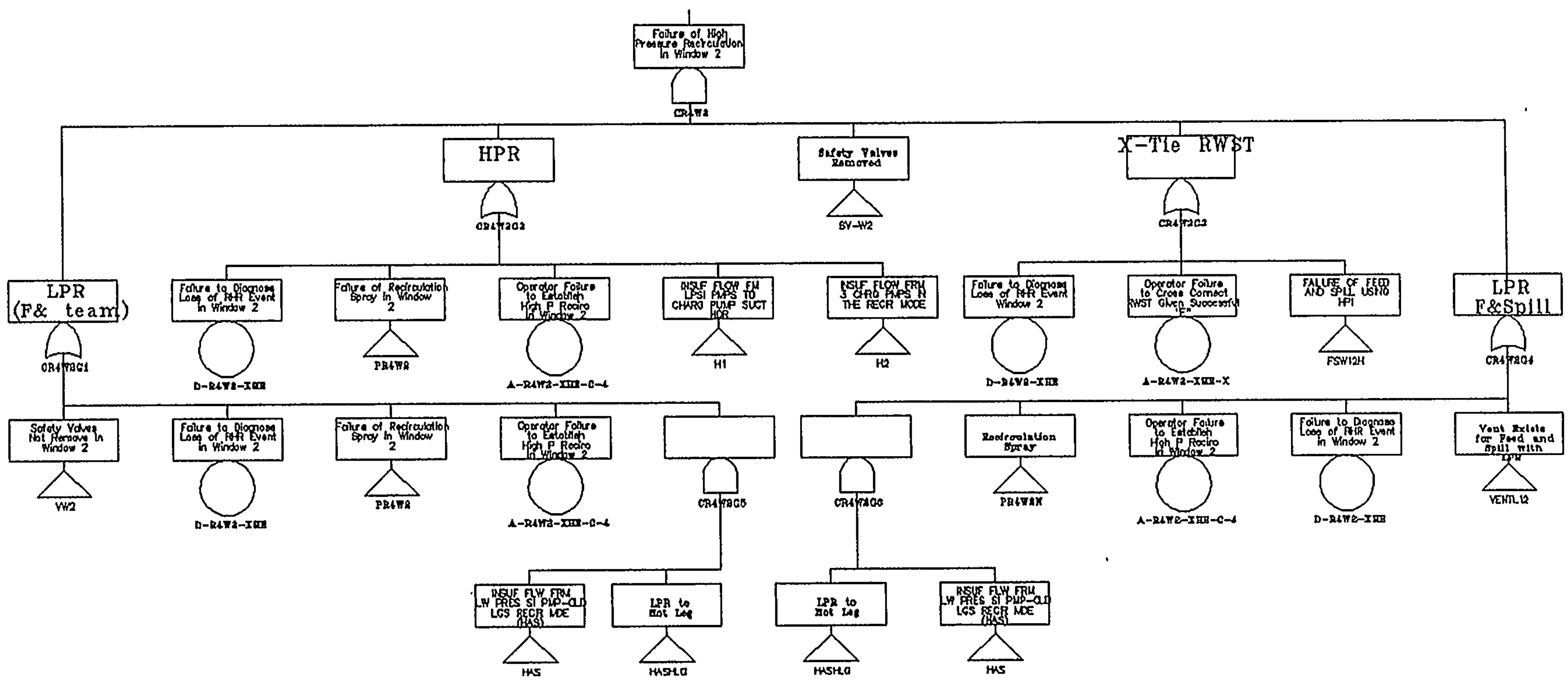
Feed and Bleed the RCS with V failed in RHR4, Window 2



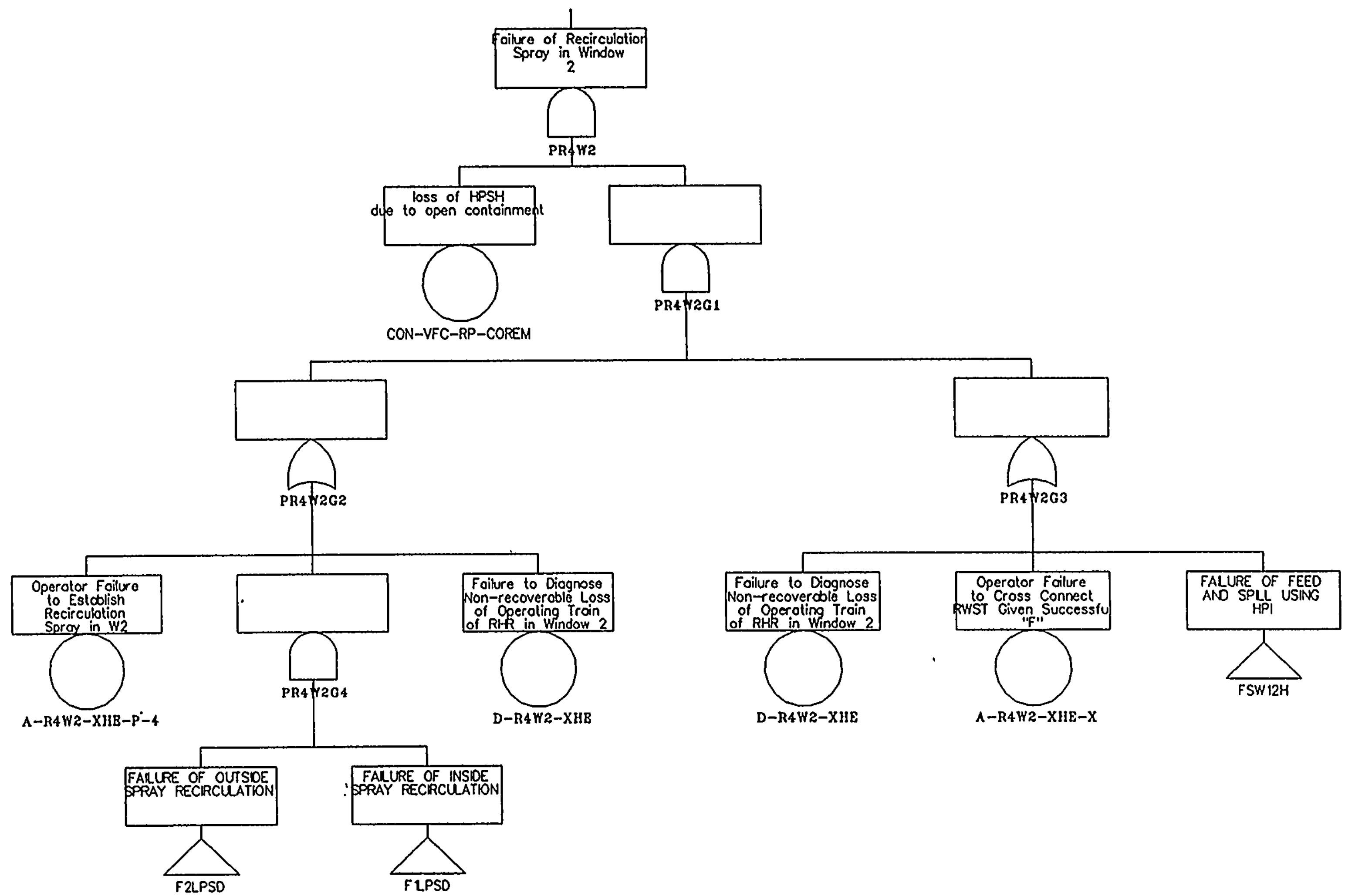
Gravity from RWST in RHR4, Window 2



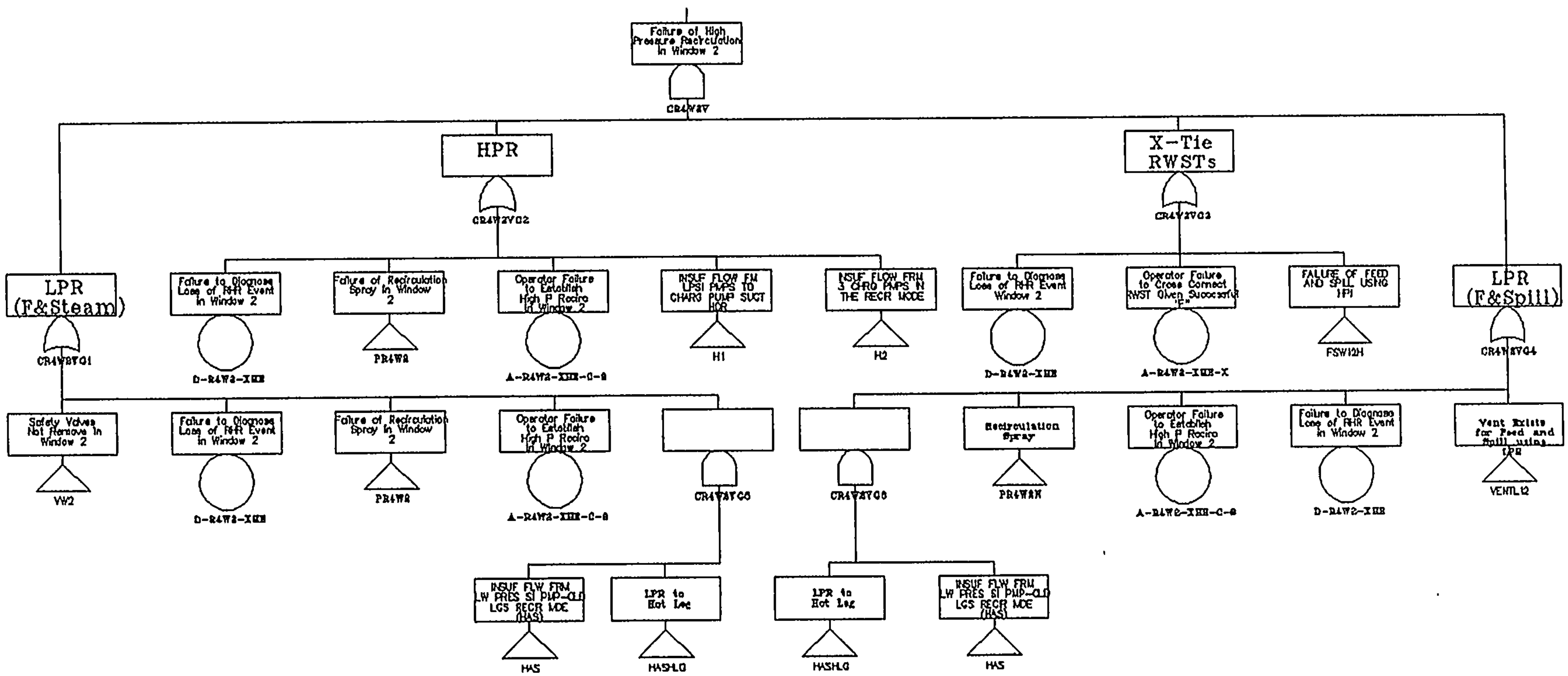
Failure of High Pressure Recirculation in Window 2

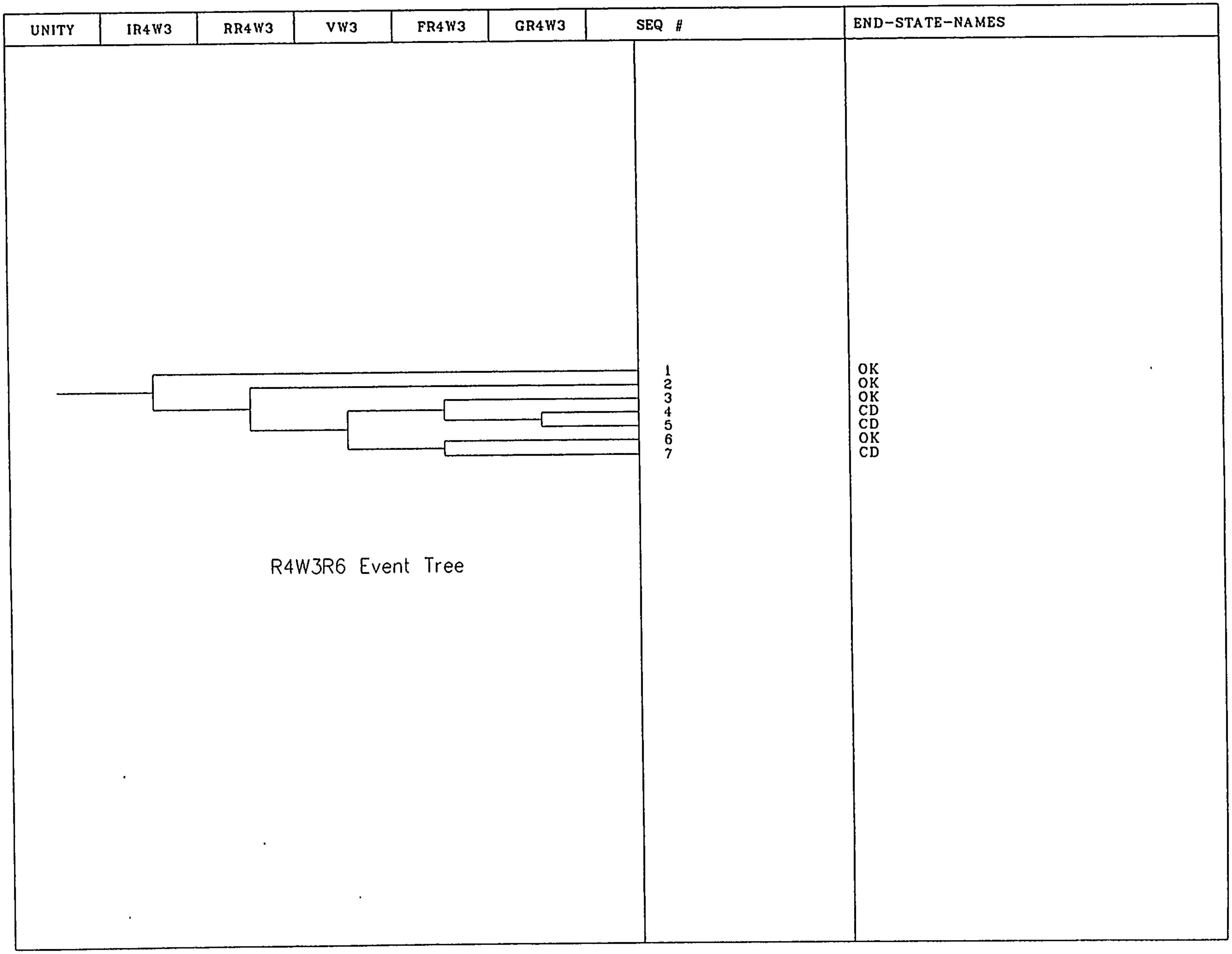


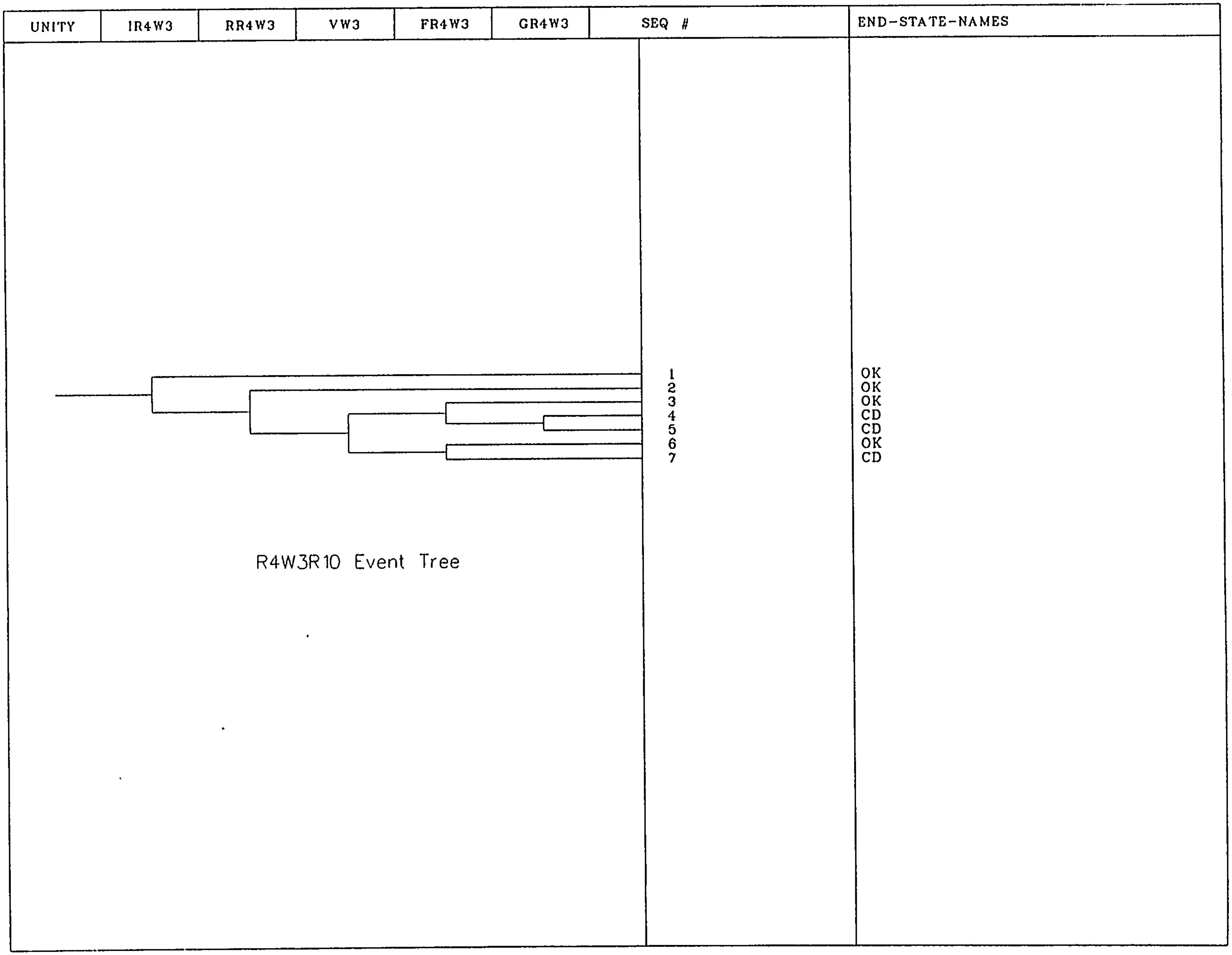
Failure of Recirculation Spray in Window 2-cause HPR failure



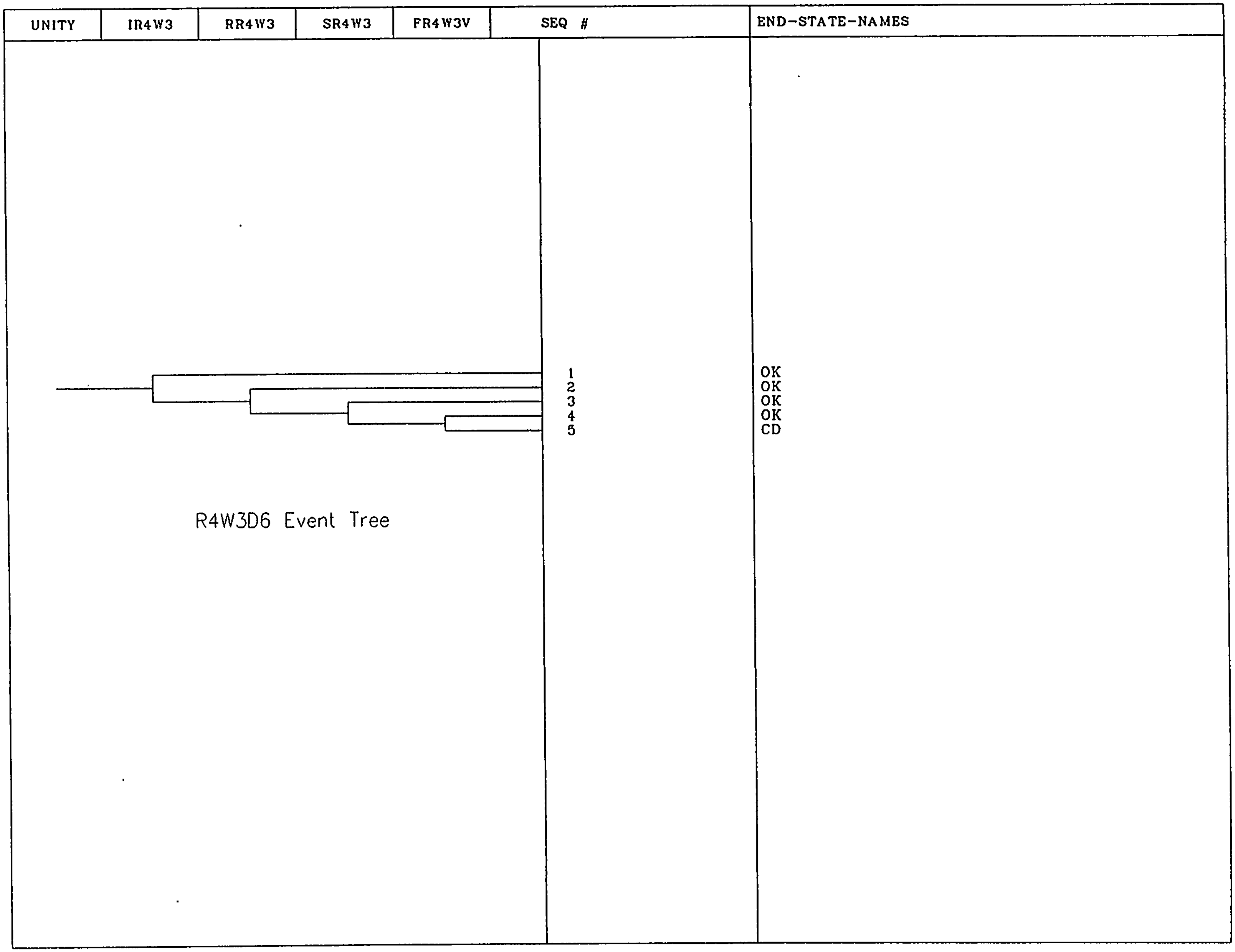
Failure of High Pressure Recirculation in Window 2



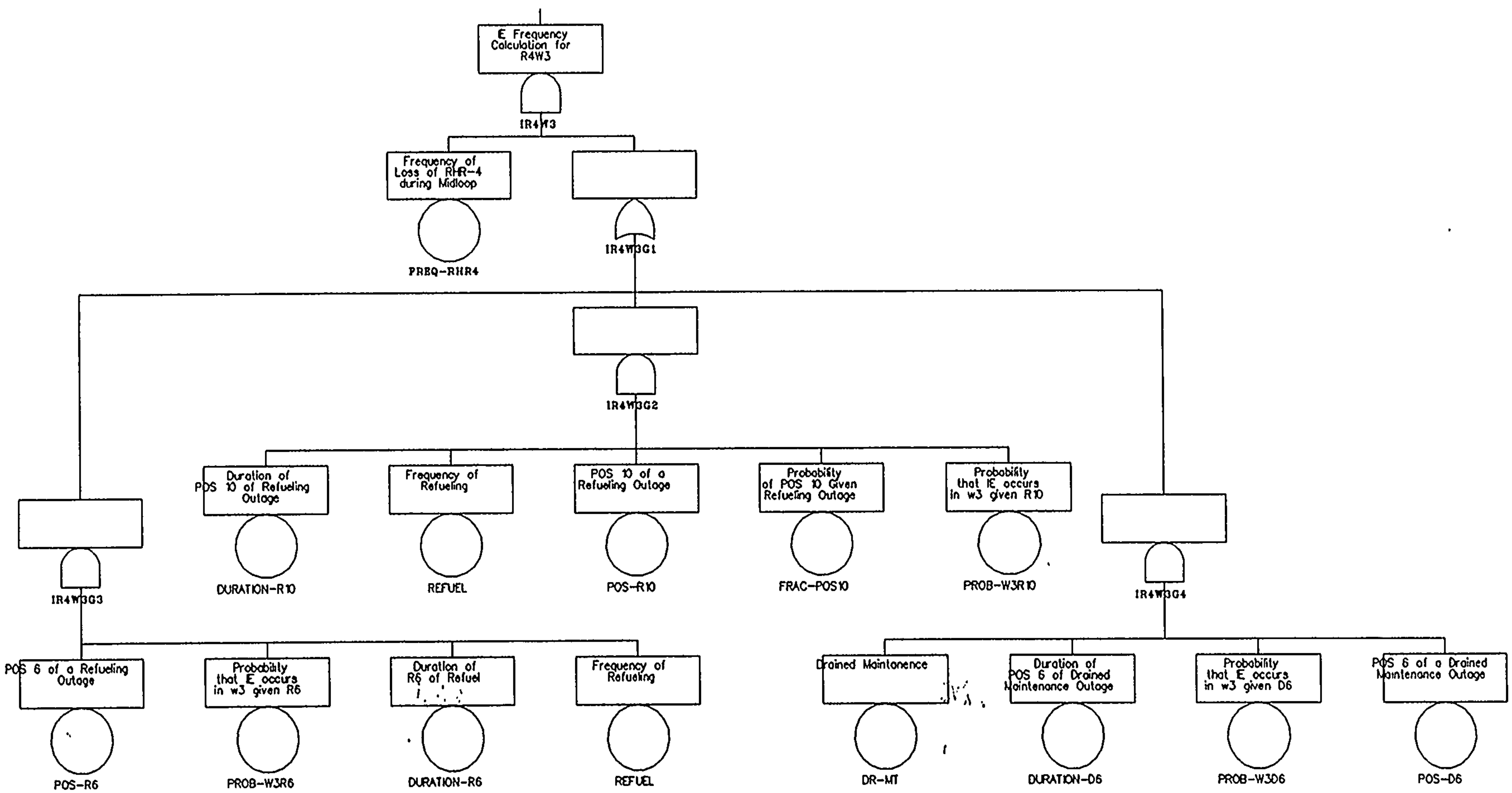

UNITY
IR4W3
RR4W3
VW3
FR4W3
GR4W3
SEQ #
END-STATE-NAMES
1 OK
2 OK
3 OK
4 CD
5 CD
6 OK
7 CD
R4W3R6 Event Tree



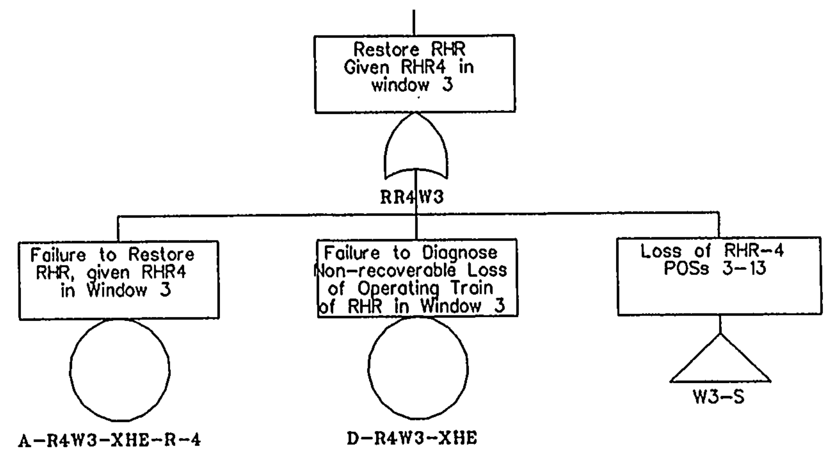
R4W3R10 Event Tree


UNITY
IR4W3
RR4W3
SR4W3
FR4W3V
SEQ #
END-STATE-NAMES
1 OK
2 OK
3 OK
4 OK
5 CD
R4W3D6 Event Tree

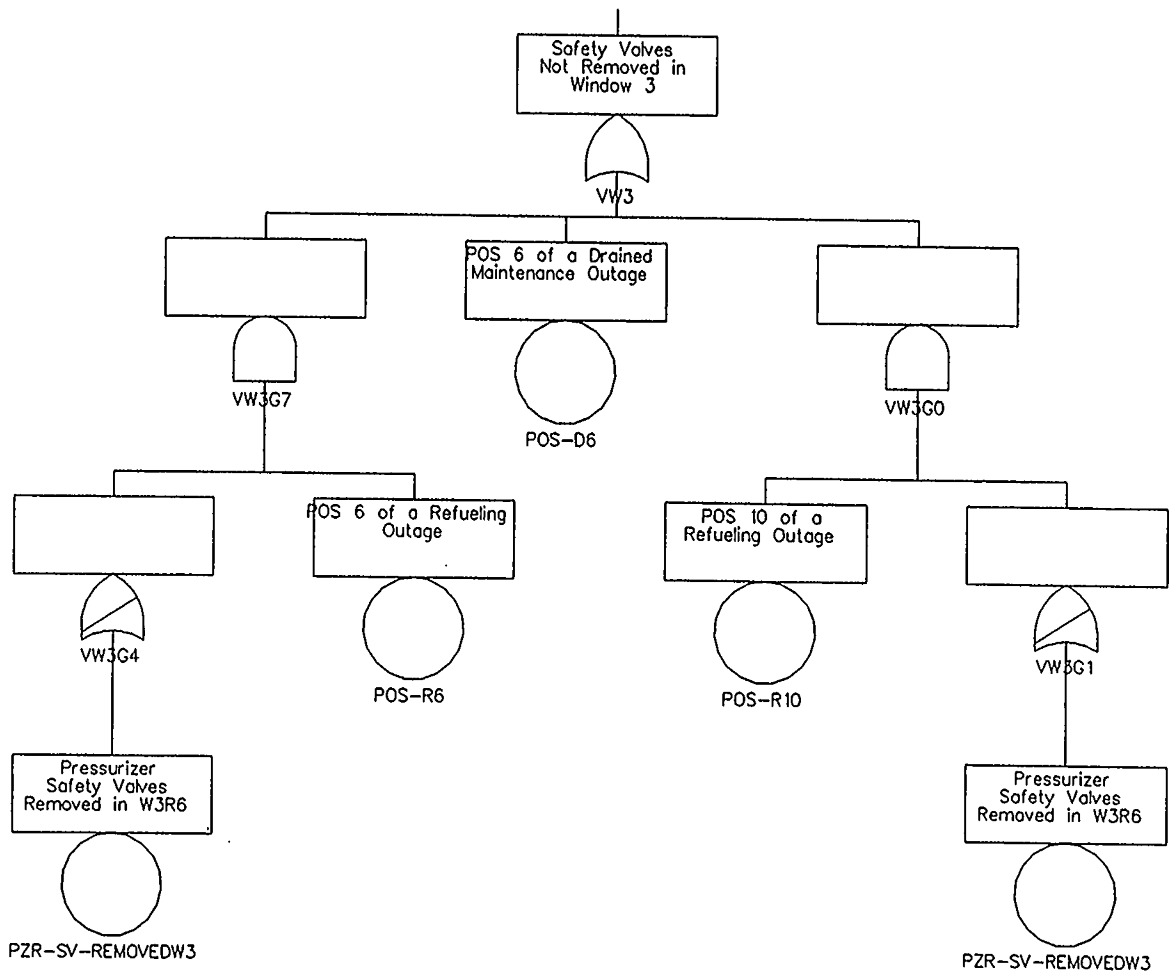
I top event for loss of RHR-4 in window 3



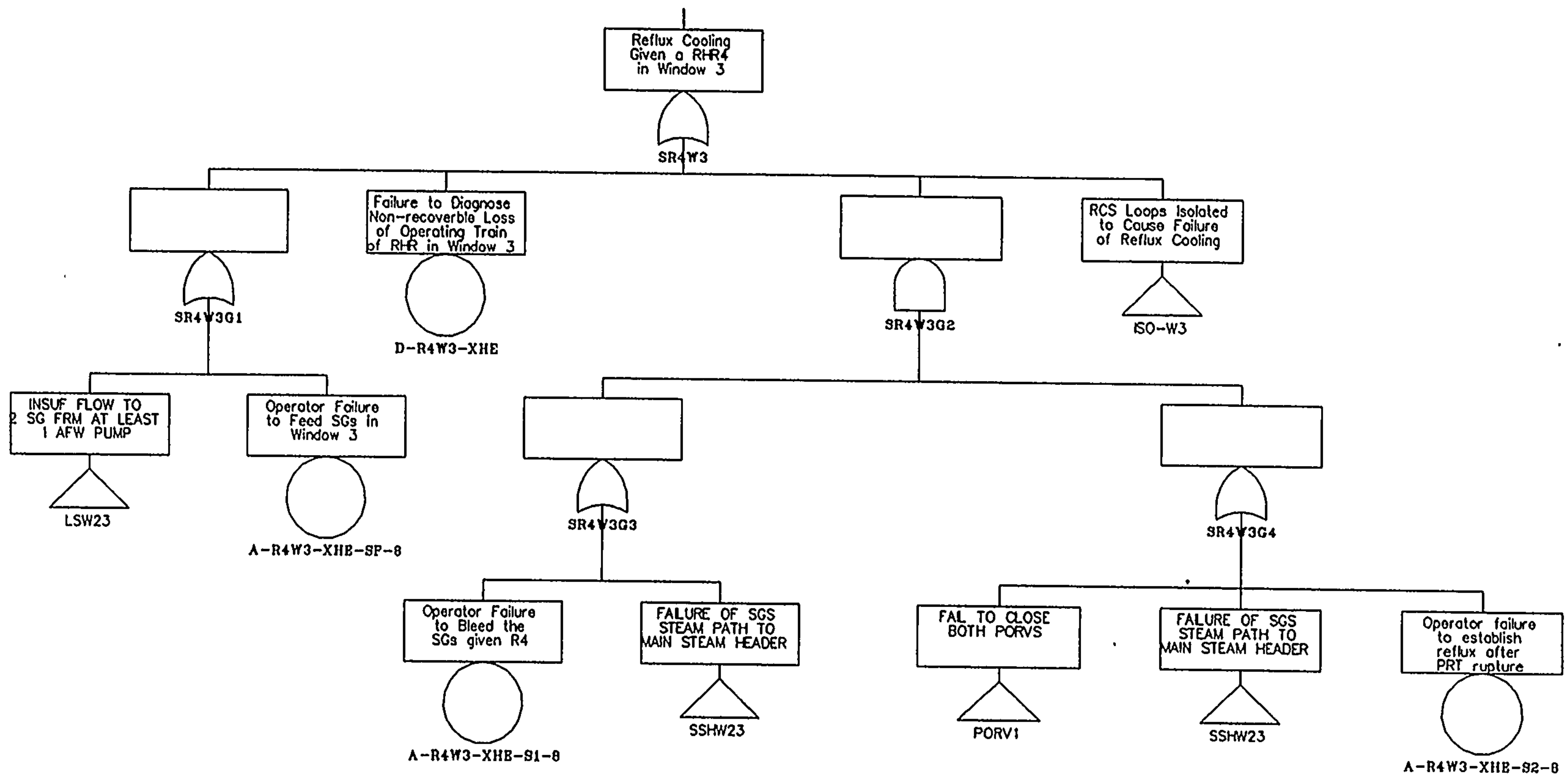
Restore RHR given RHR4 in Window 3



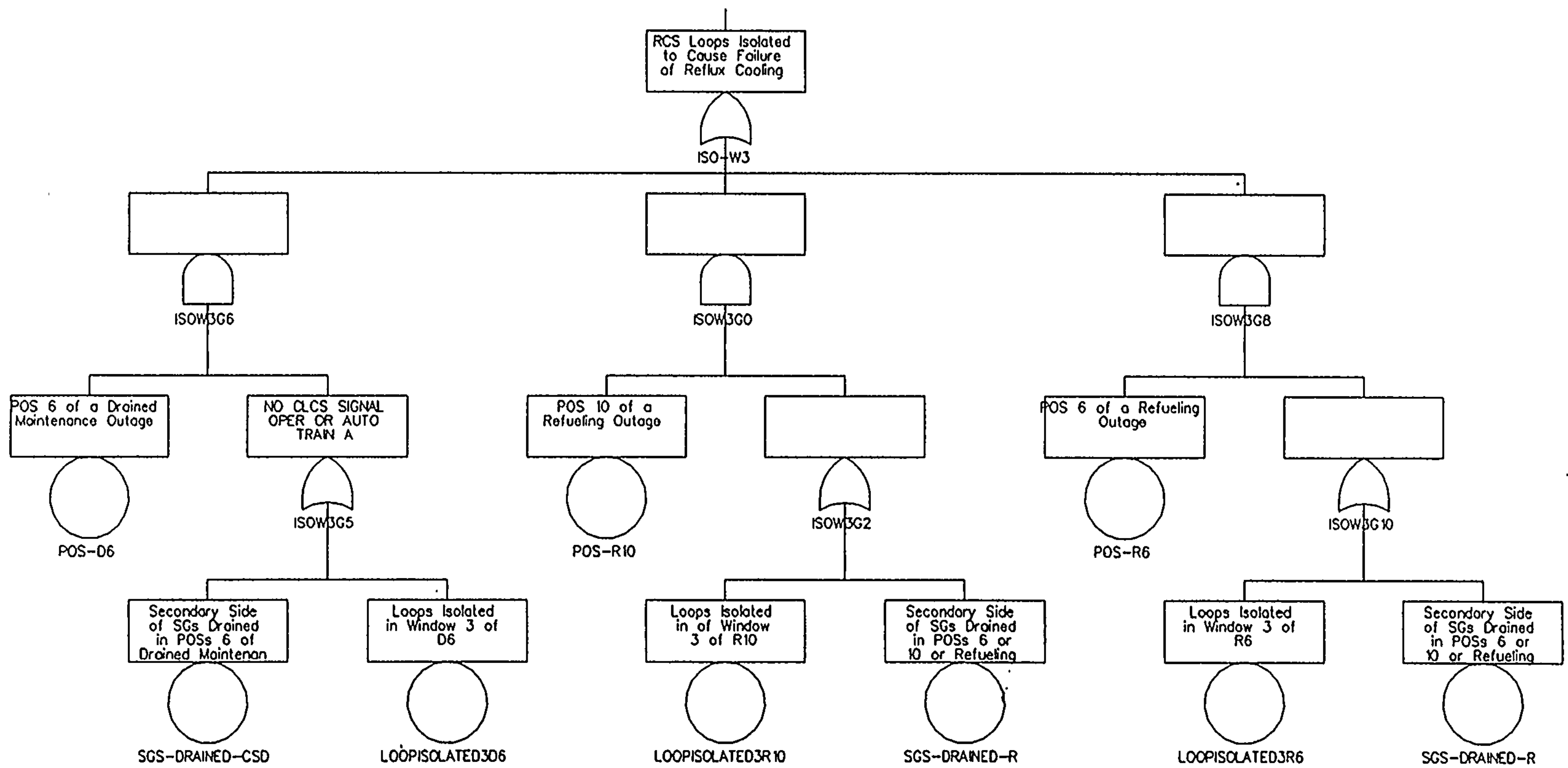
Safety Valves Not Removed in Window 3



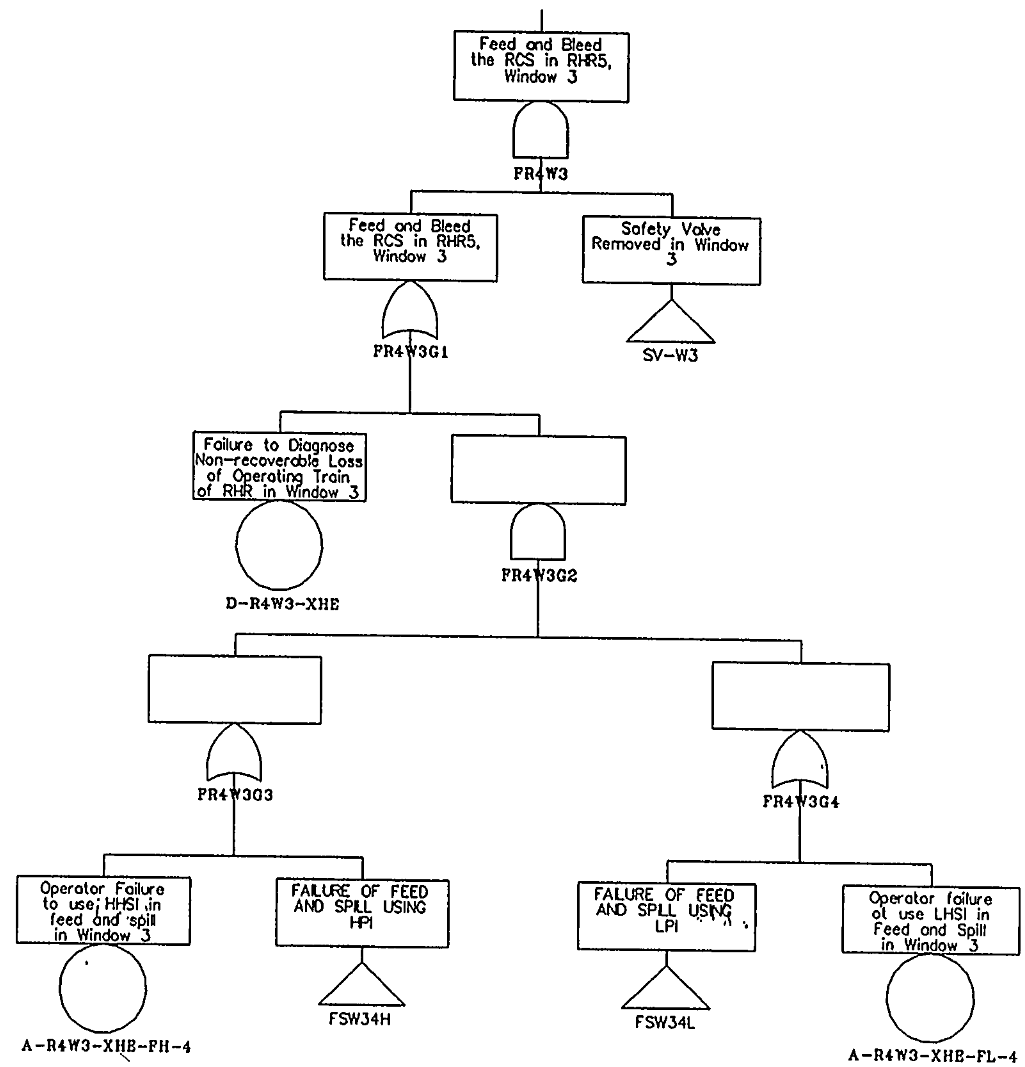
Reflux Cooling in Window 3



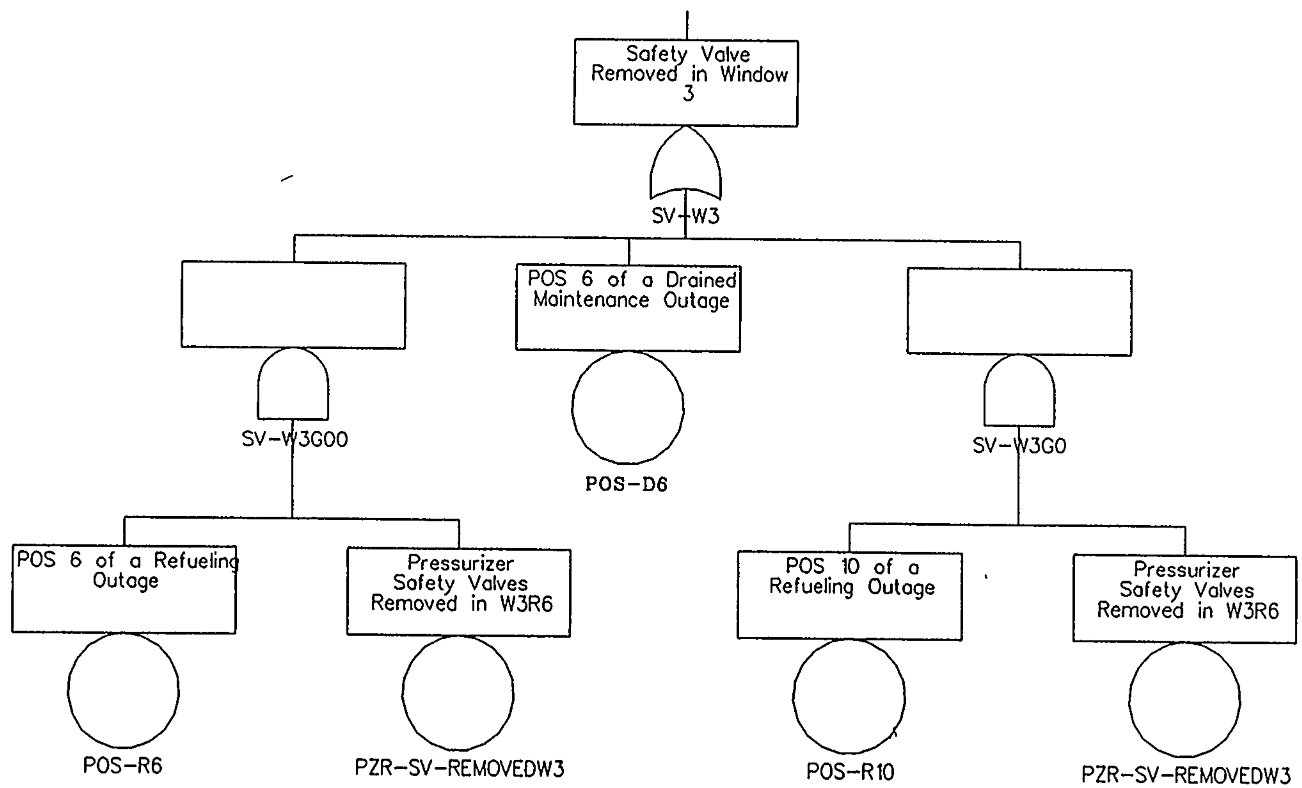
RCS Loops Isolated to Cause Failure of Reflux in Window 3



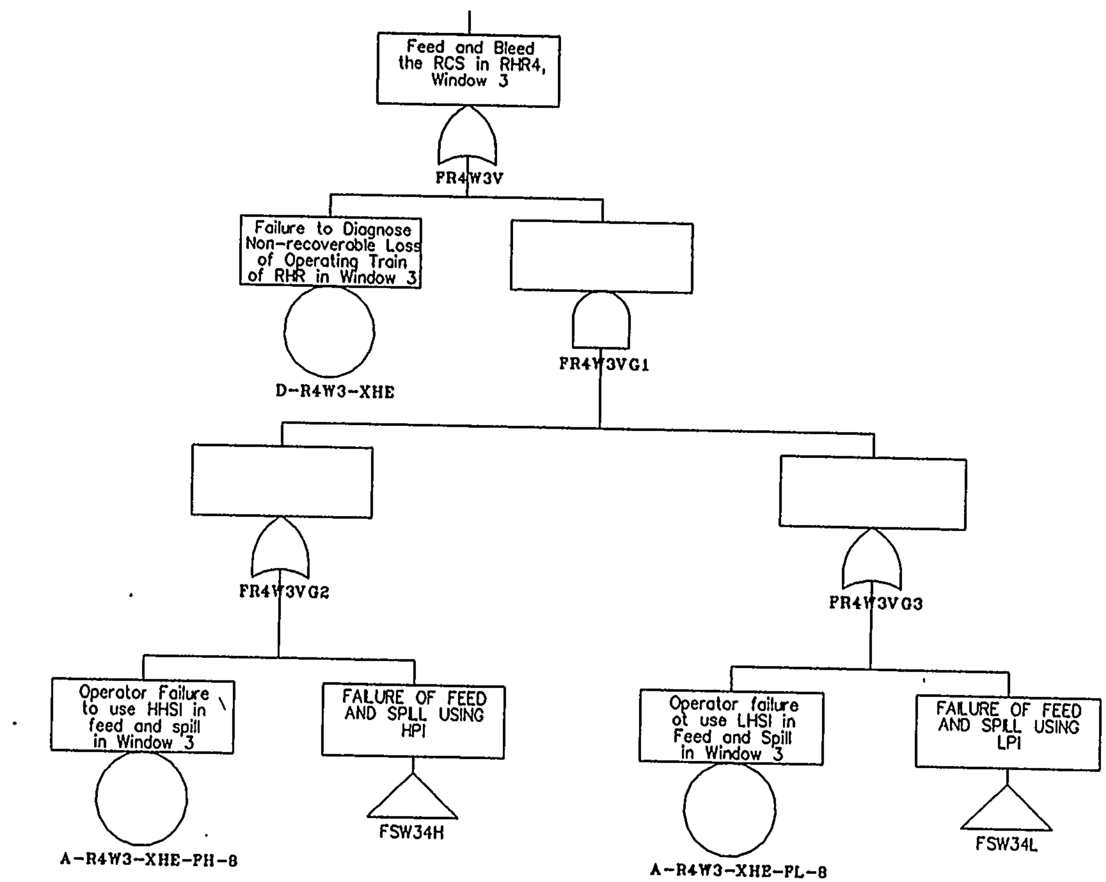
Feed and Bleed the RCS in RHR5, Window 3



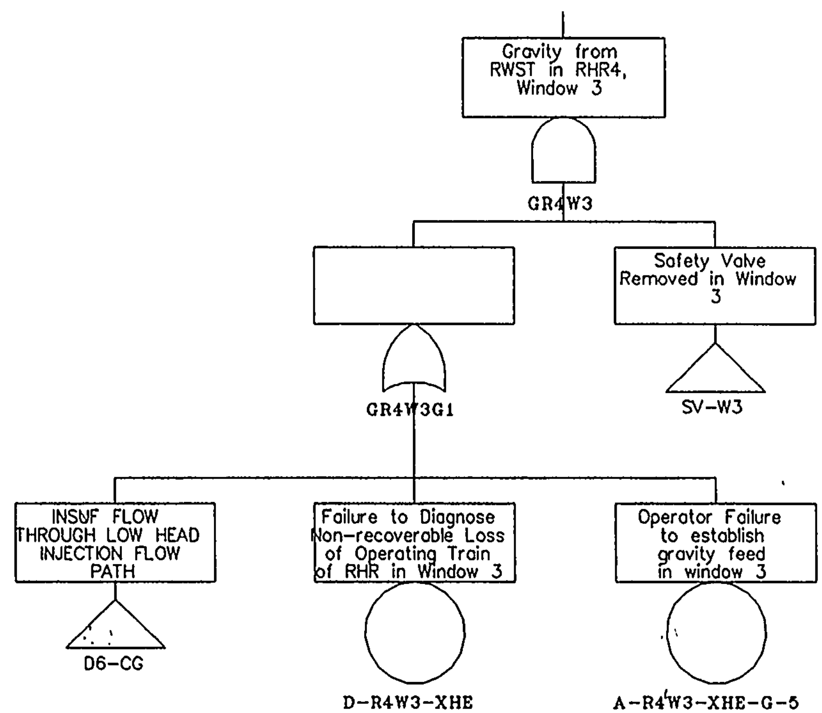
Safety Valves Removed in Window 3

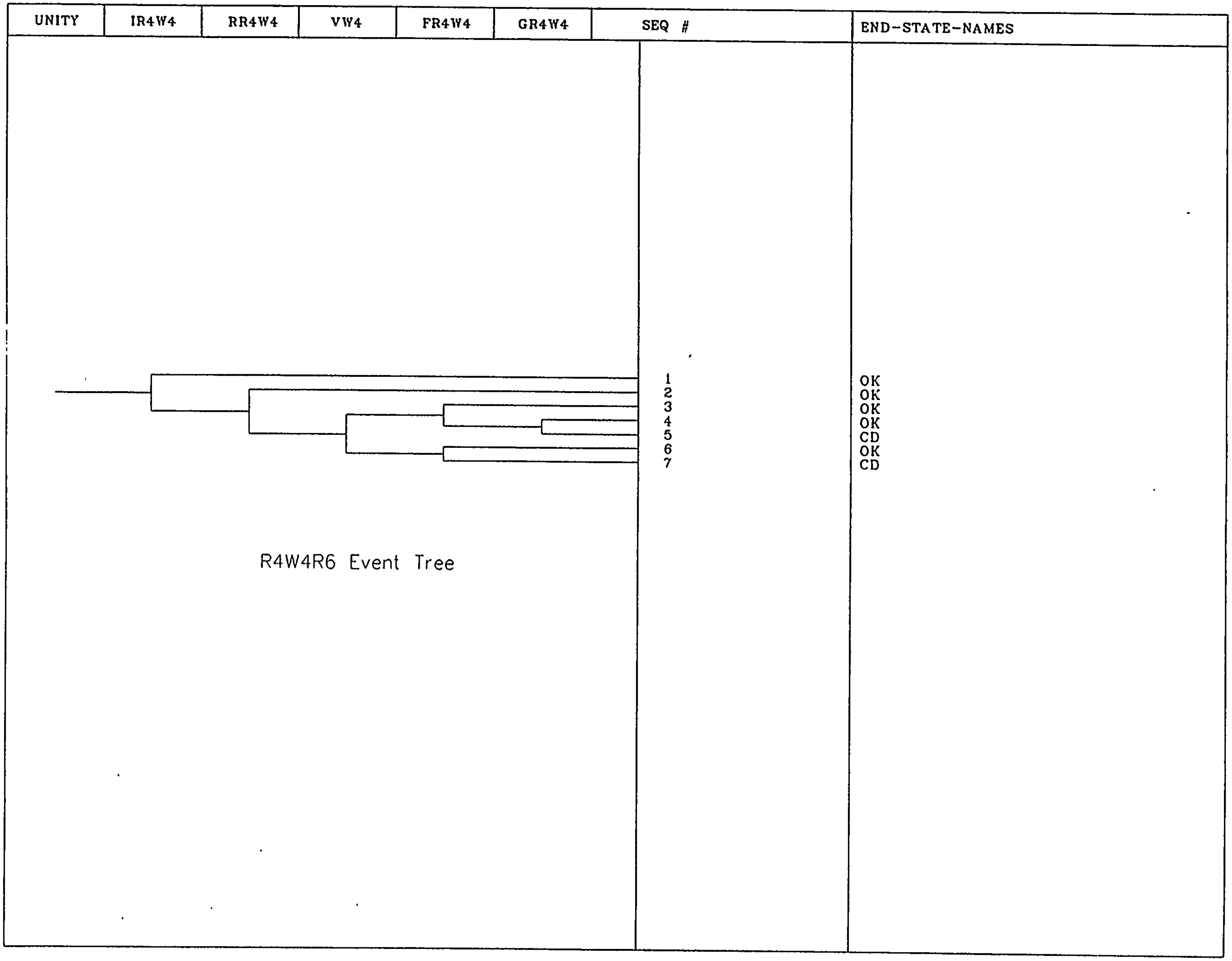


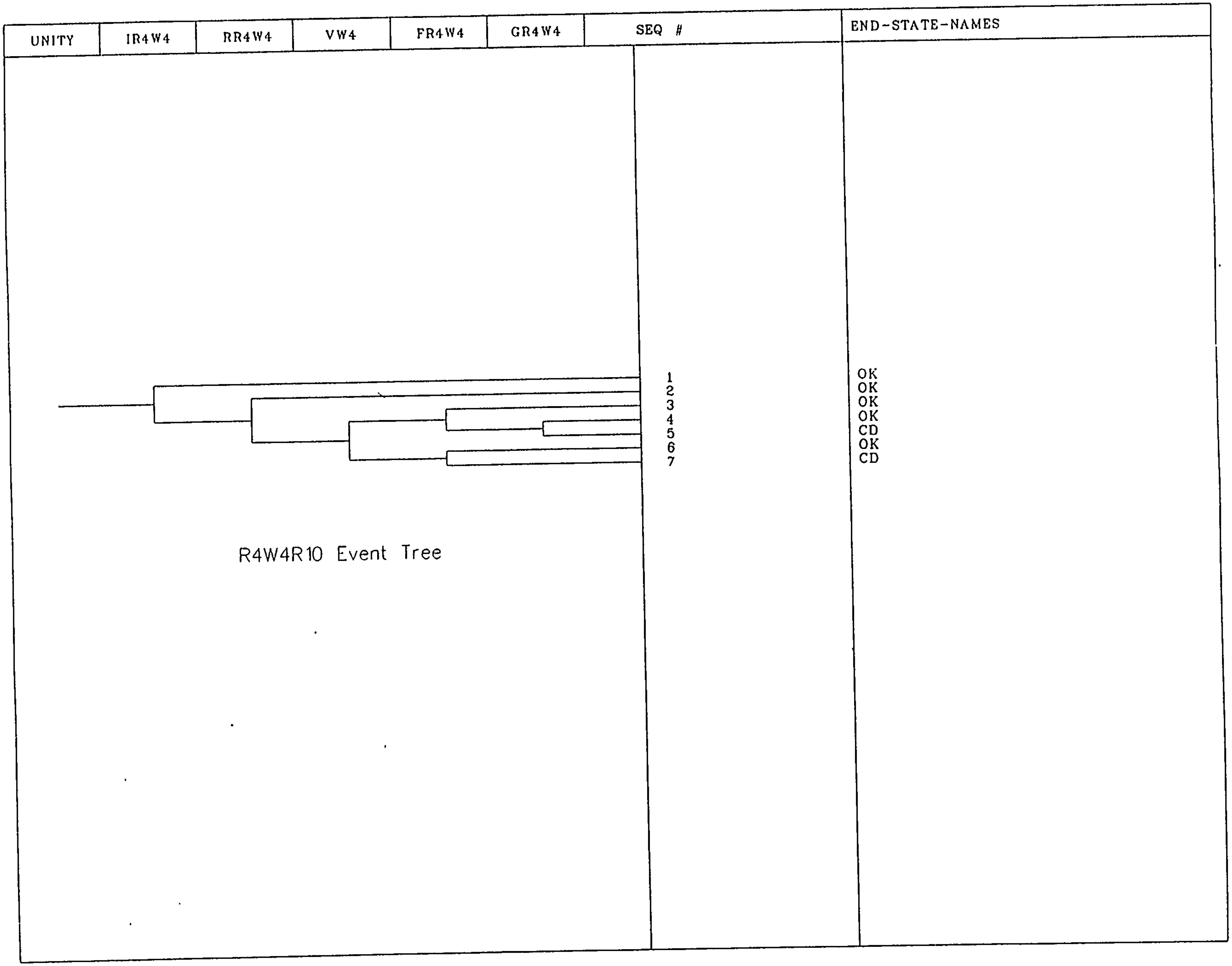
Feed and Bleed the RCS with V failed in RHR4, Window 3



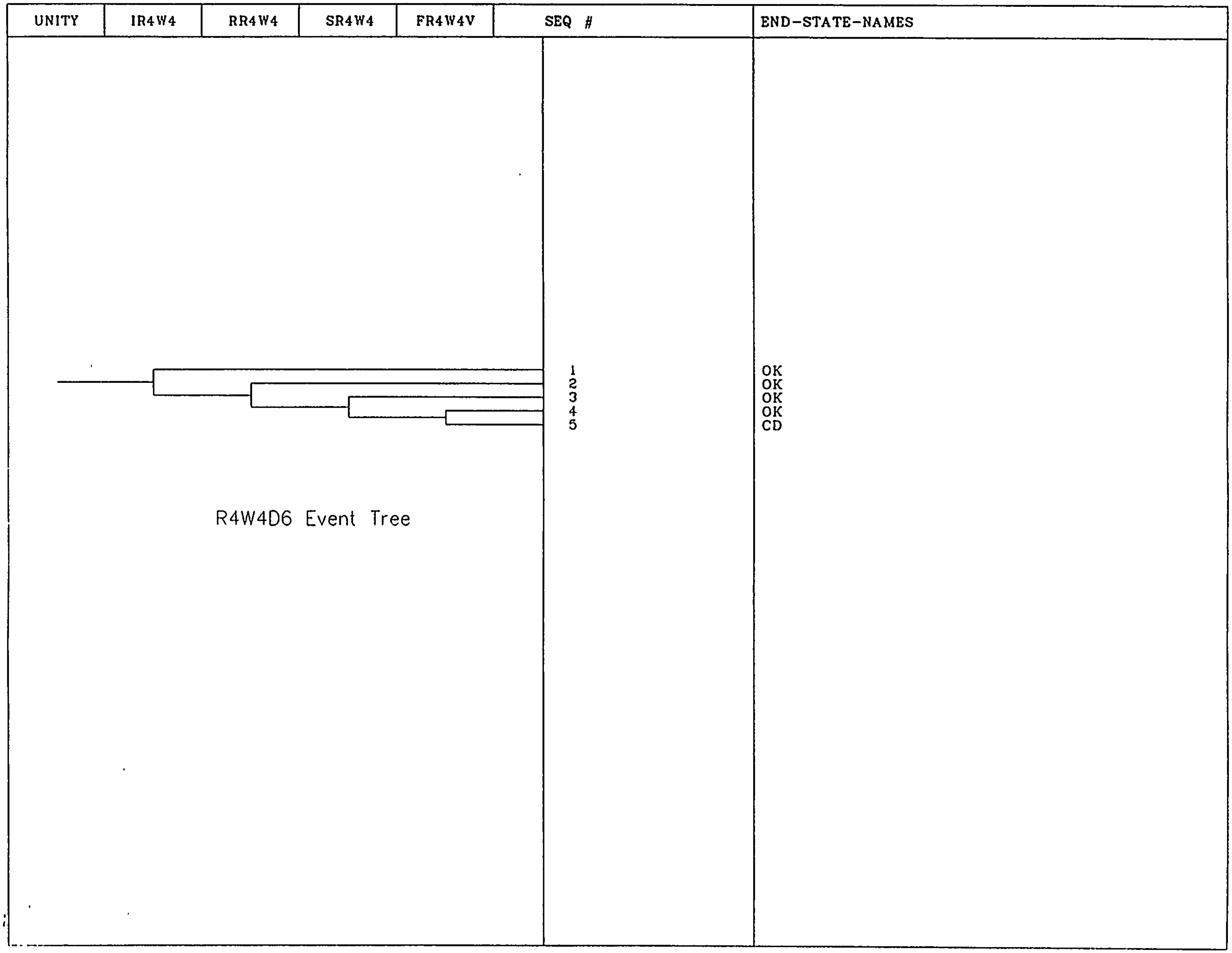
Gravity from RWST in RHR4, Window 3



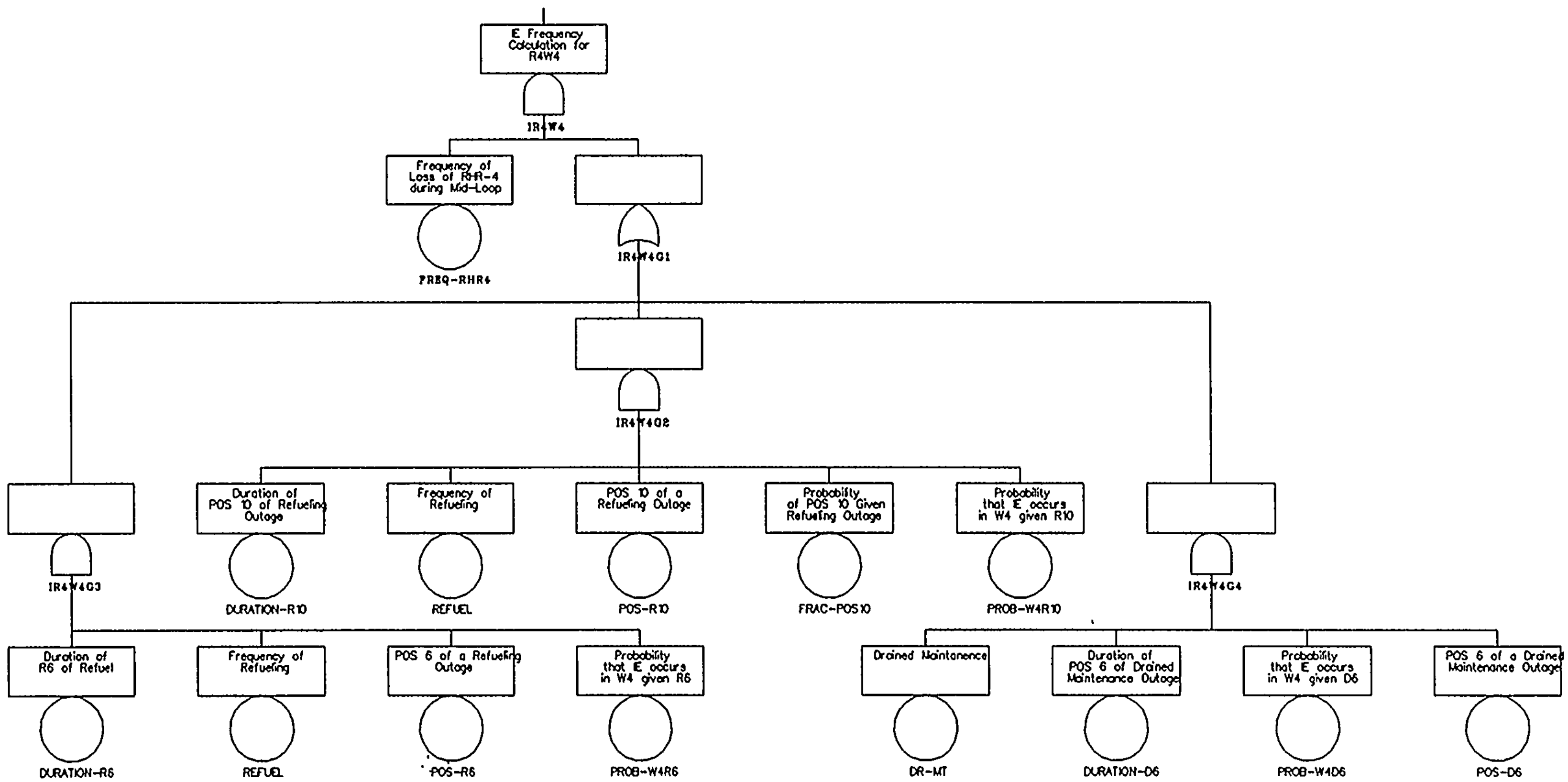

UNITY
IR4W4
RR4W4
VW4
FR4W4
GR4W4
SEQ #
END-STATE-NAMES
1 OK
2 OK
3 OK
4 OK
5 CD
6 OK
7 CD
R4W4R6 Event Tree



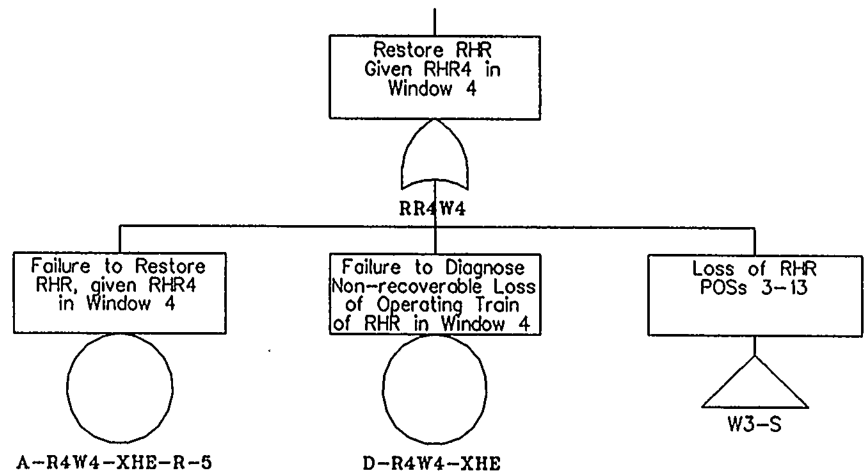
R4W4R10 Event Tree


UNITY
IR4W4
RR4W4
SR4W4
FR4W4V
SEQ #
END-STATE-NAMES
1 OK
2 OK
3 OK
4 OK
5 CD
R4W4D6 Event Tree

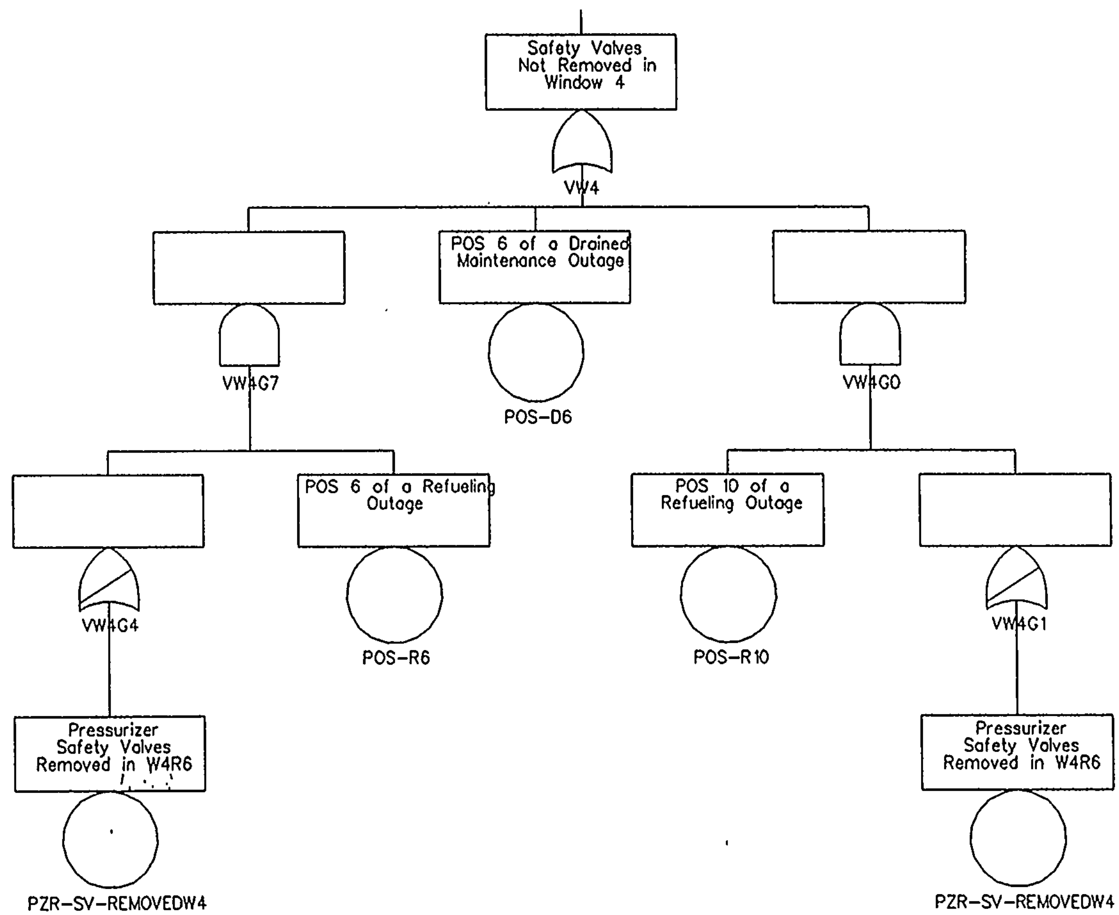
I top event for loss of RHR-4 in window 4



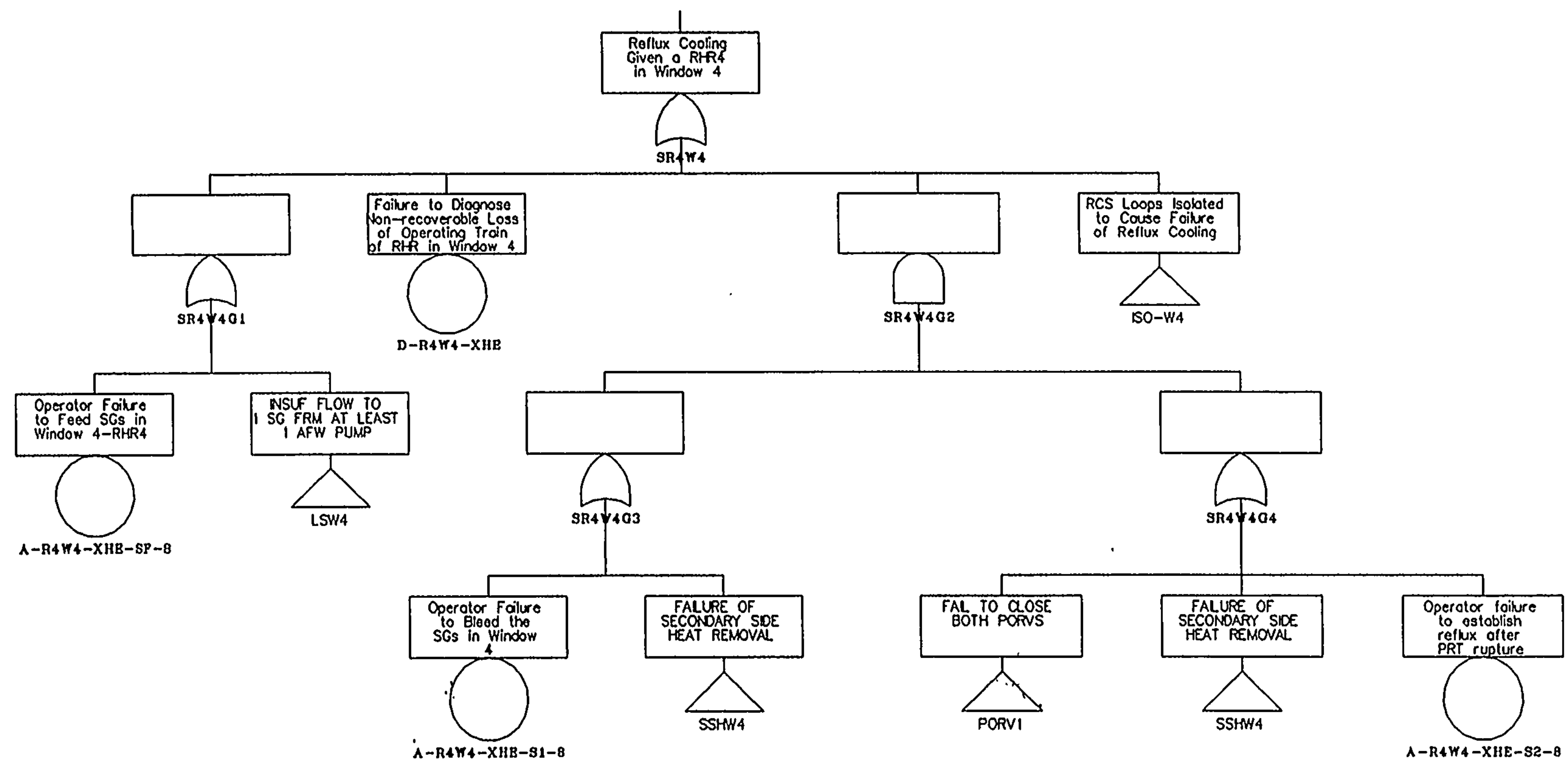
Restore RHR given RHR4 in Window 4



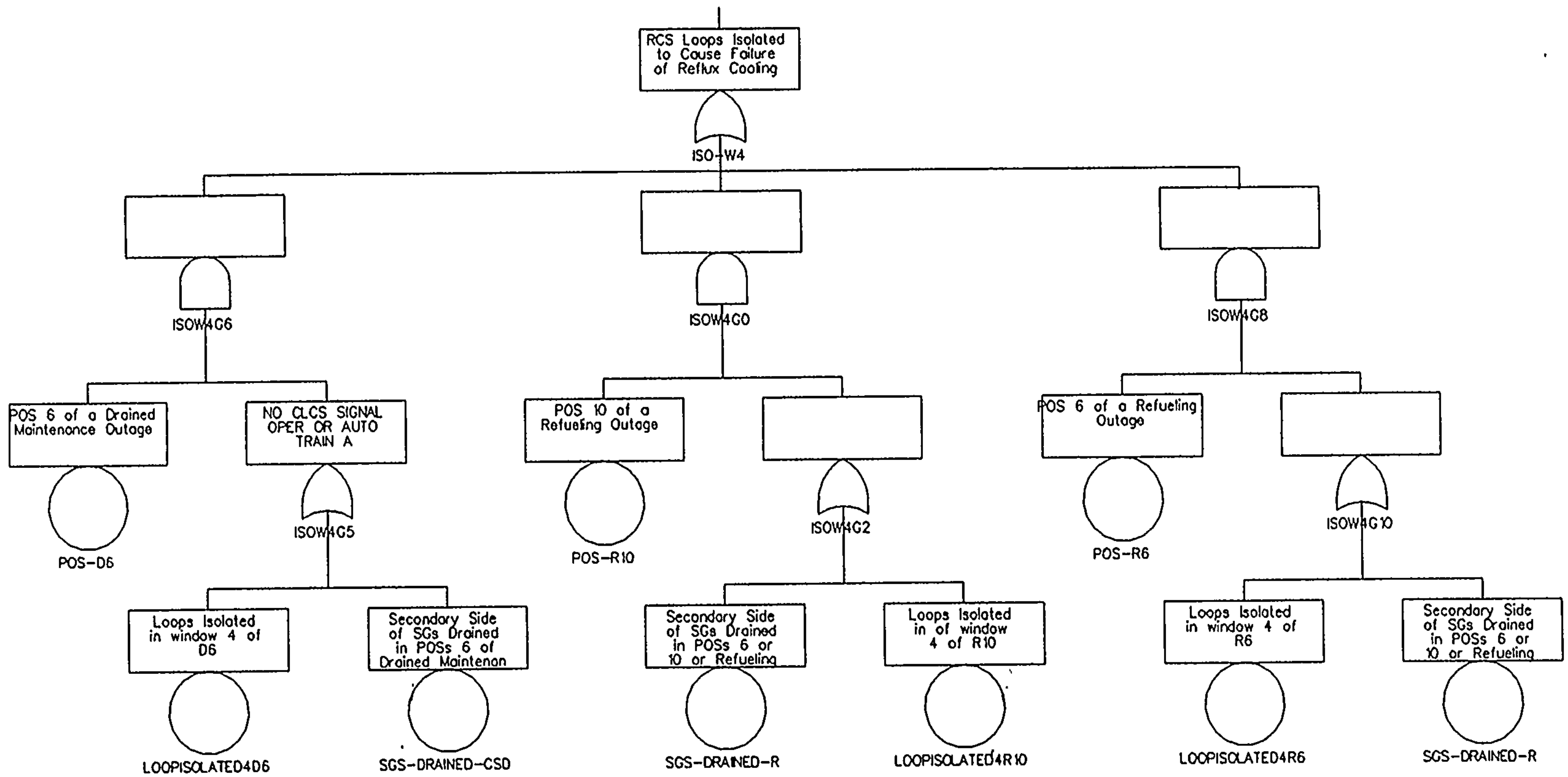
Safety Valves Not Removed in Window 4



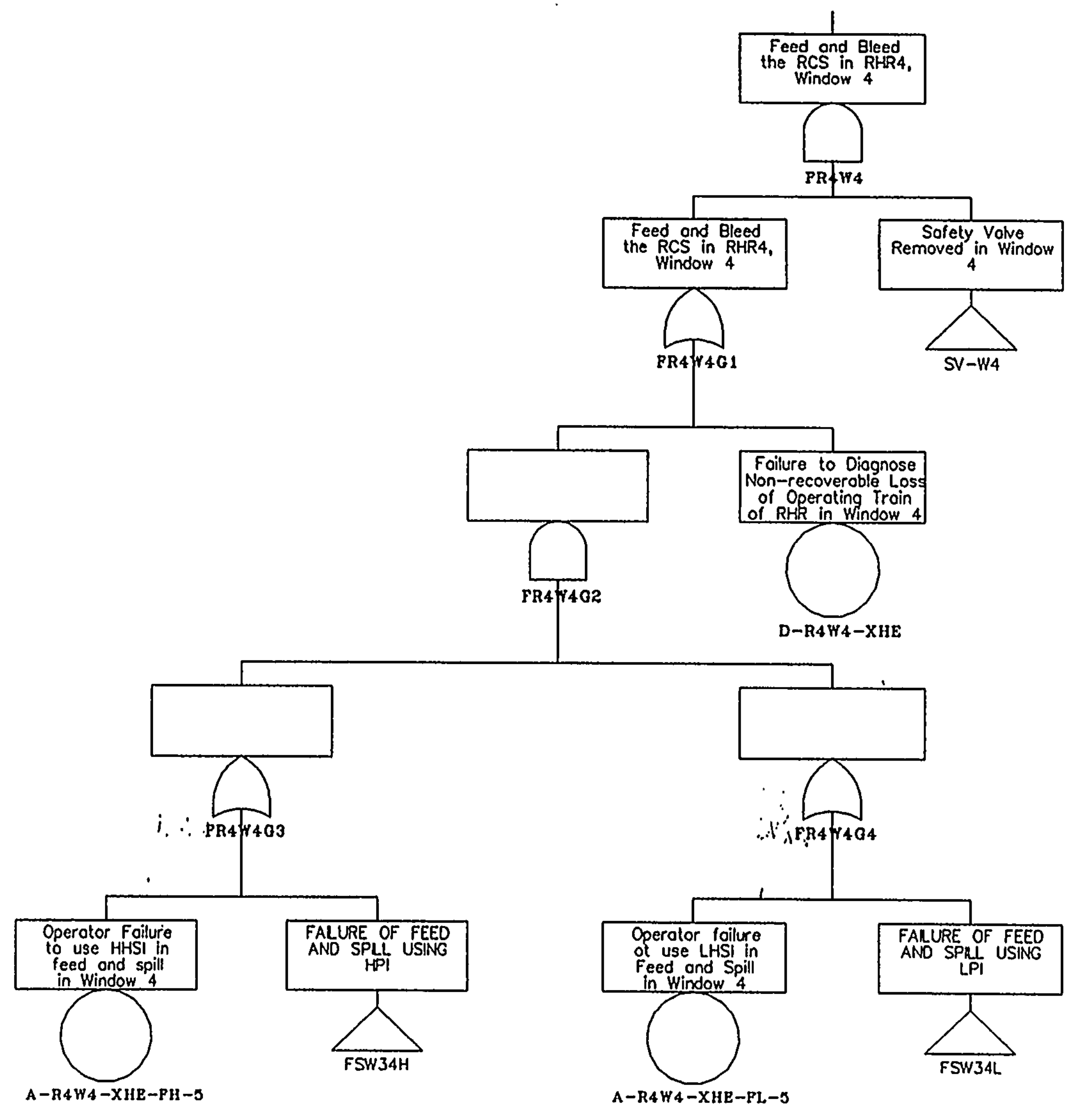
Reflux Cooling in Window 4



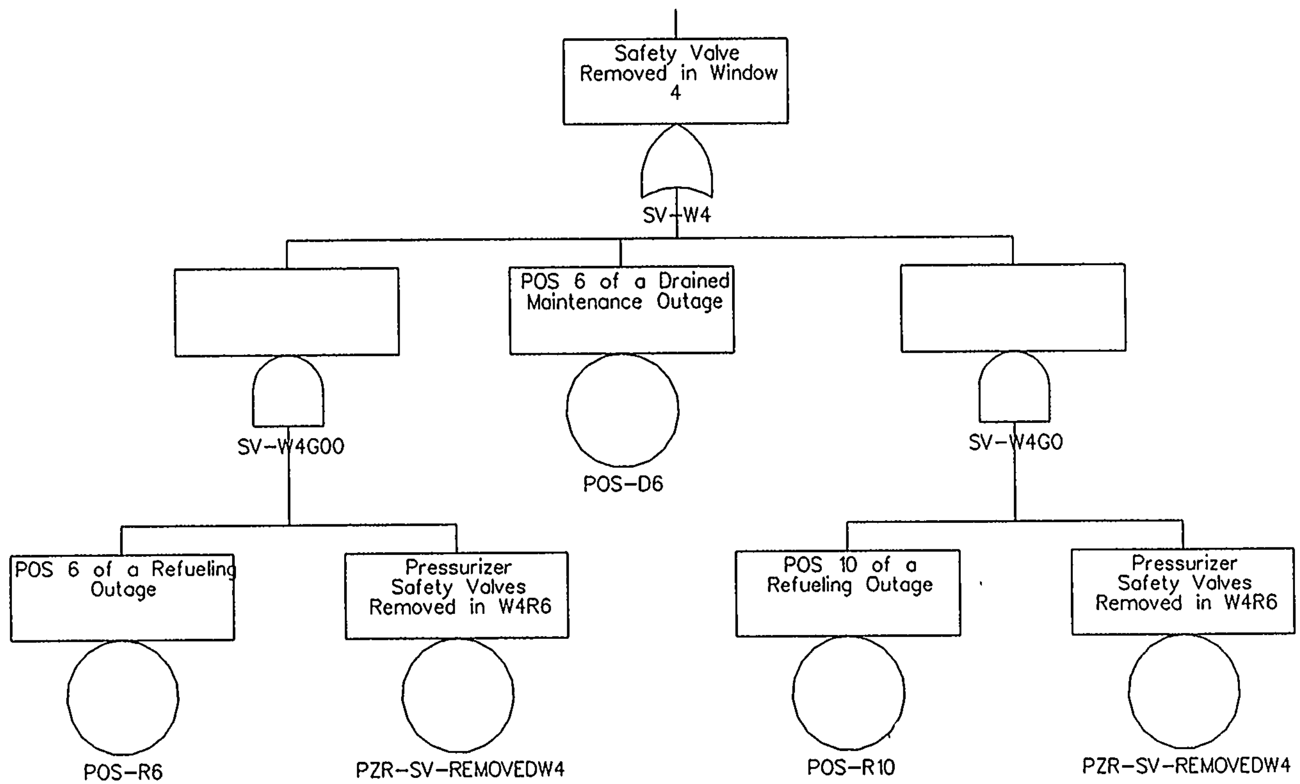
RCS Loops Isolated to Cause Failure of Reflux in Window 4



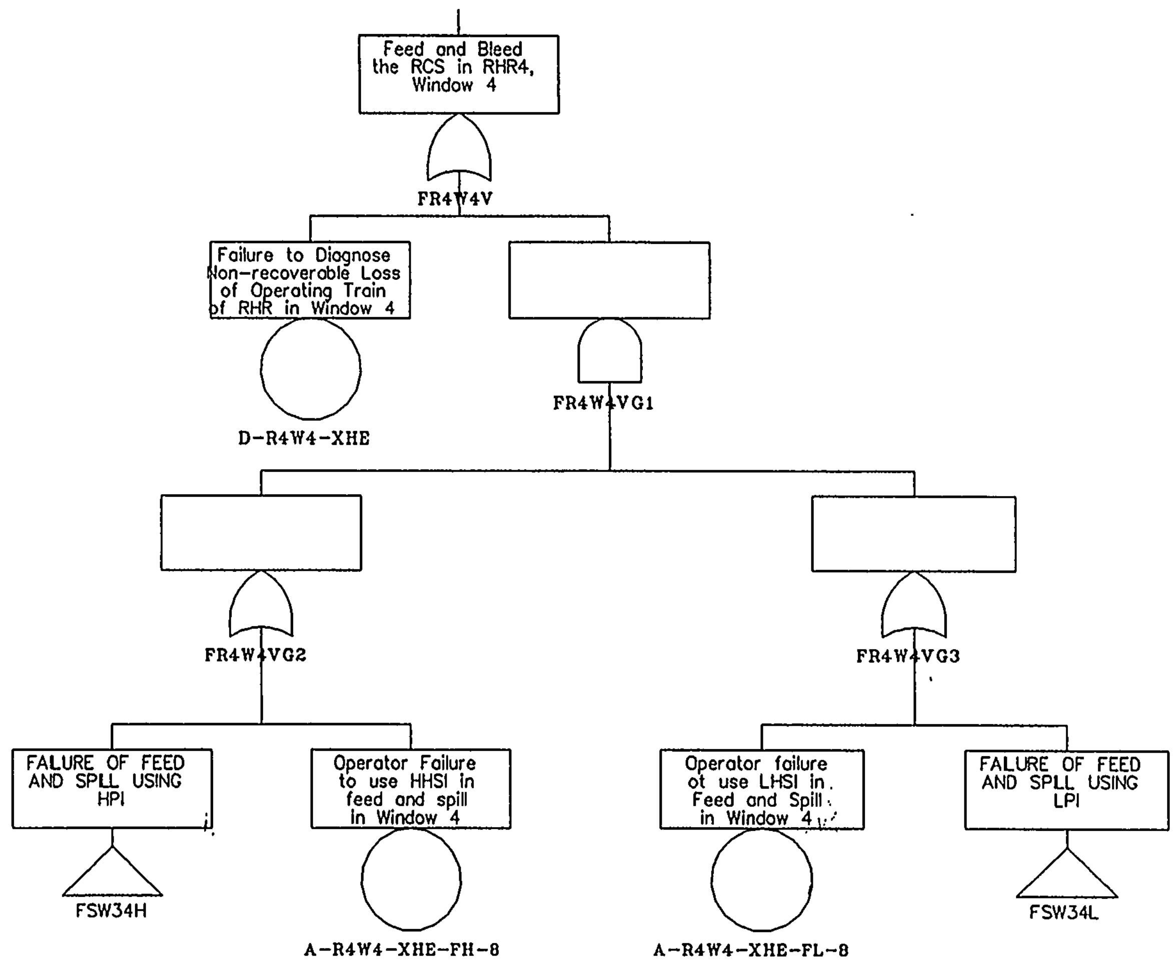
Feed and Bleed the RCS in RHR4, Window 4



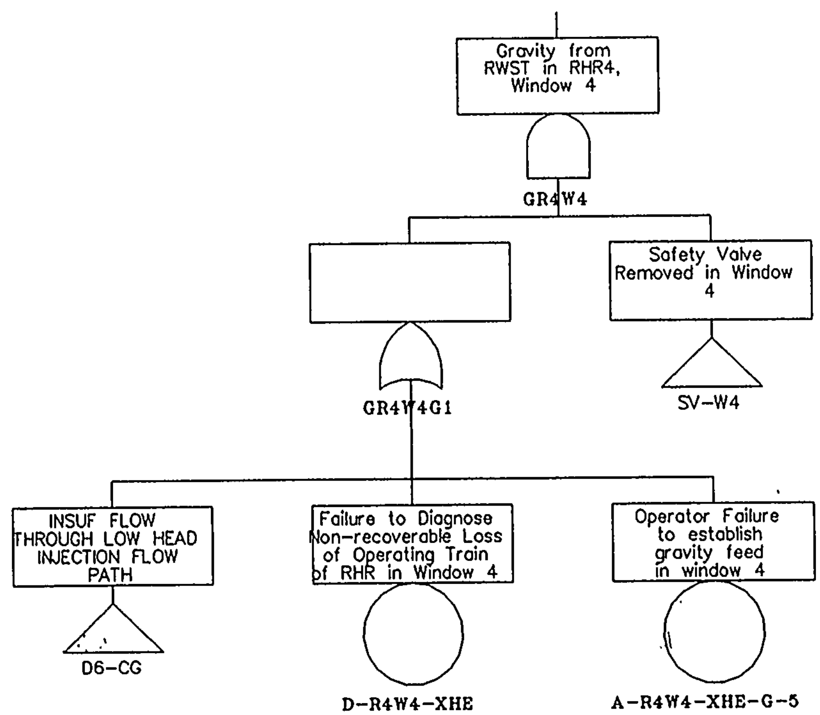
Safety Valves Removed in Window 4



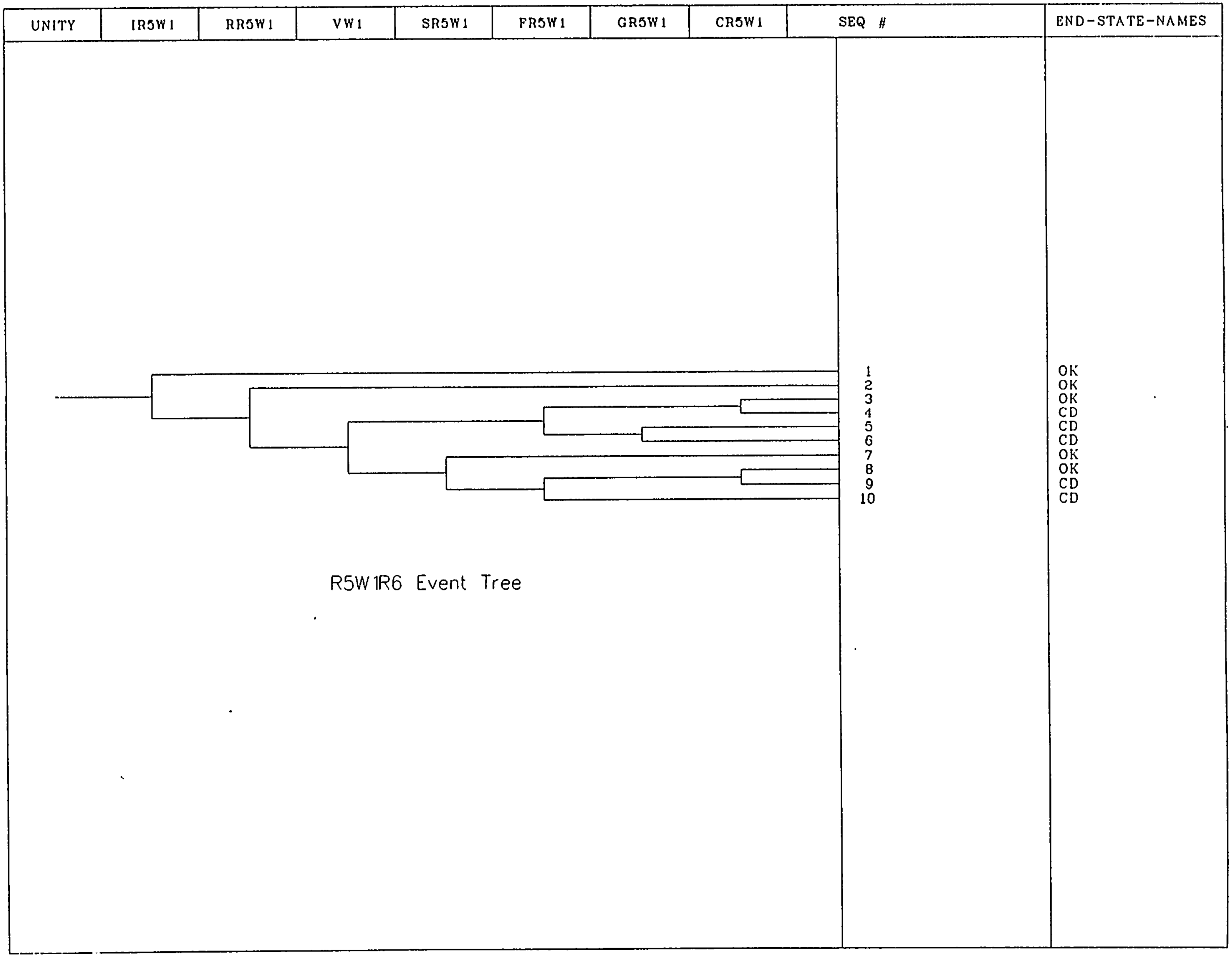
Feed and Bleed the RCS with V failed in RHR4, Window 4

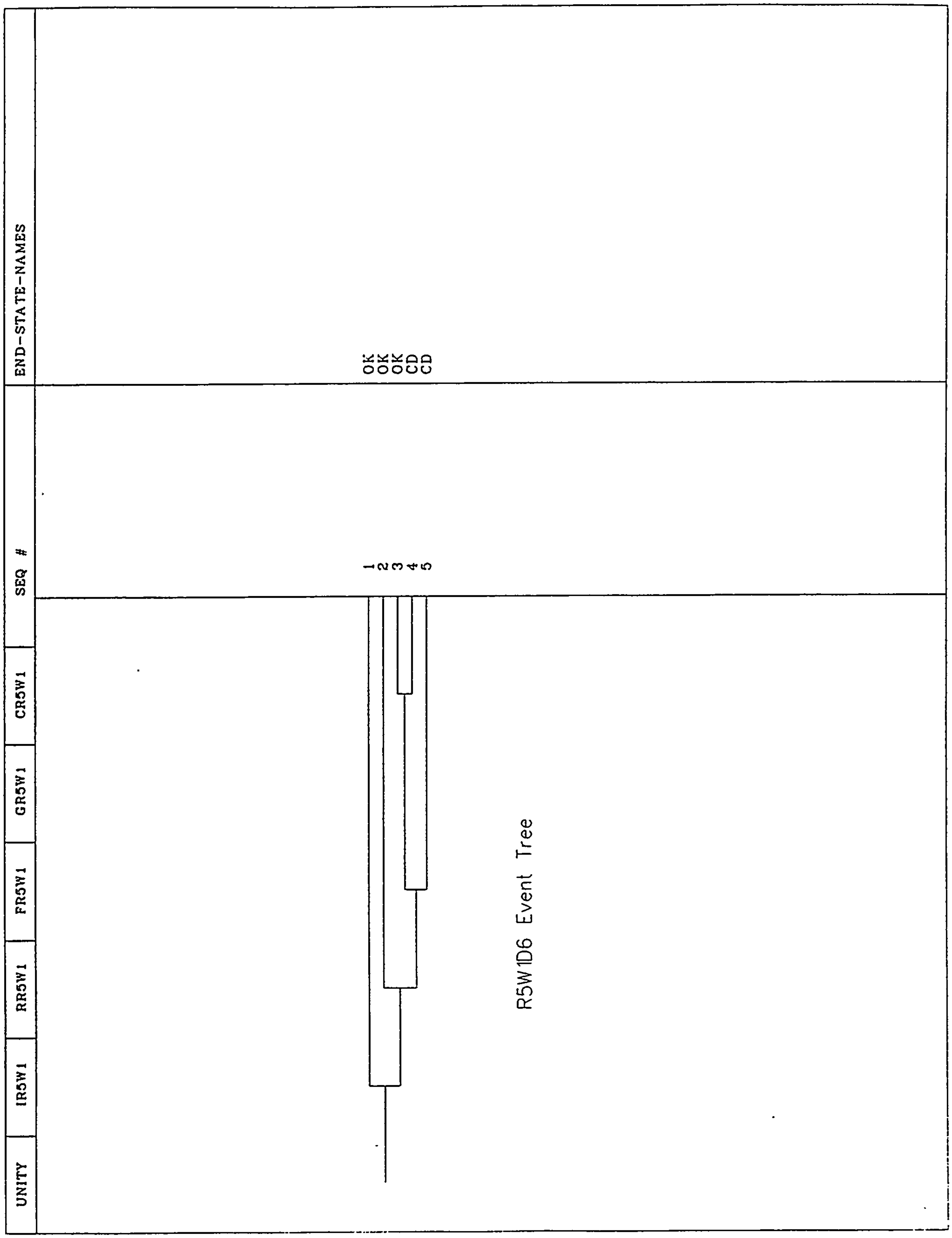


Gravity from RWST in RHR4, Window 4

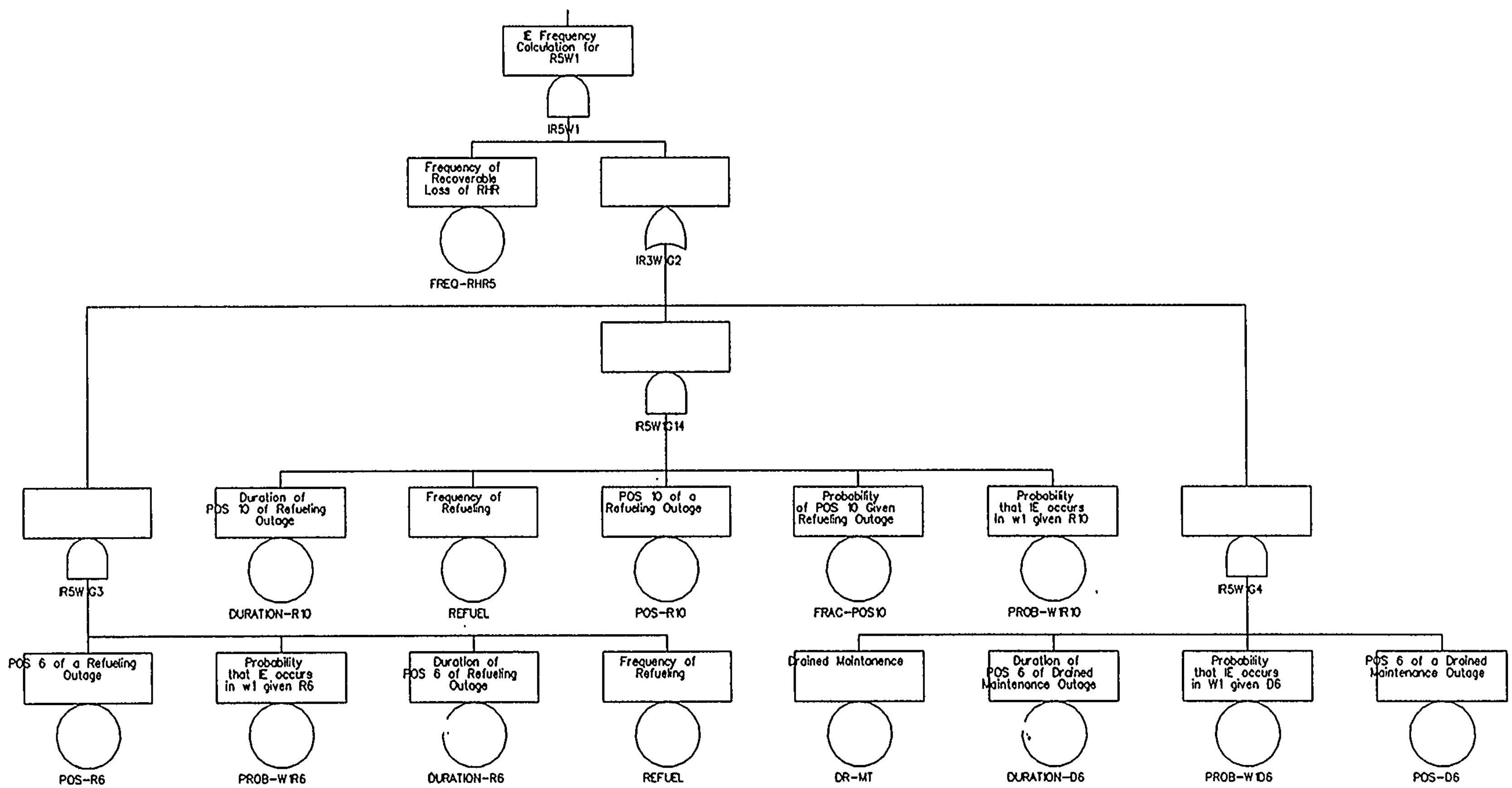


Appendix E.5 Event Trees and High Level Fault Trees for Recoverable Loss of RHR (RHR5)

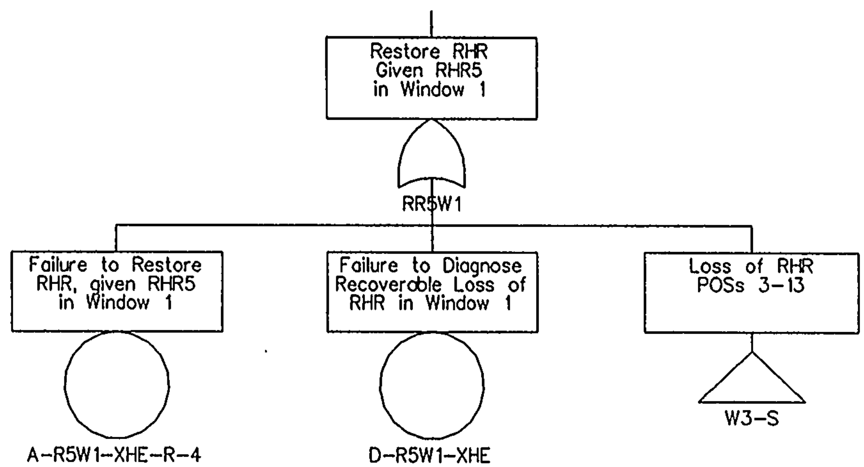

UNITY
IR5W1
RR5W1
VW1
SR5W1
FR5W1
GR5W1
CR5W1
SEQ #
END-STATE-NAMES
1 OK
2 OK
3 OK
4 CD
5 CD
6 CD
7 OK
8 OK
9 CD
10 CD
R5W1R6 Event Tree


UNITY
IR5W1
RR5W1
FR5W1
GR5W1
CR5W1
SEQ #
END-STATE-NAMES
1 OK
2 OK
3 OK
4 CD
5 CD
R5W1D6 Event Tree

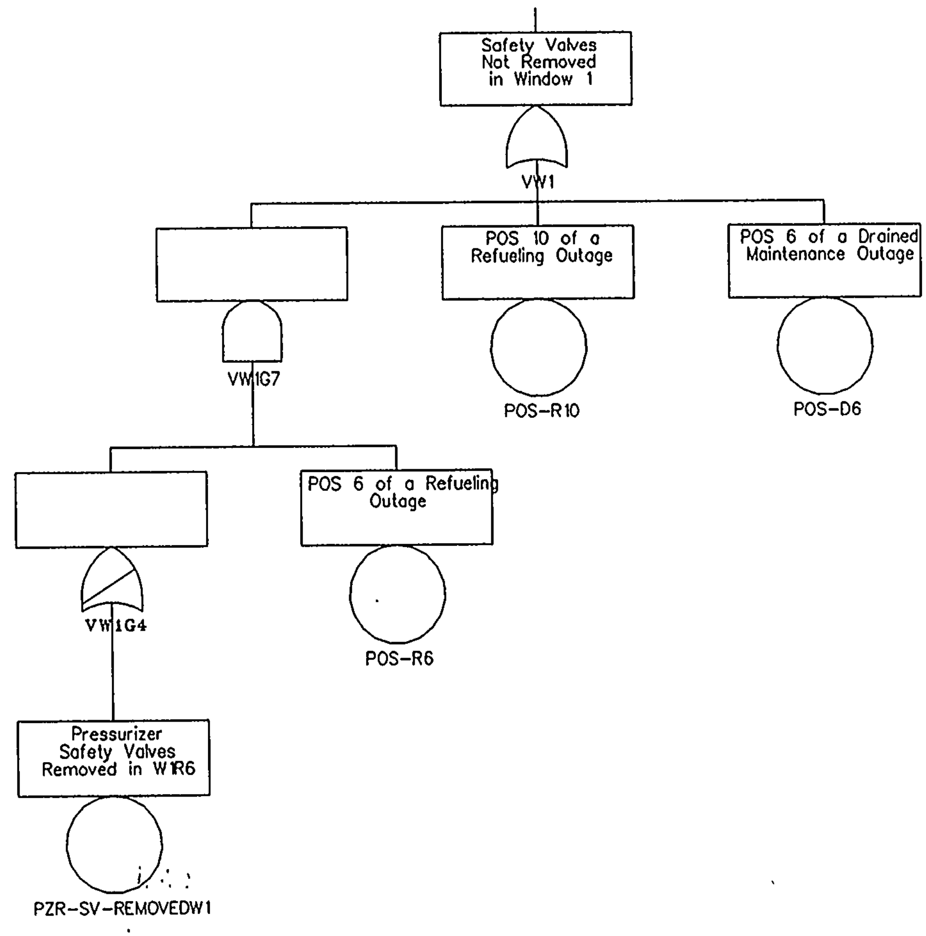
I top event for loss of RHR– R5 in Window 1



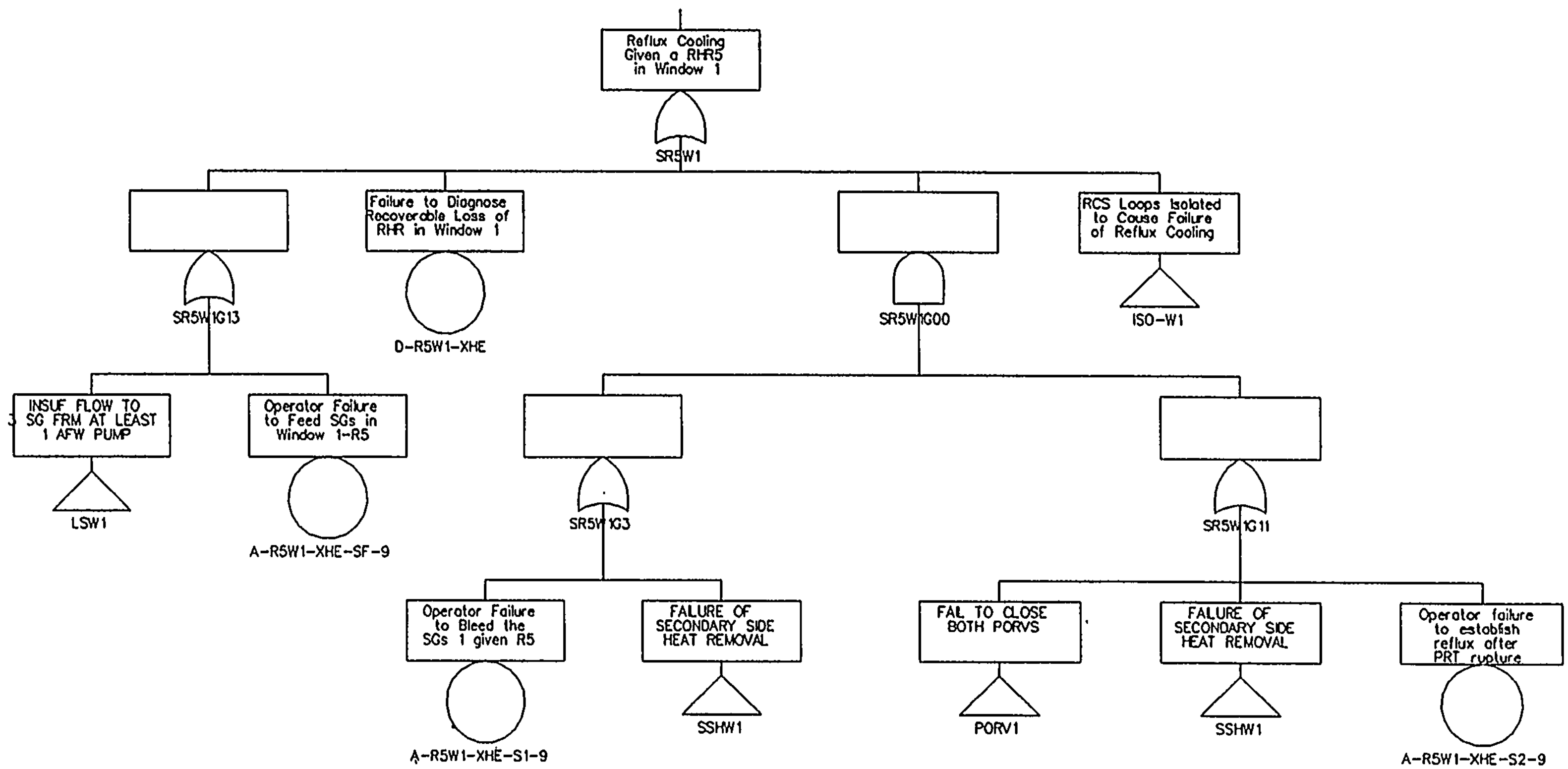
Restore RHR given RHR5 in Window 1



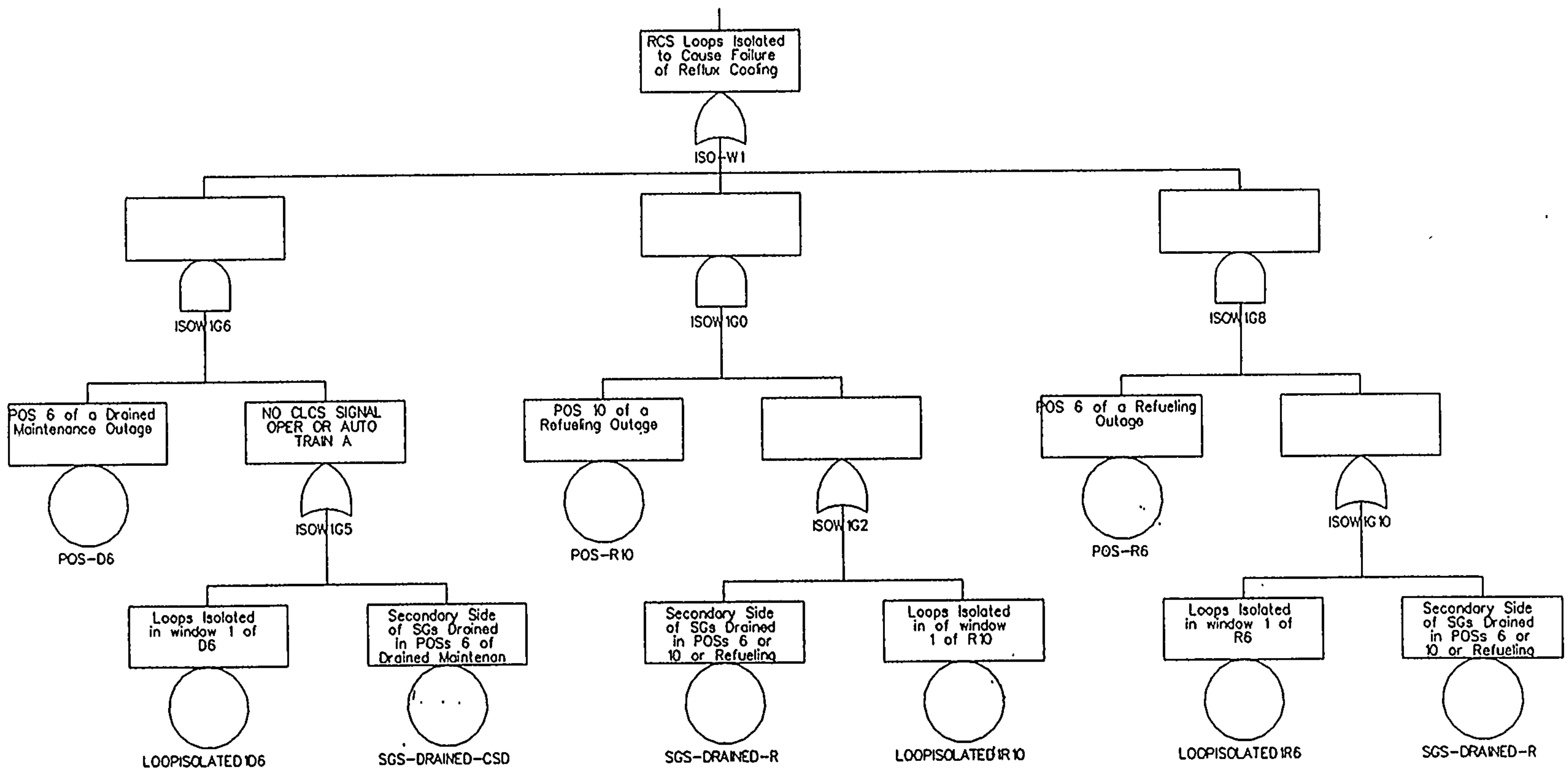
Safety Valves Not Removed in Window 1



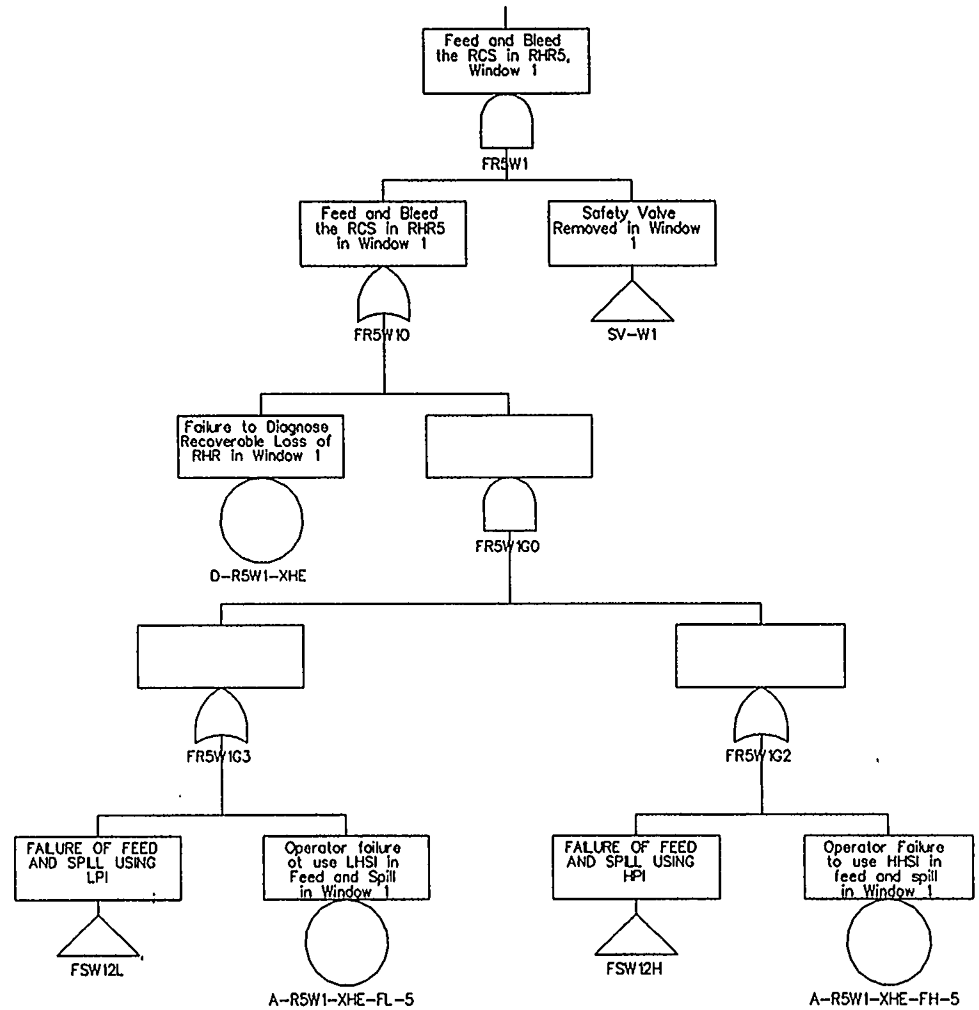
Reflux Cooling Given RHR5 in Window 1



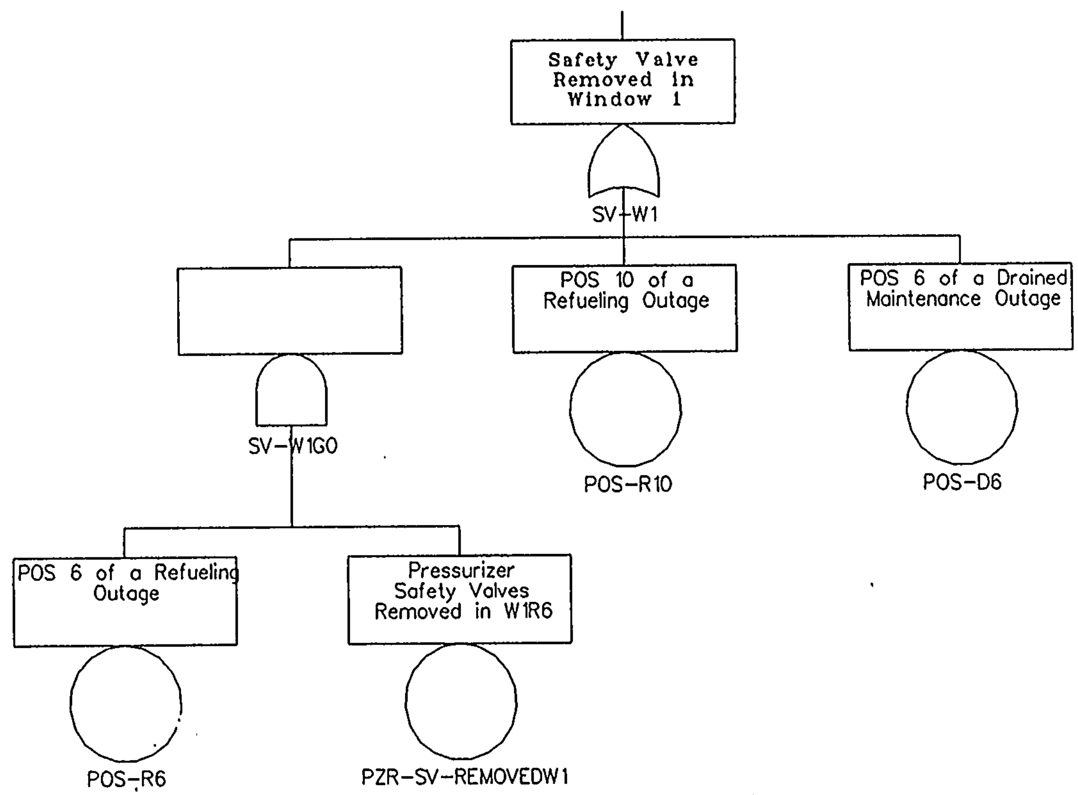
RCS Loops Isolated to Cause Failure of Reflux in Window 1



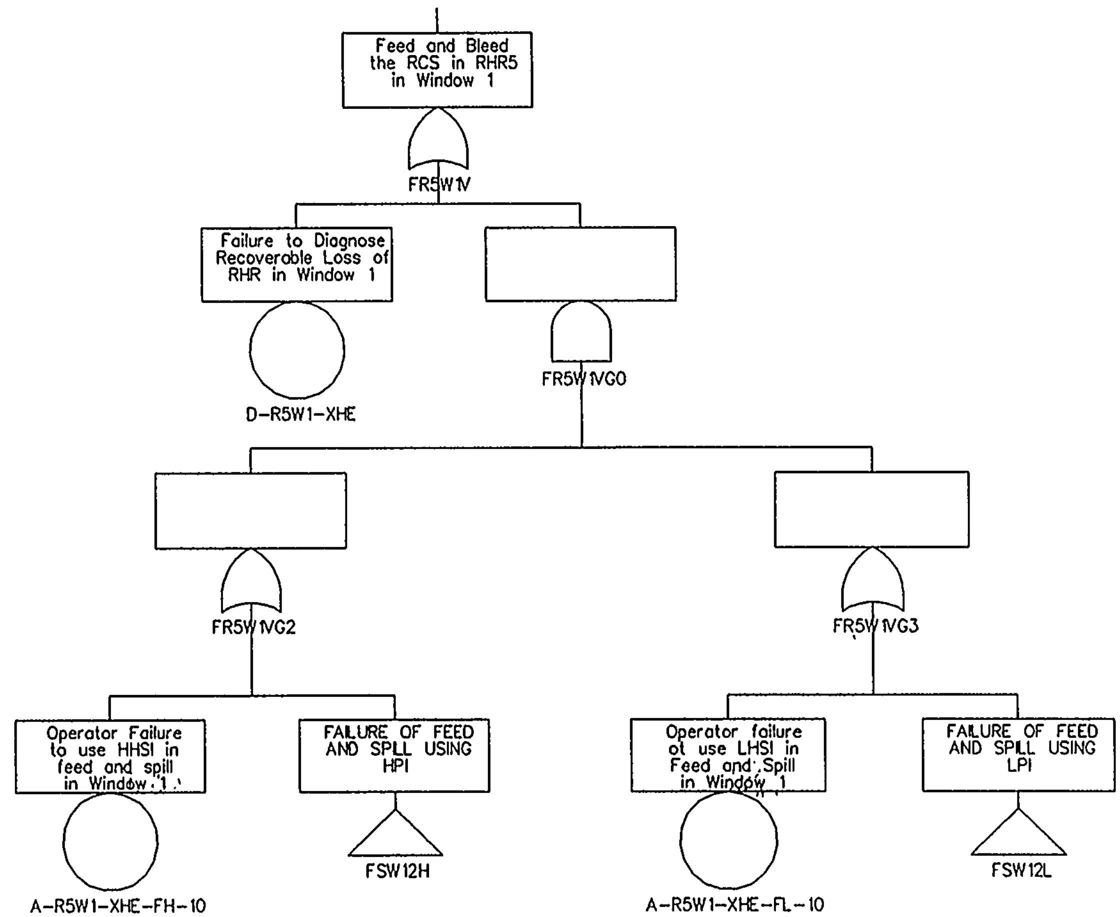
Feed and Bleed the RCS in RHR5, Window 1



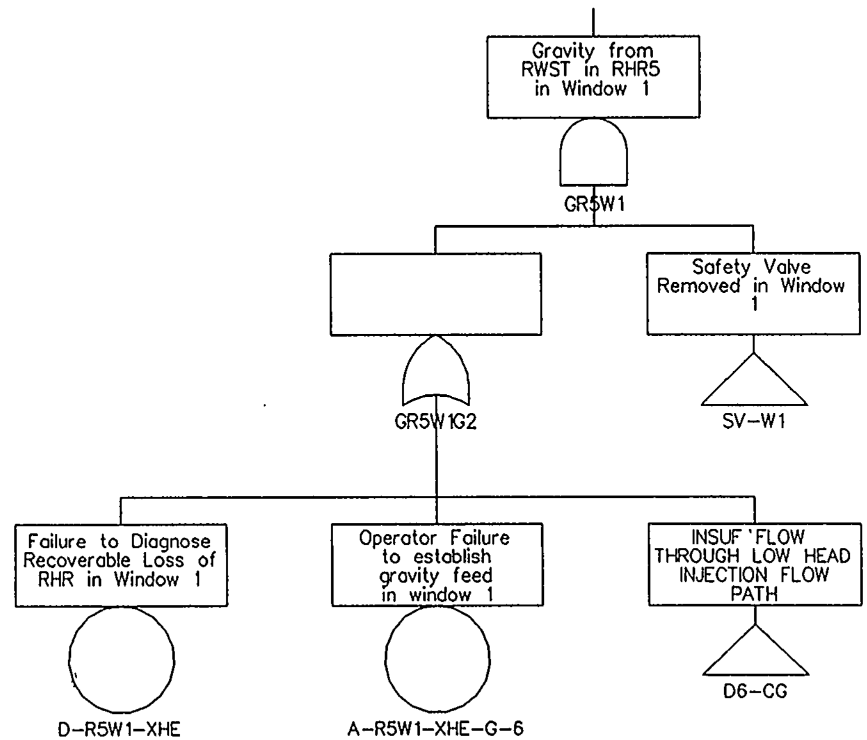
Safety Valves Removed in Window 1



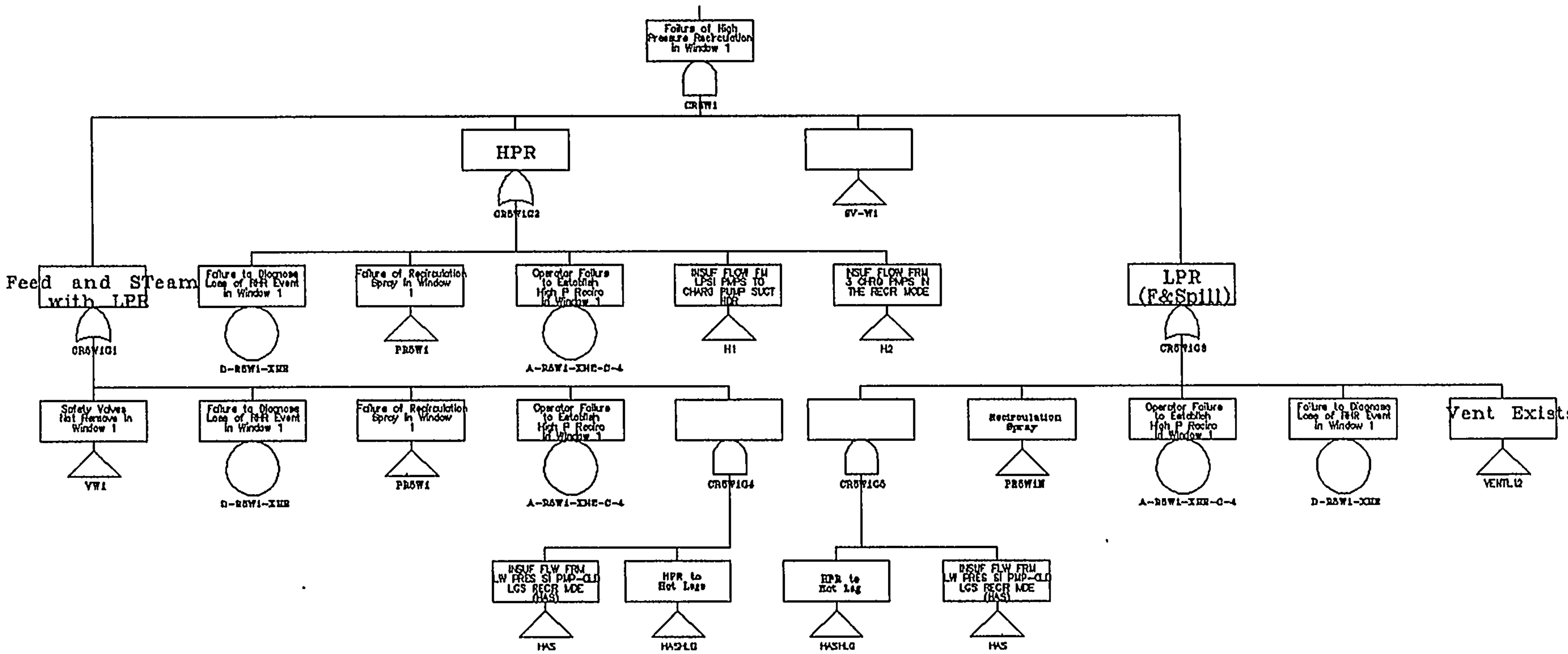
Feed and Bleed the RCS with V failed in RHR5, Window 1



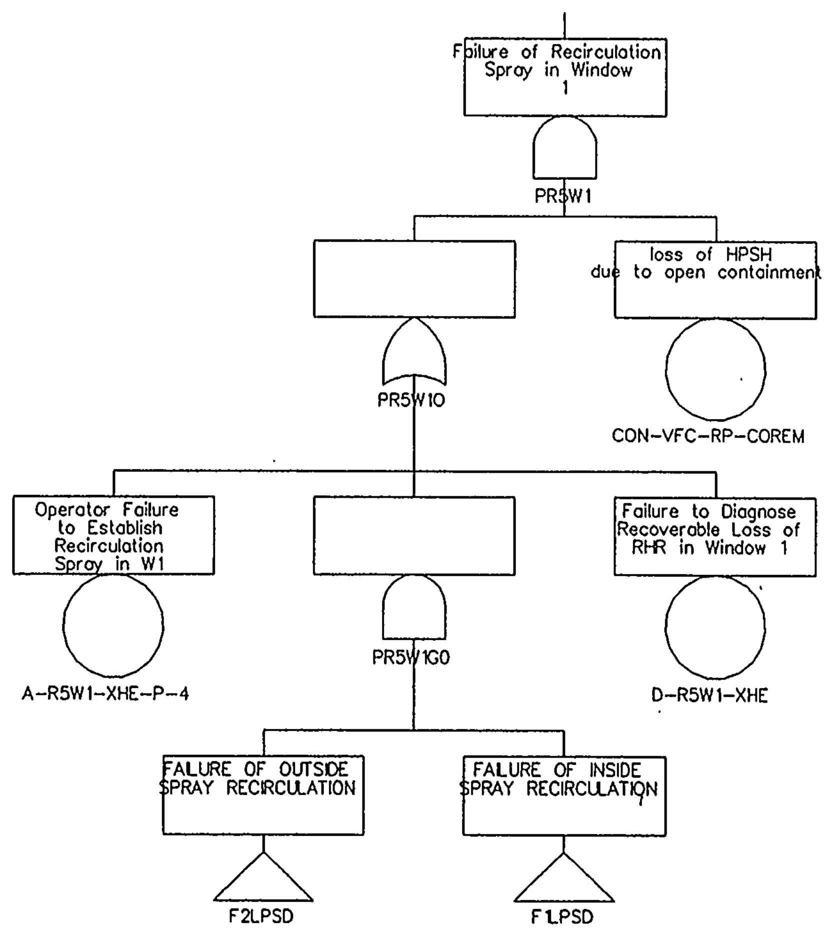
Gravity from RWST in RHR5, Window 1



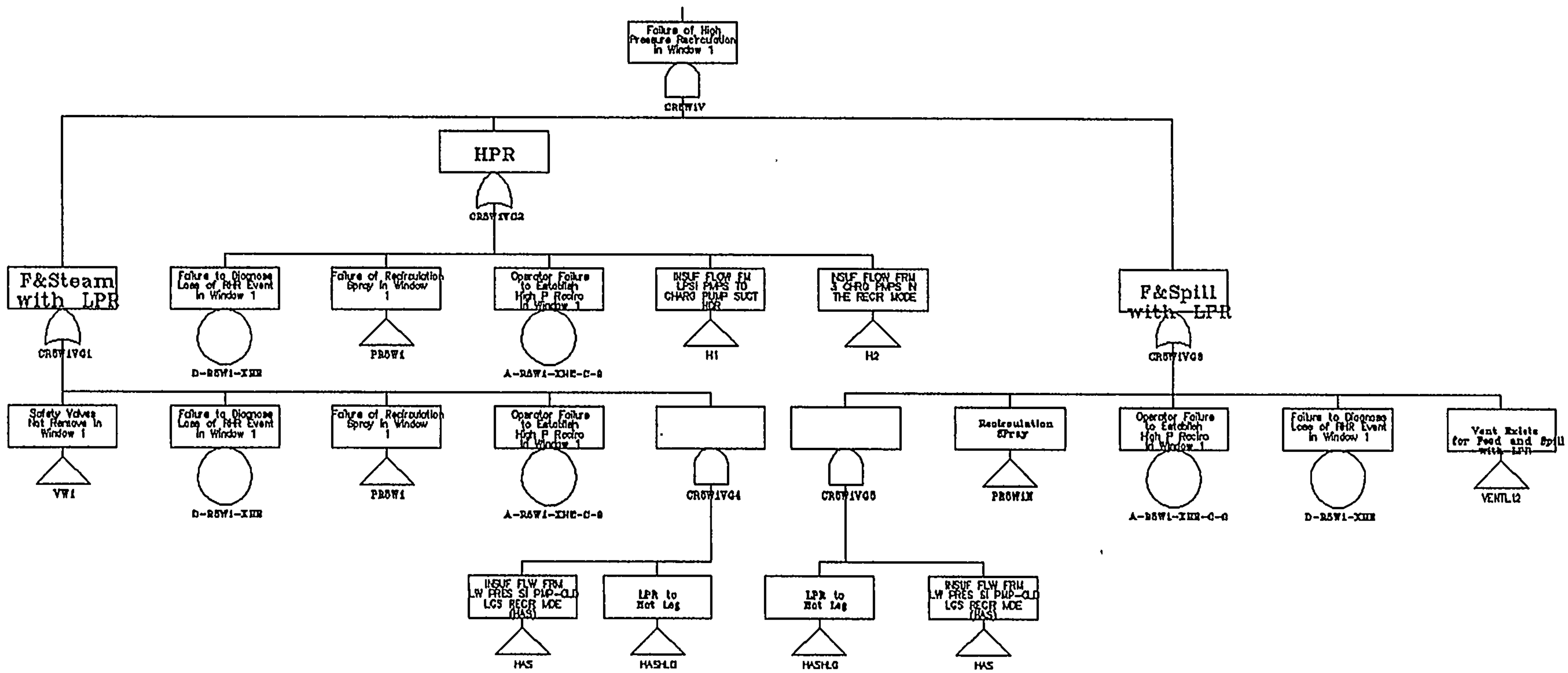
Failure of High Pressure Recirculation in Window 1

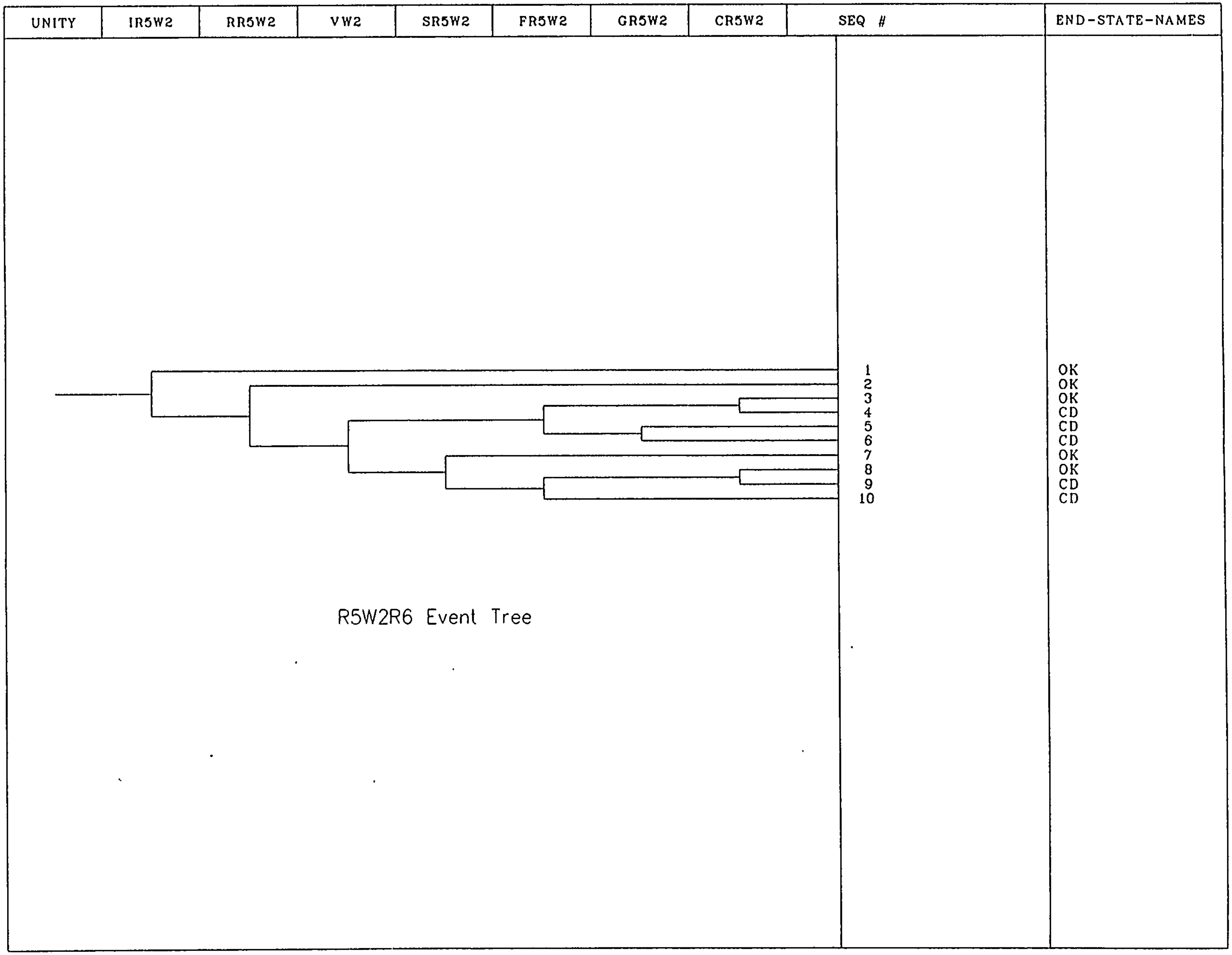


Failure of Recirculation Spray in Window 1-cause HPR failure for RHR5 Event

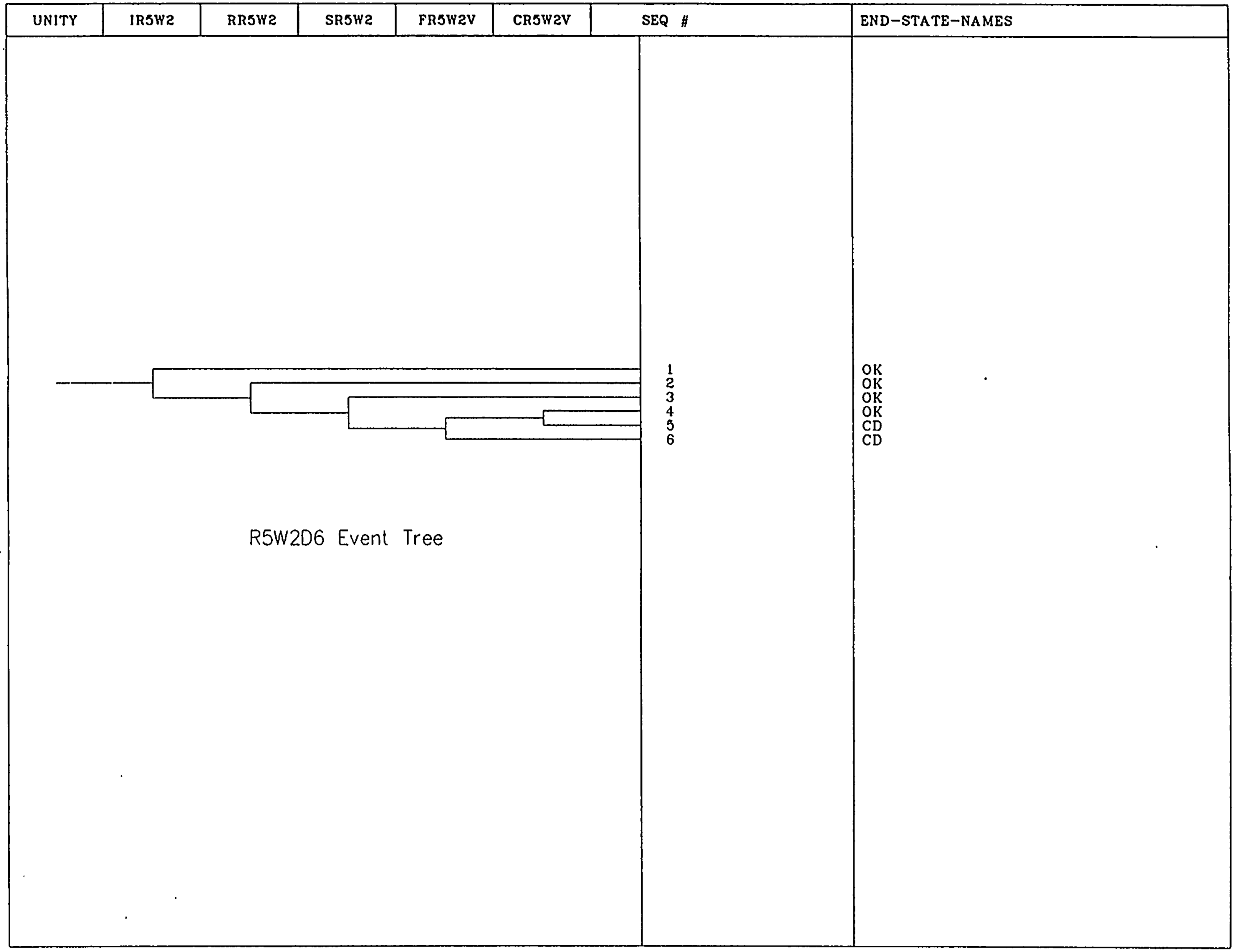


Failure of High Pressure Recirculation in Window 1

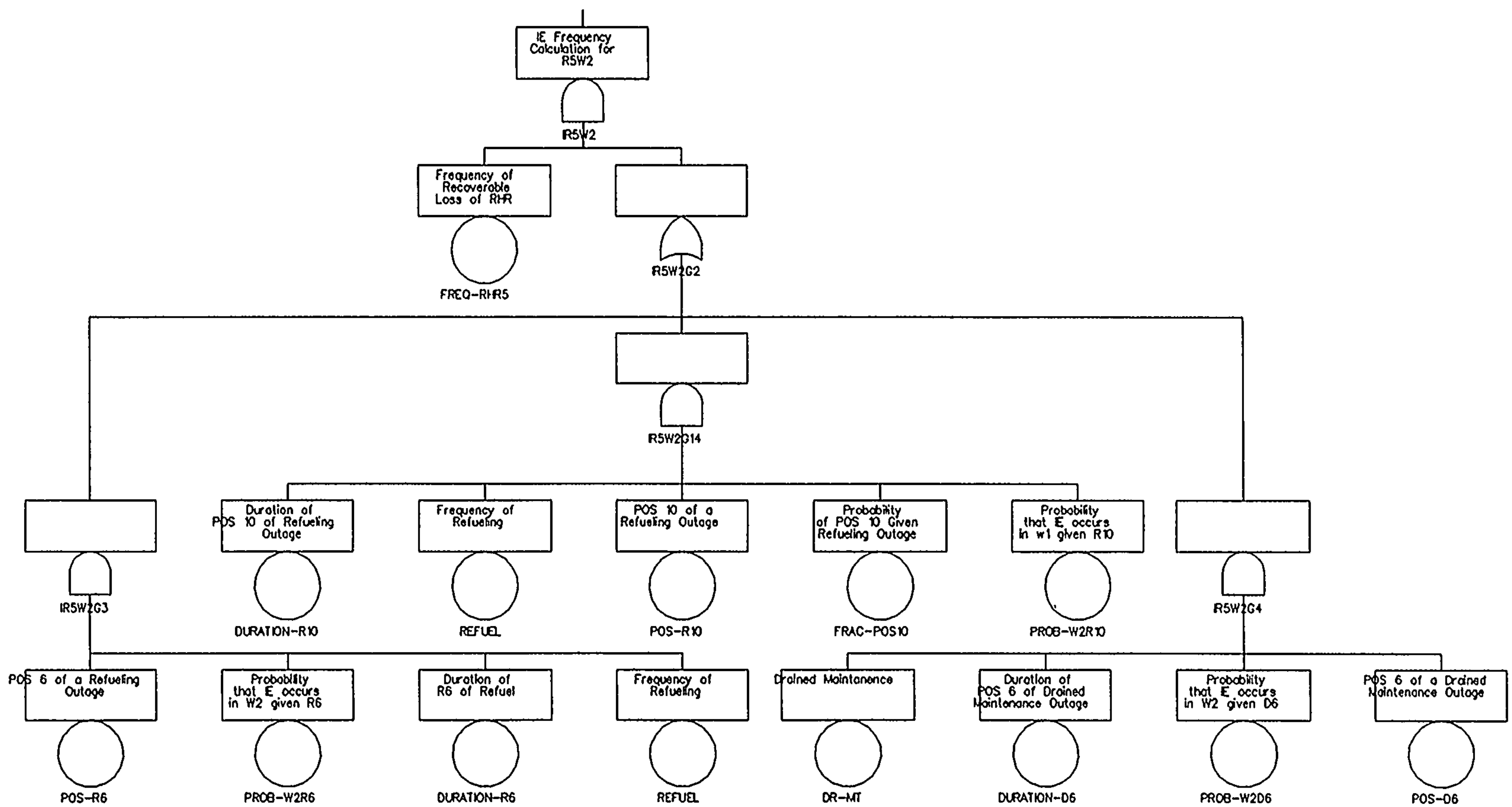




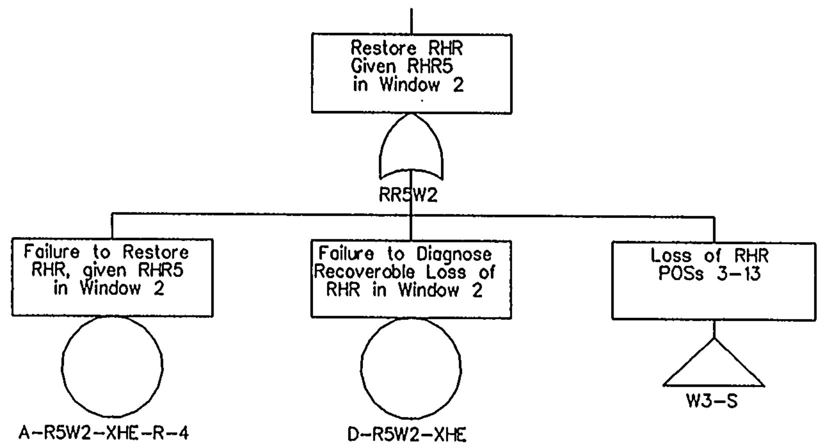
R5W2R6 Event Tree


UNITY
IR5W2
RR5W2
SR5W2
FR5W2V
CR5W2V
SEQ #
END-STATE-NAMES
1 OK
2 OK
3 OK
4 OK
5 CD
6 CD
R5W2D6 Event Tree

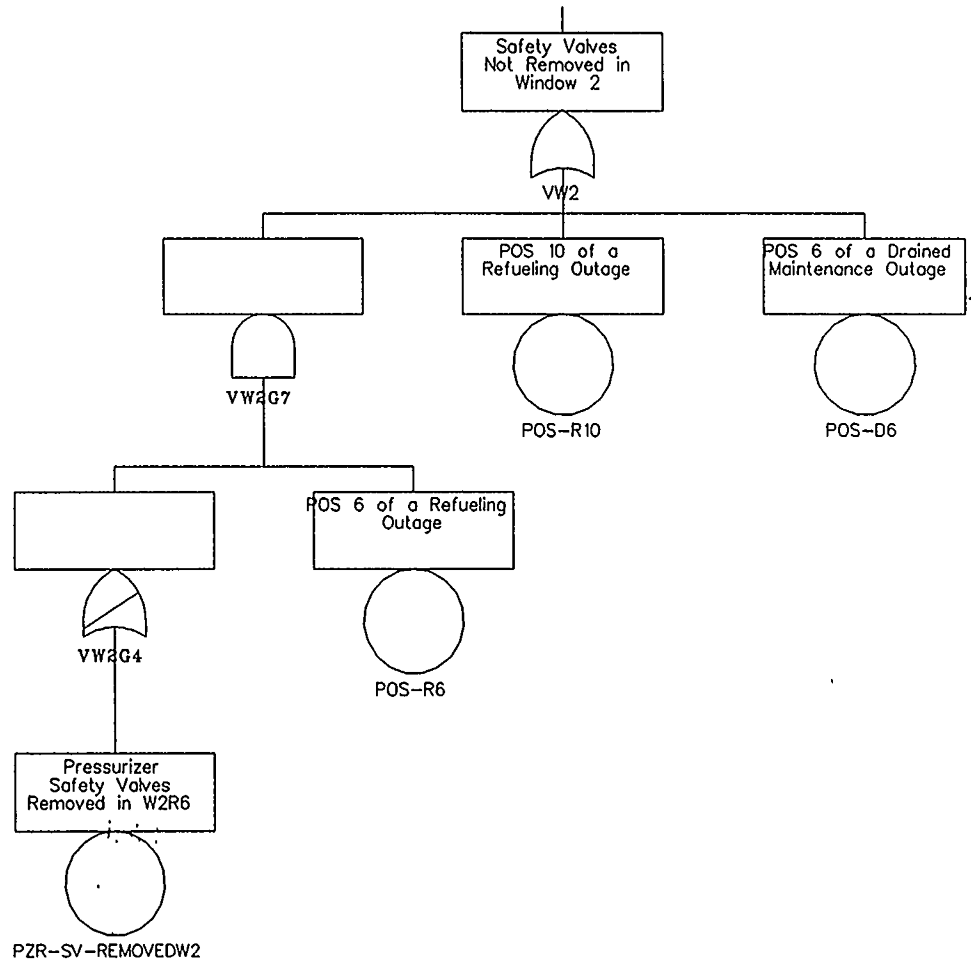
I Top Event for Loss of RHR- R5 in Window 2



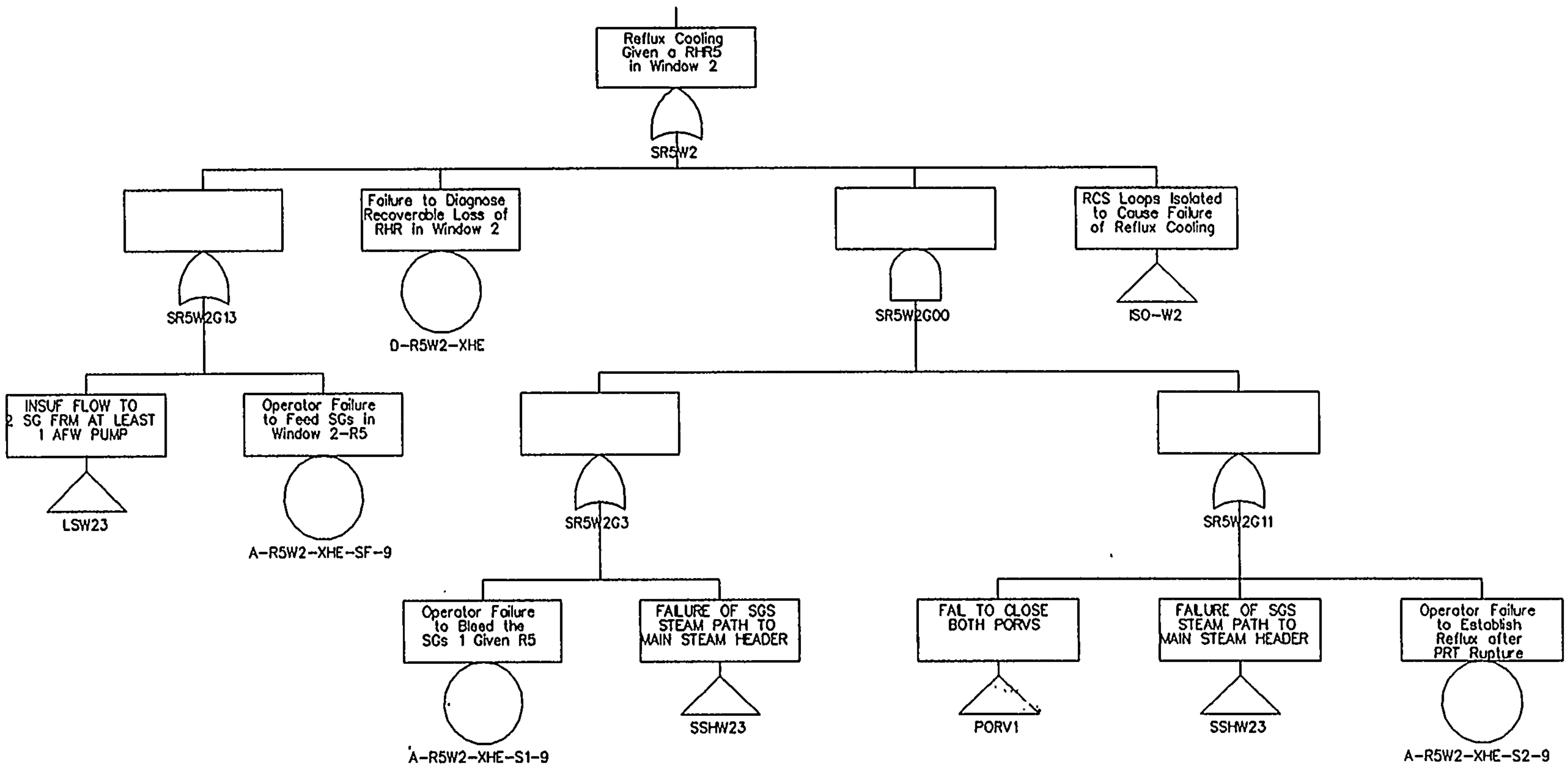
Restore RHR given RHR5 in Window 2



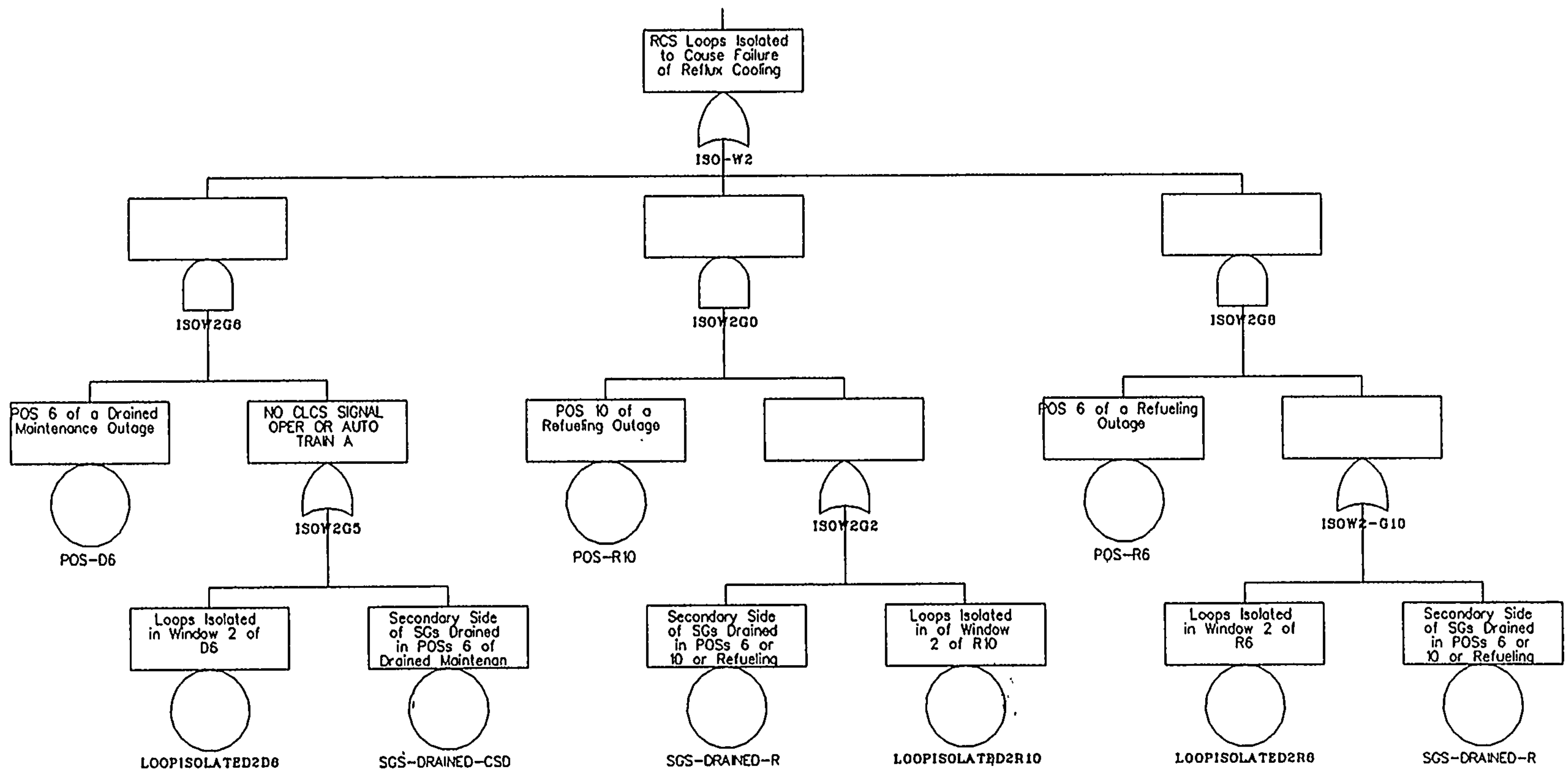
Safety Valves Not Removed in Window 2



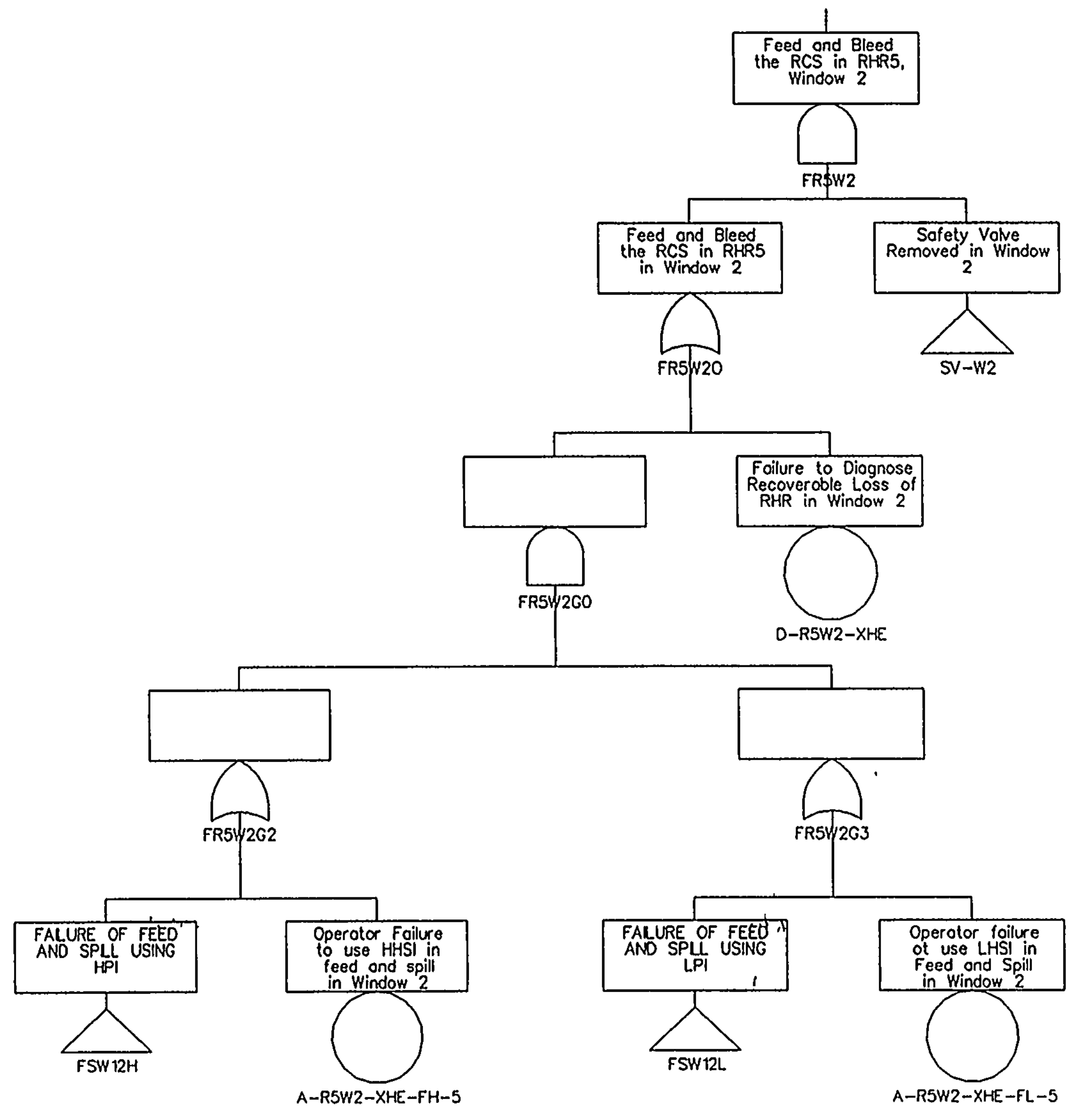
Reflux Cooling Given RHR5 in Window 2



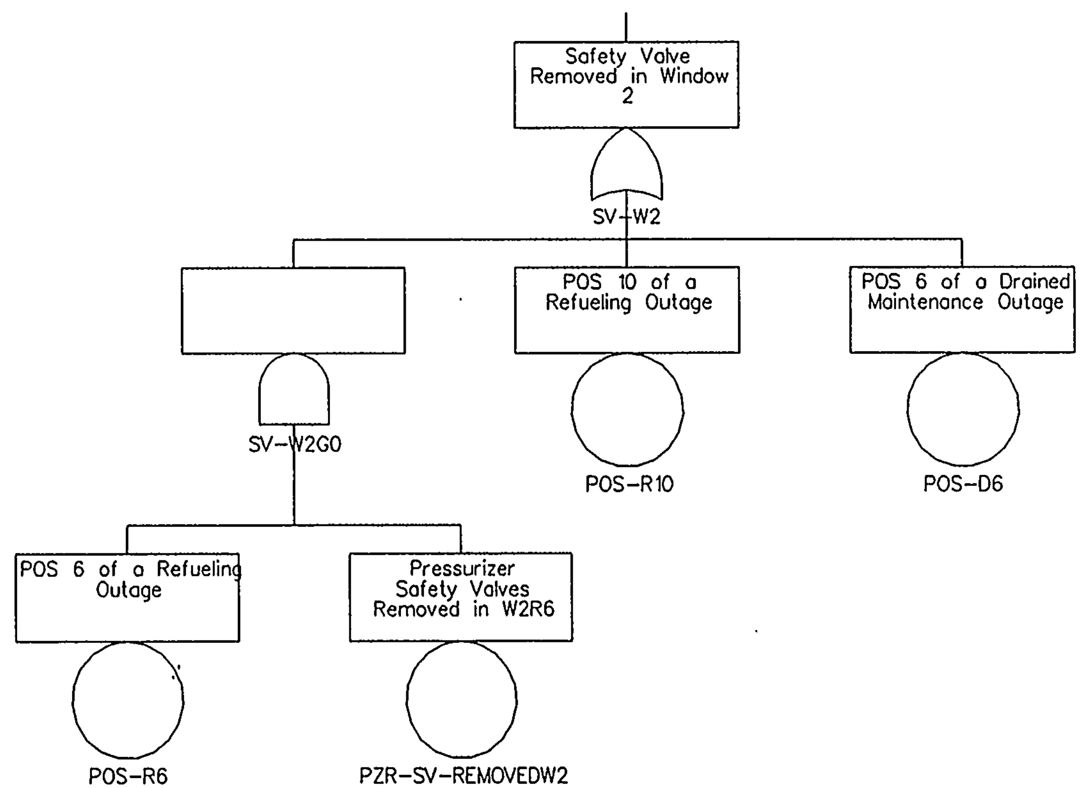
RCS Loops Isolated to Cause Failure of Reflux in Window 2



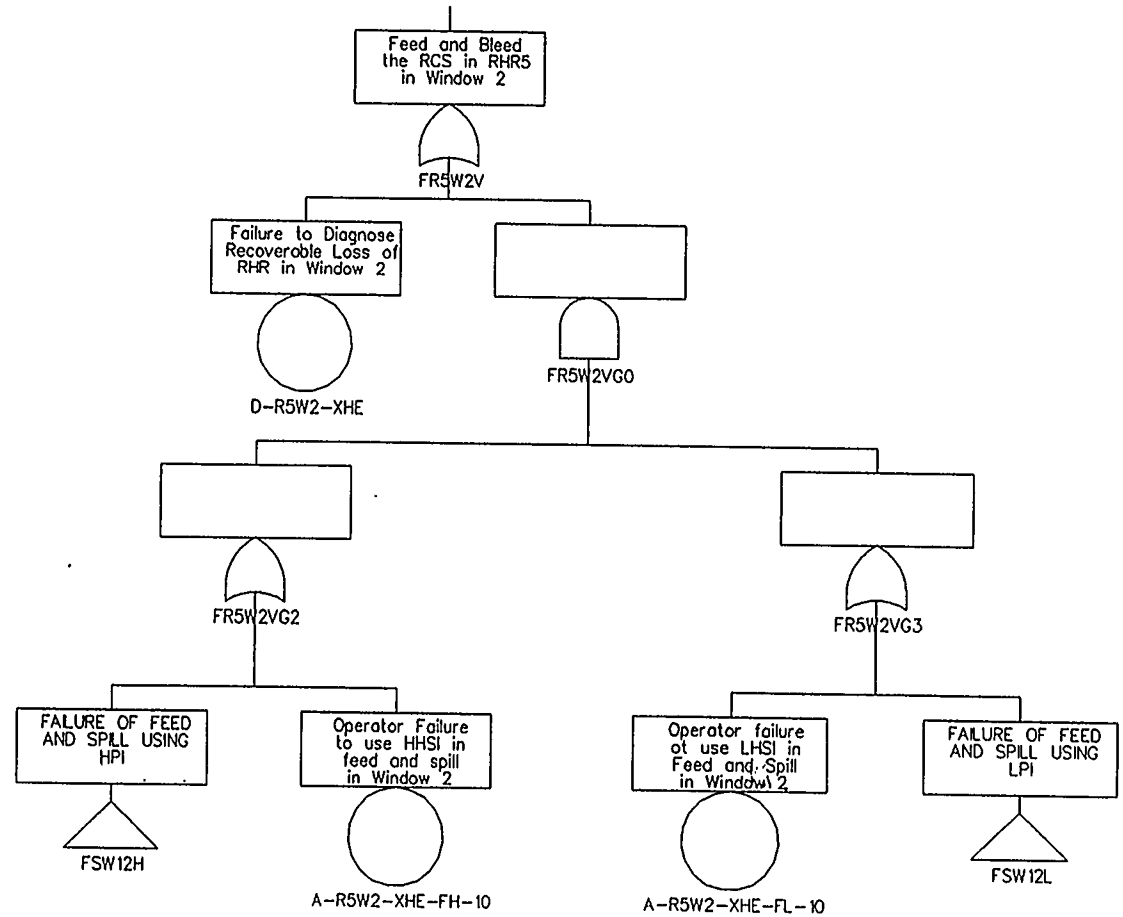
Feed and Bleed the RCS in RHR5, Window 2



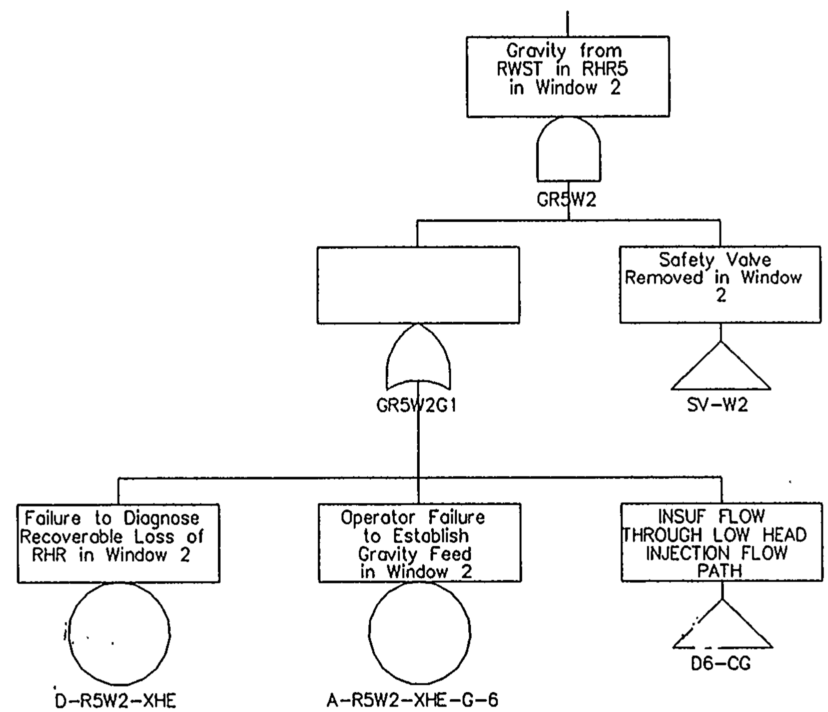
Safety Valves Removed in Window 2



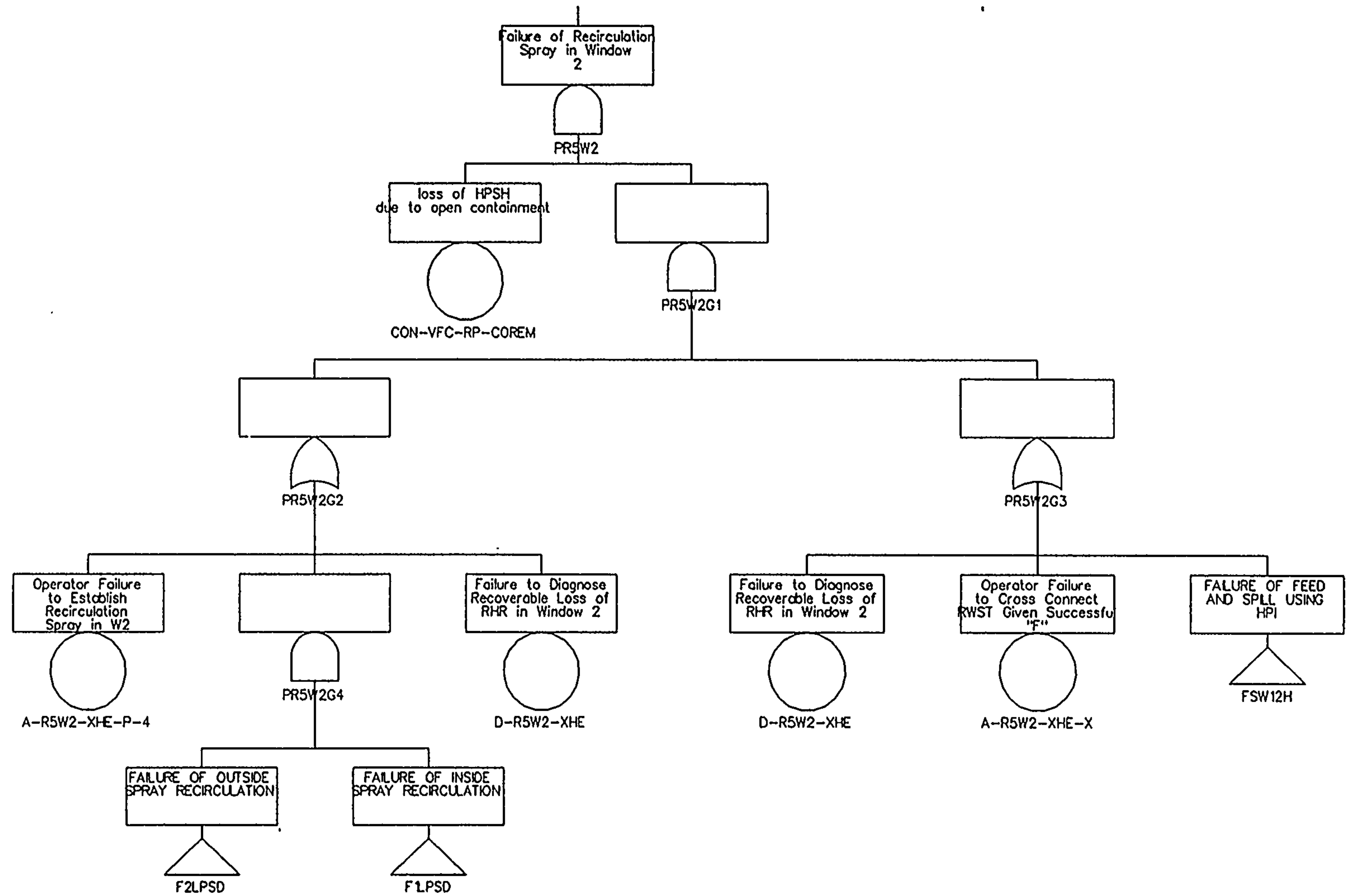
Feed and Bleed the RCS with V failed in RHR5, Window 2



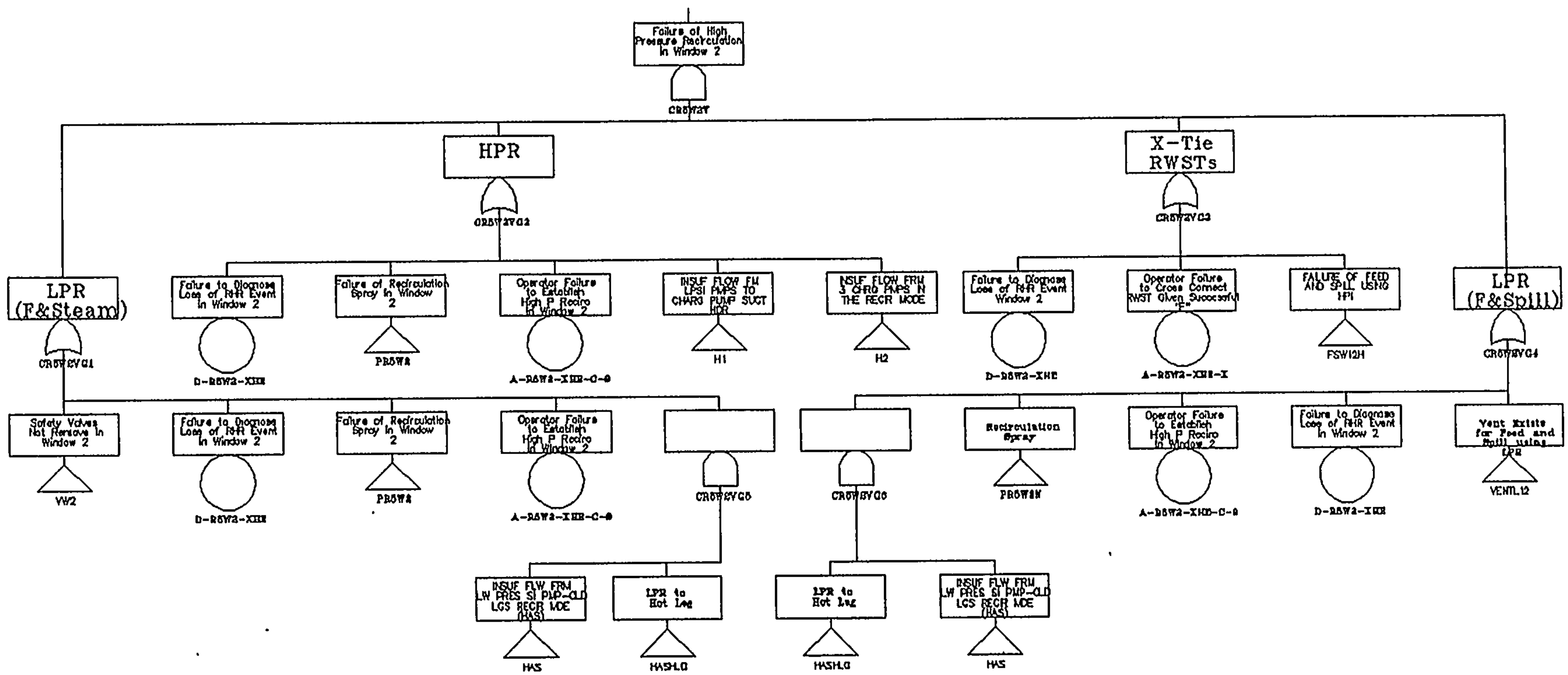
Gravity from RWST in RHR5, Window 2



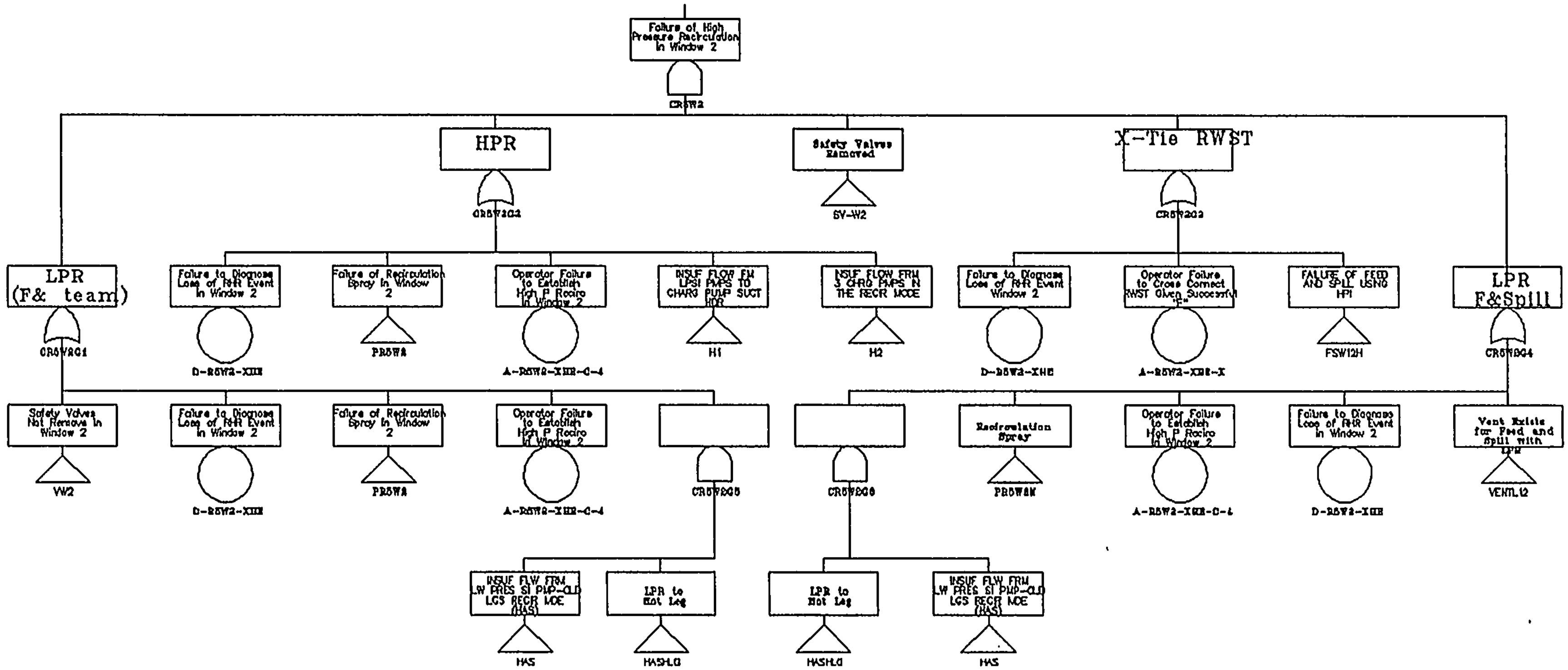
Failure of Recirculation Spray in Window 2-cause HPR failure for RHR5 Event

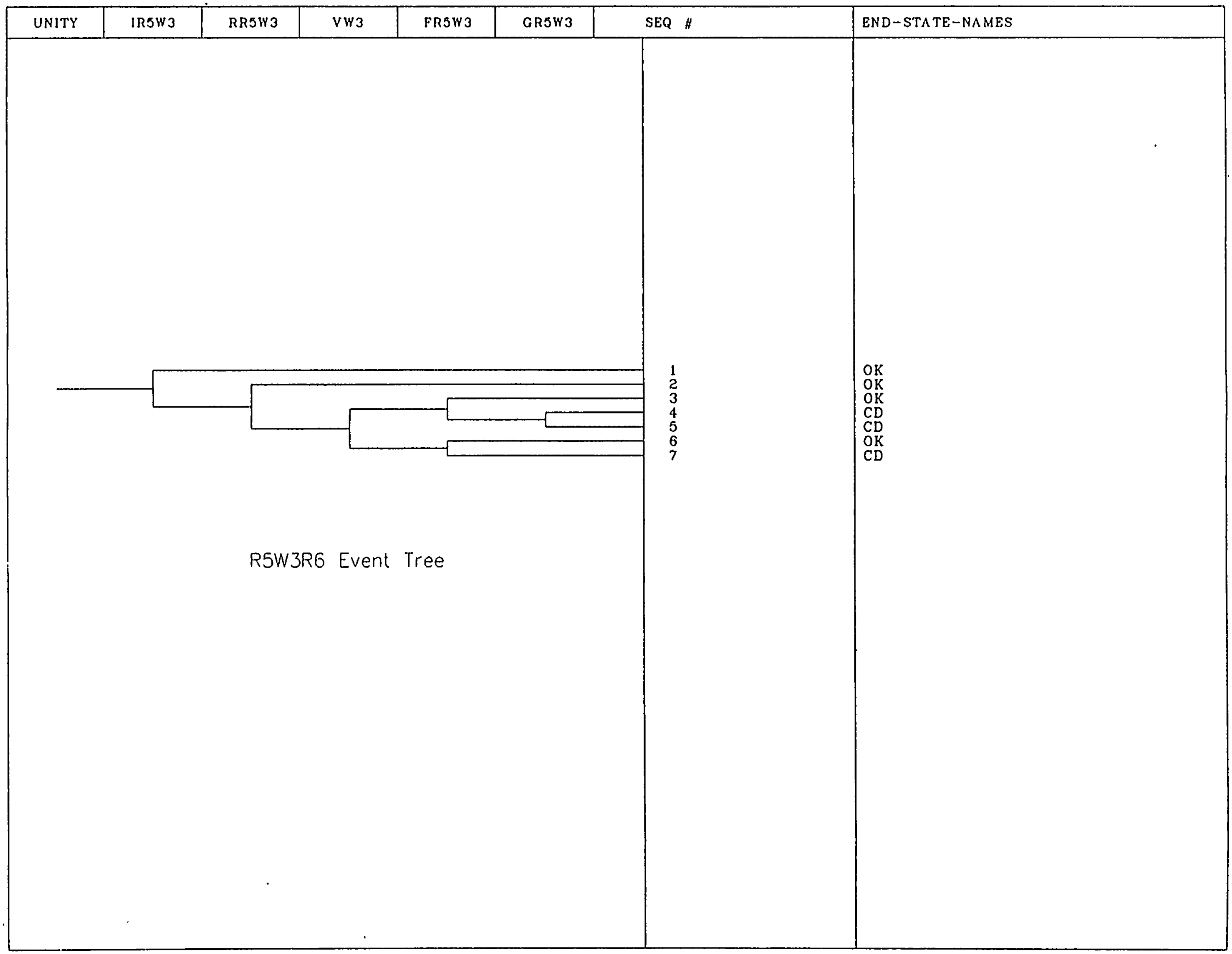


Failure of High Pressure Recirculation in Window 2

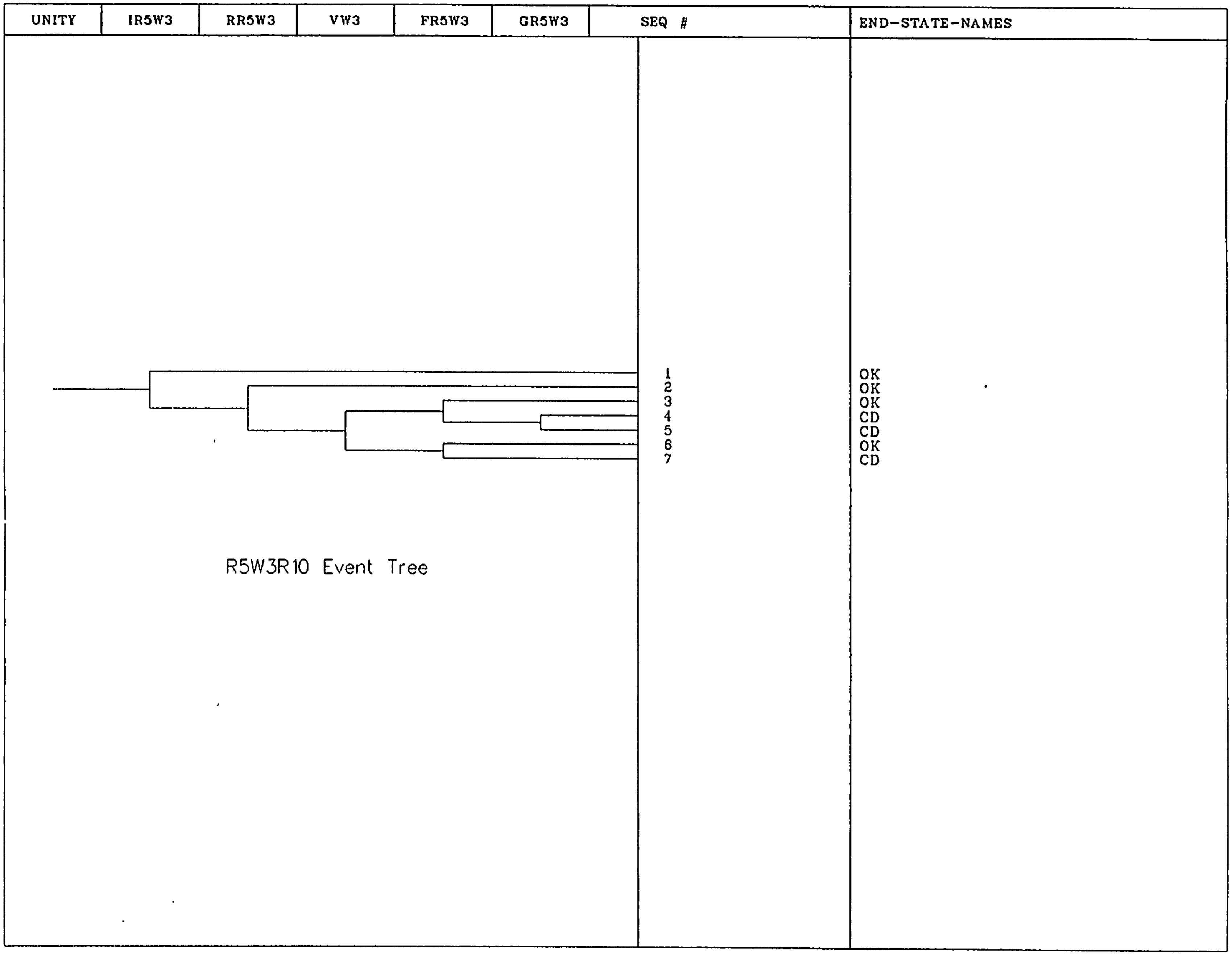


Failure of High Pressure Recirculation in Window 2

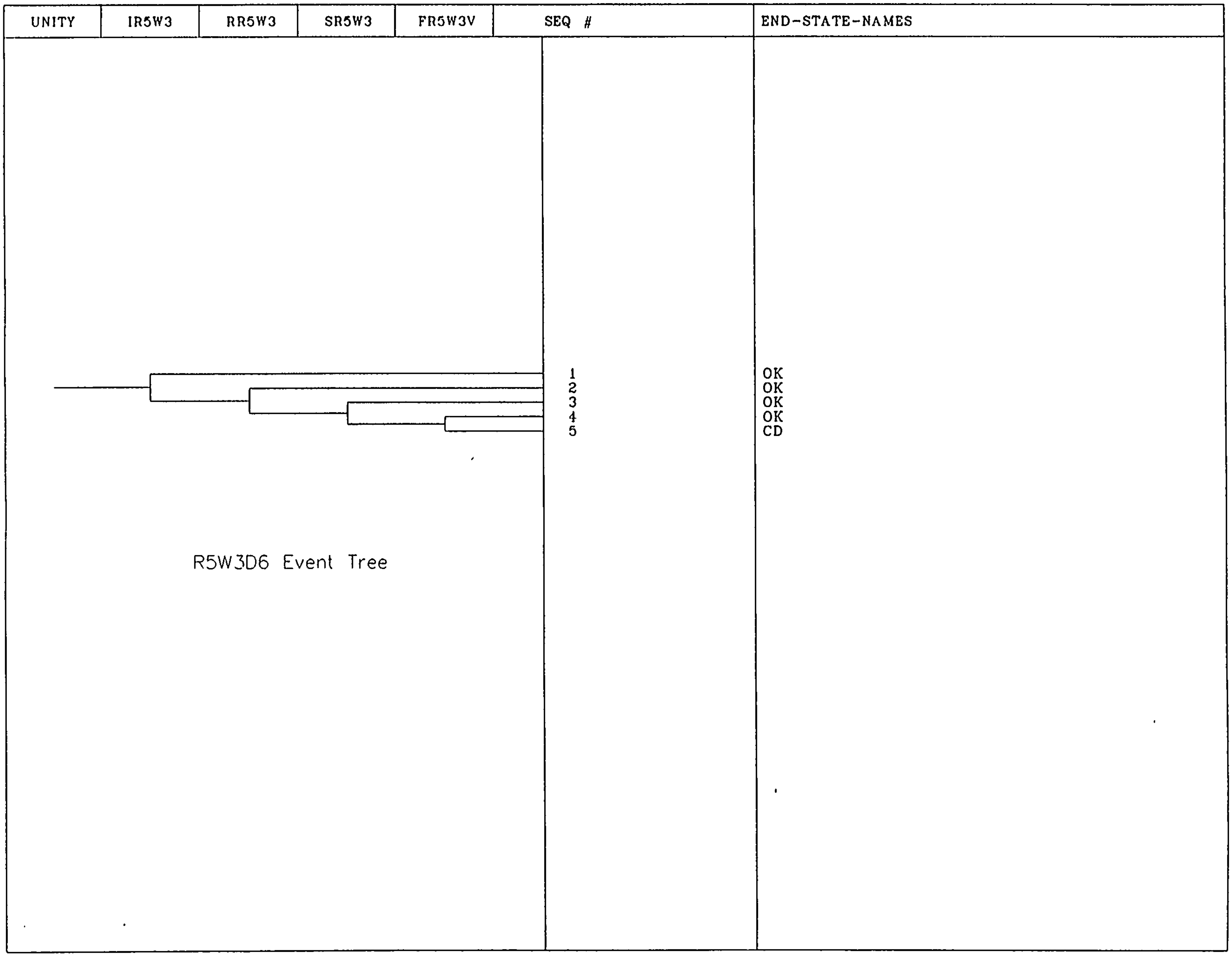




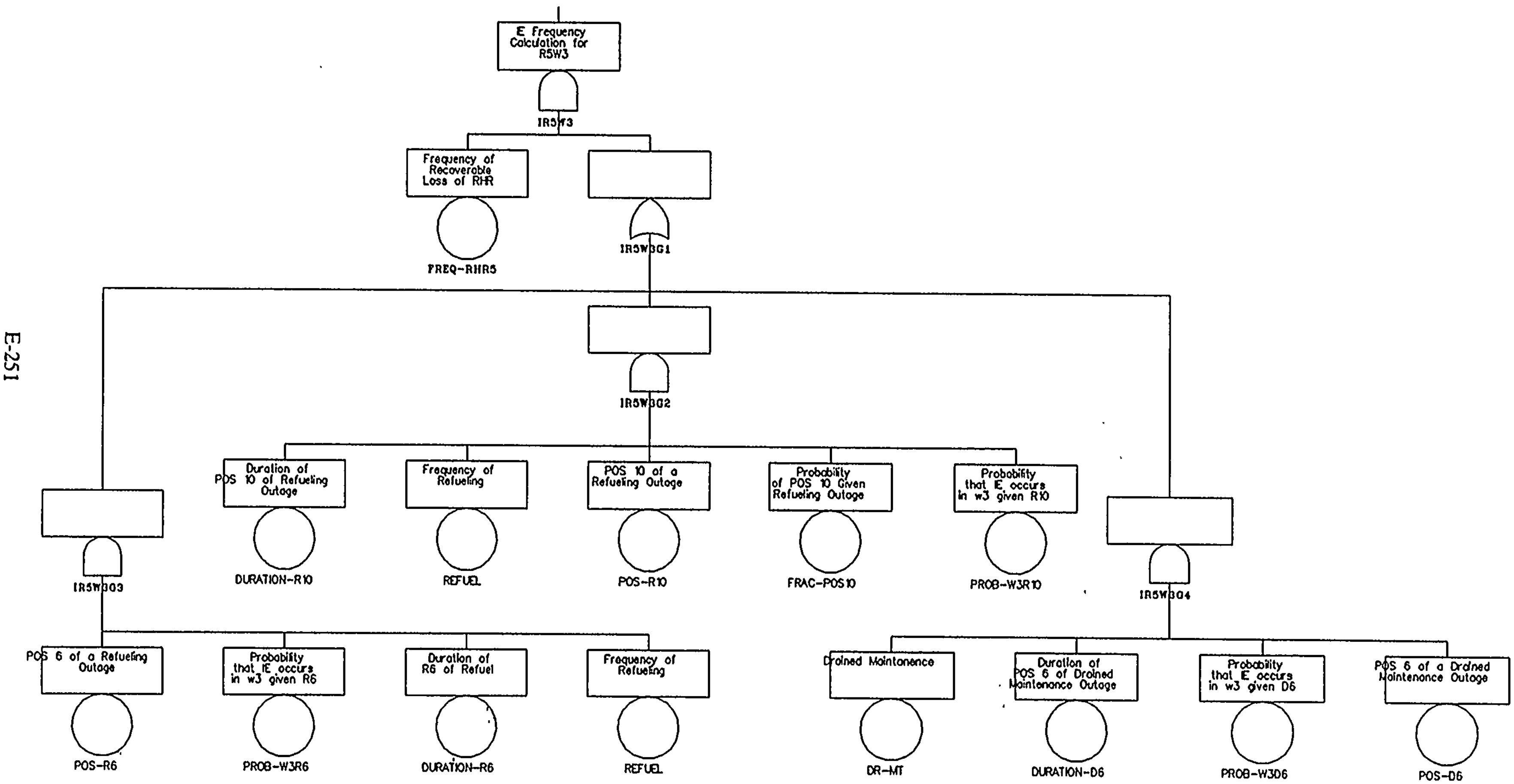
R5W3R6 Event Tree



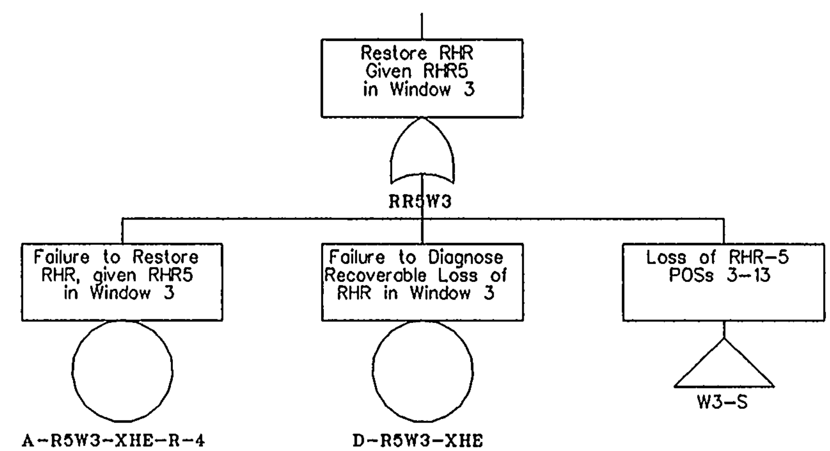
UNITY
IR5W3
RR5W3
VW3
FR5W3
GR5W3
SEQ #
END-STATE-NAMES
1 OK
2 OK
3 OK
4 CD
5 CD
6 OK
7 CD
R5W3R10 Event Tree


UNITY
IR5W3
RR5W3
SR5W3
FR5W3V
SEQ #
END-STATE-NAMES
1
2
3
4
5
OK
OK
OK
OK
CD
R5W3D6 Event Tree

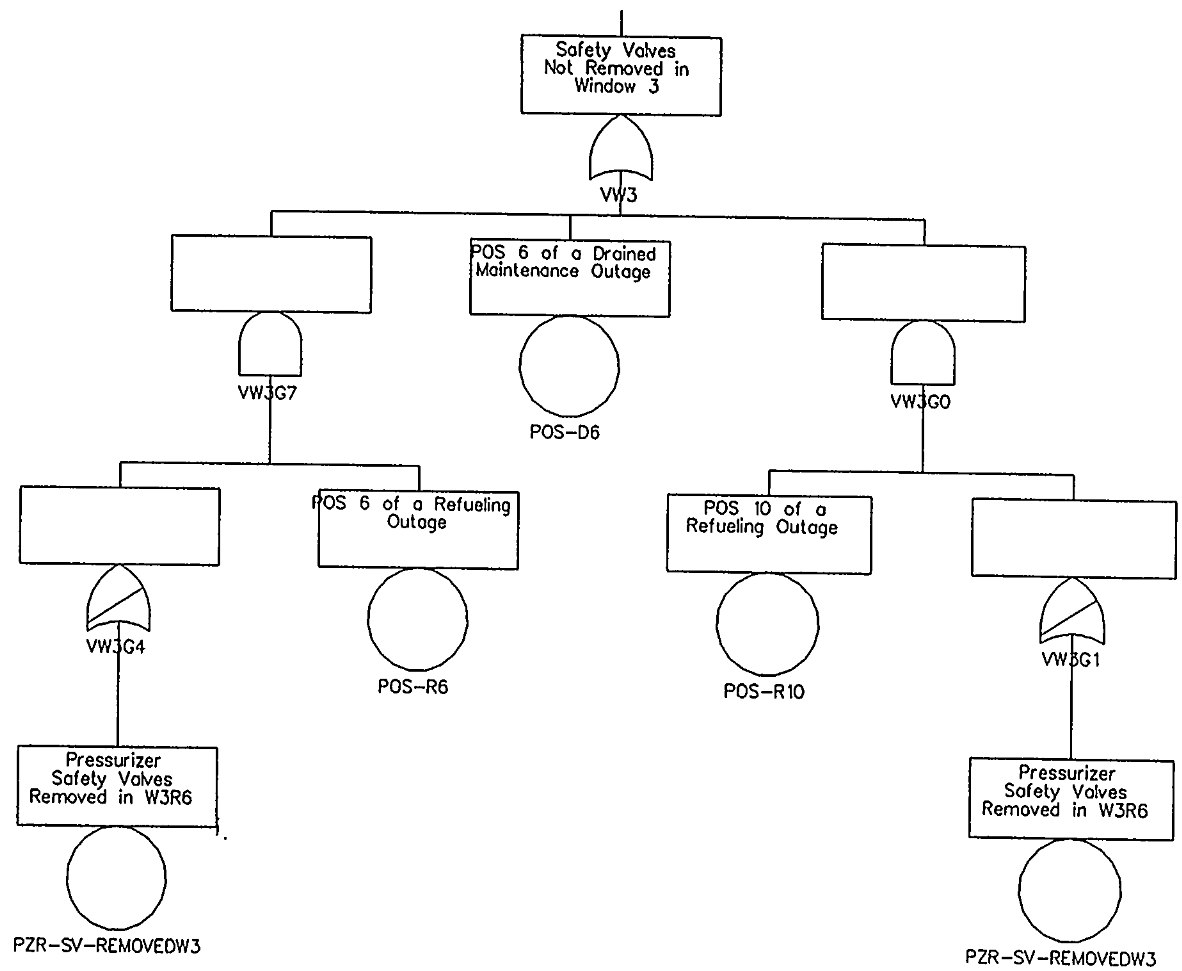
I Top Event for Loss of RHR- R5 in Window 3



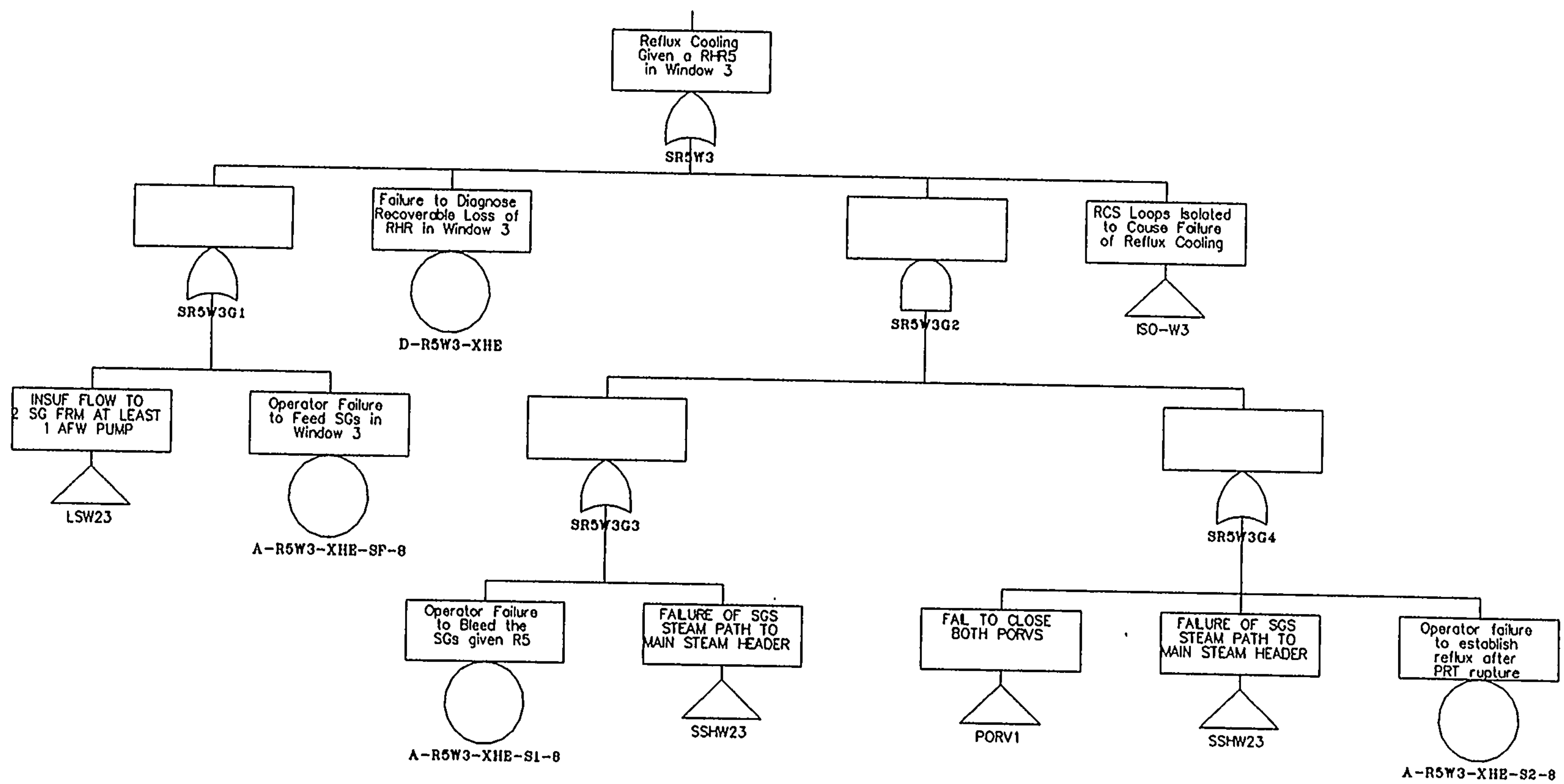
Restore RHR given RHR5 in Window 3



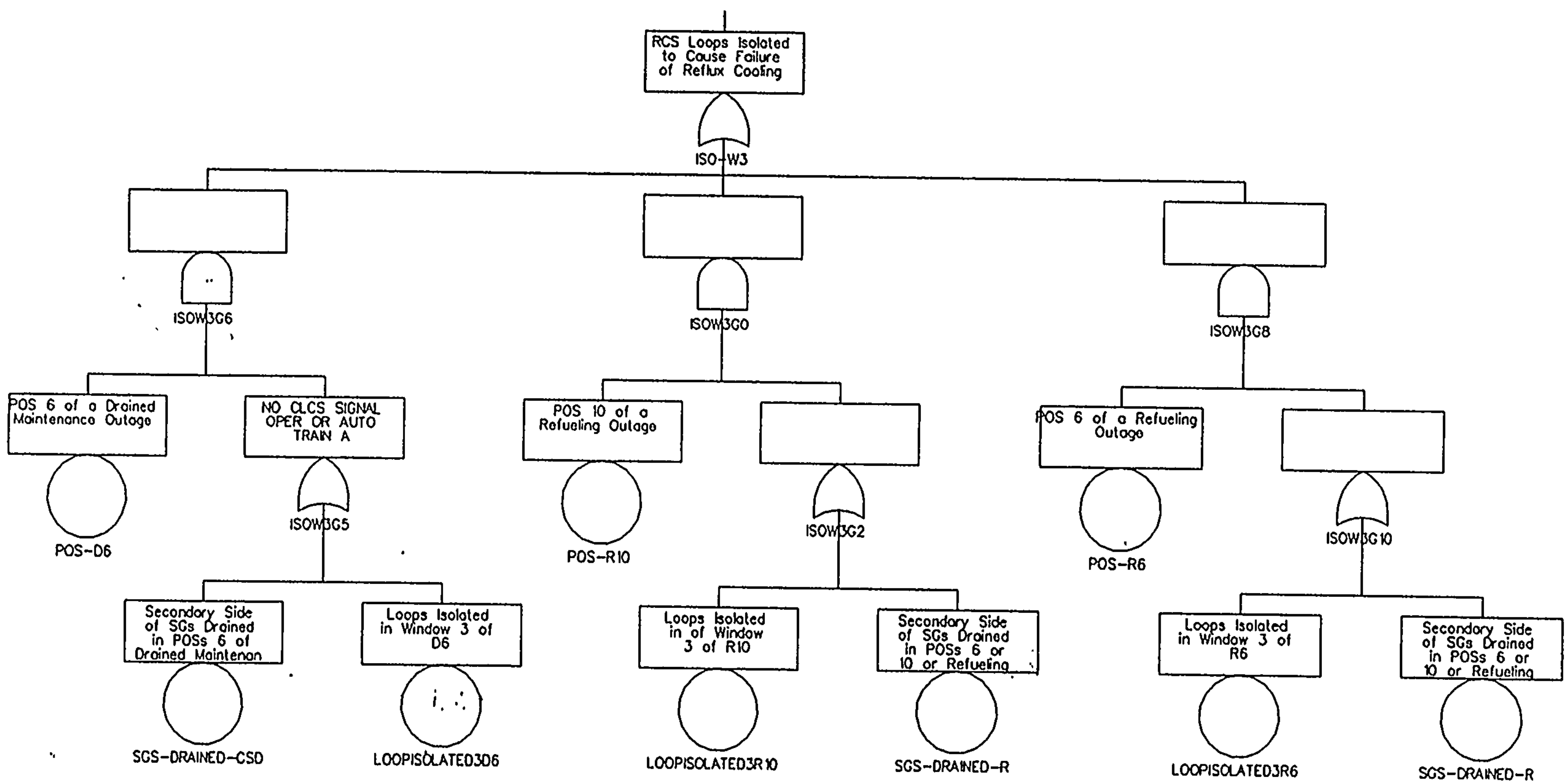
Safety Valves Not Removed in Window 3



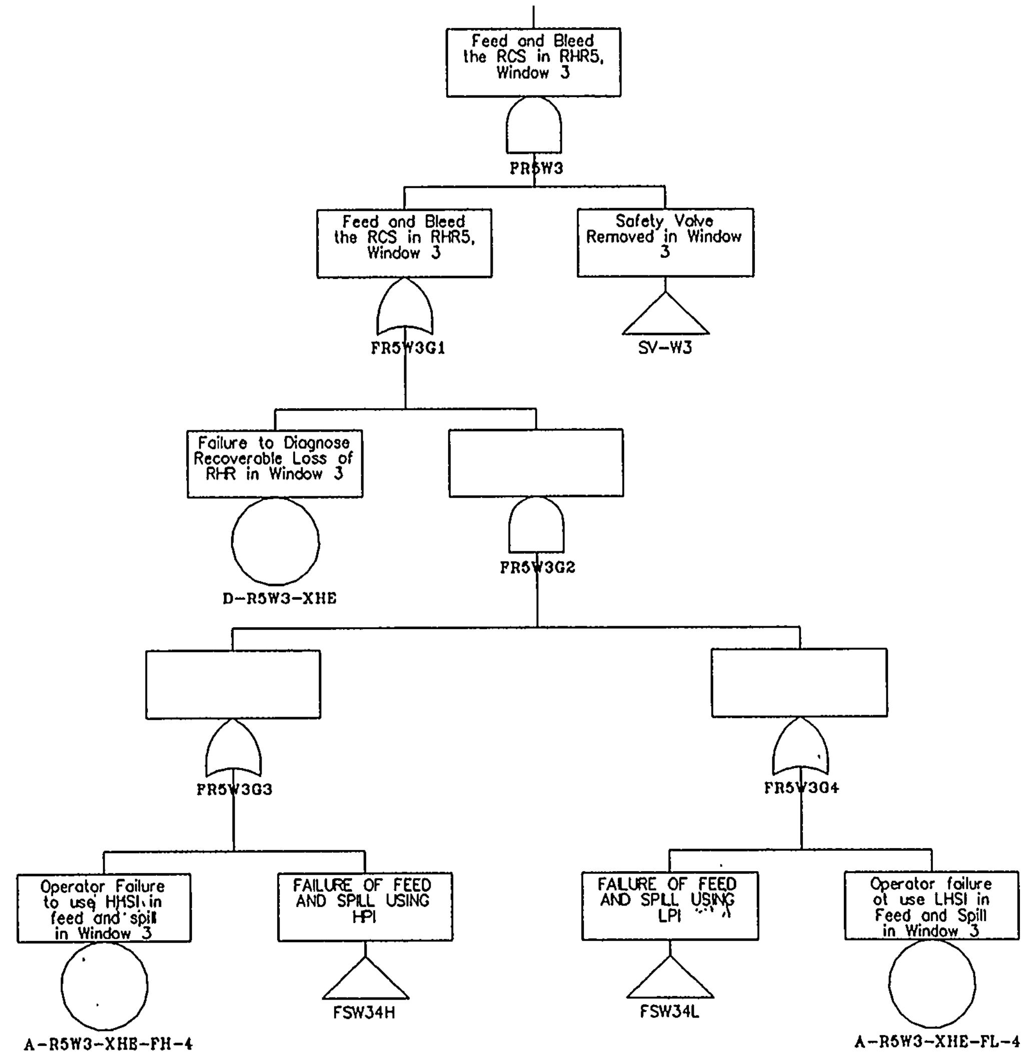
Reflux Cooling Given RHR5 in Window 3



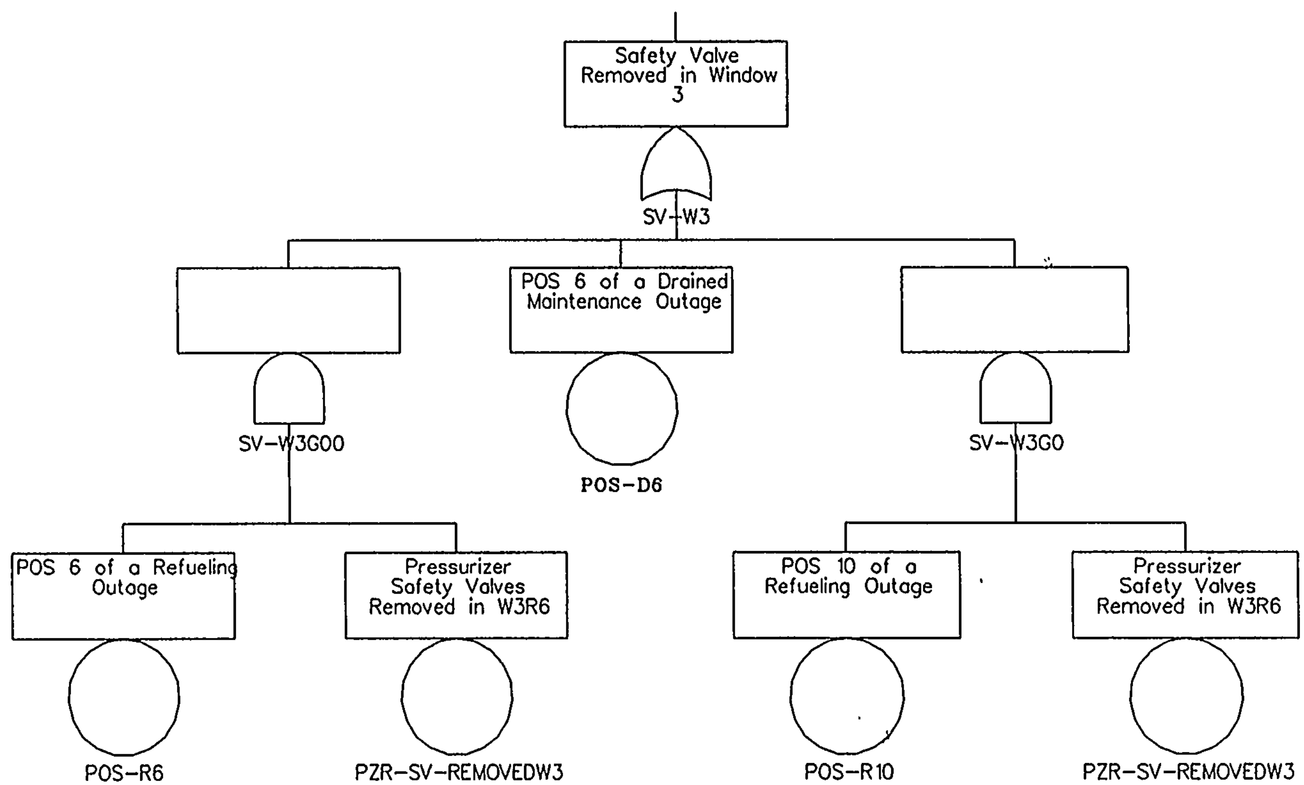
RCS Loops Isolated to Cause Failure of Reflux in Window 3



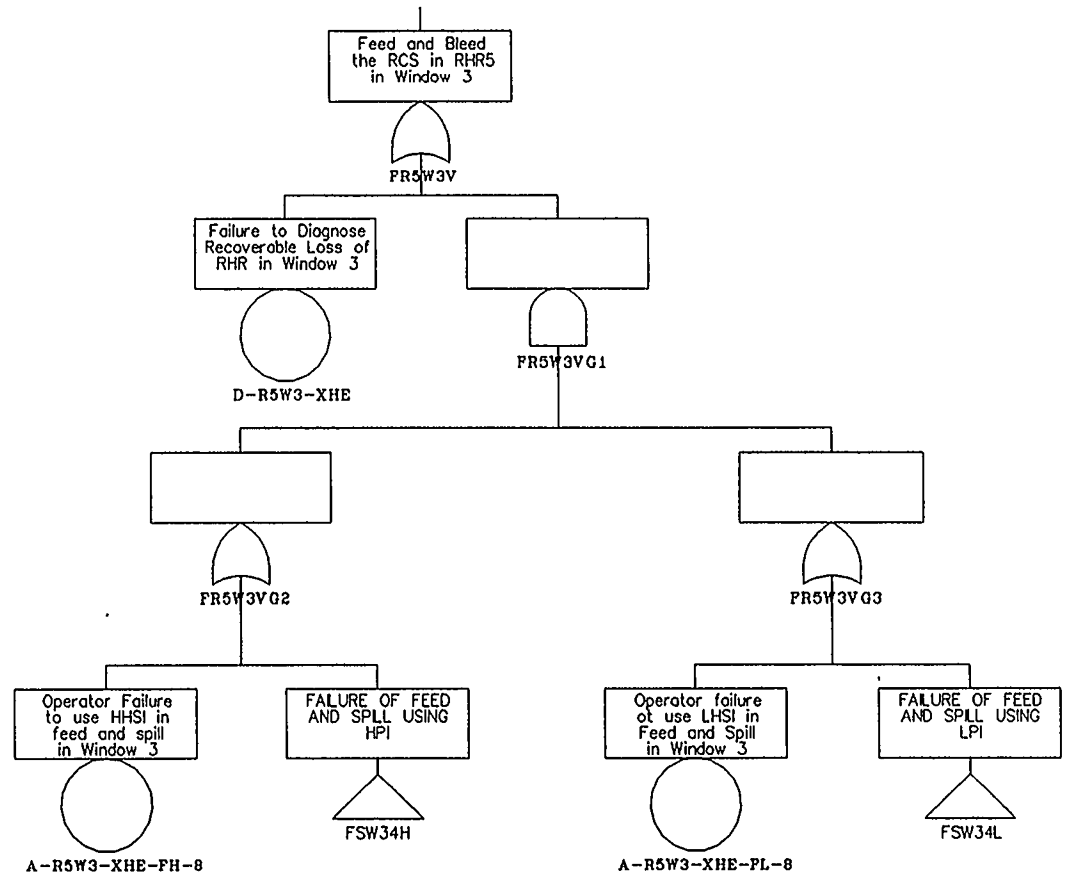
Feed and Bleed the RCS in RHR5, Window 3



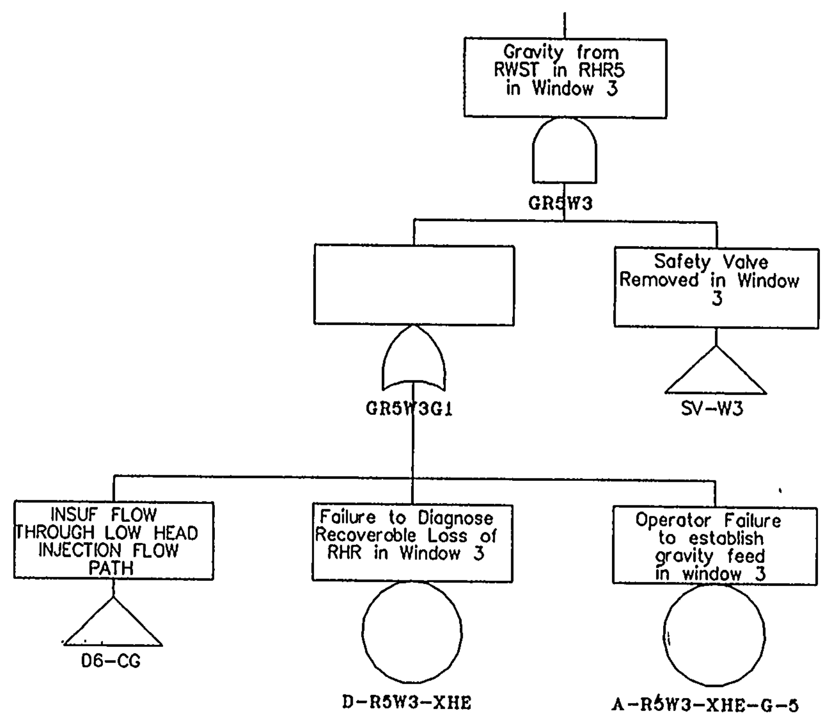
Safety Valves Removed in Window 3

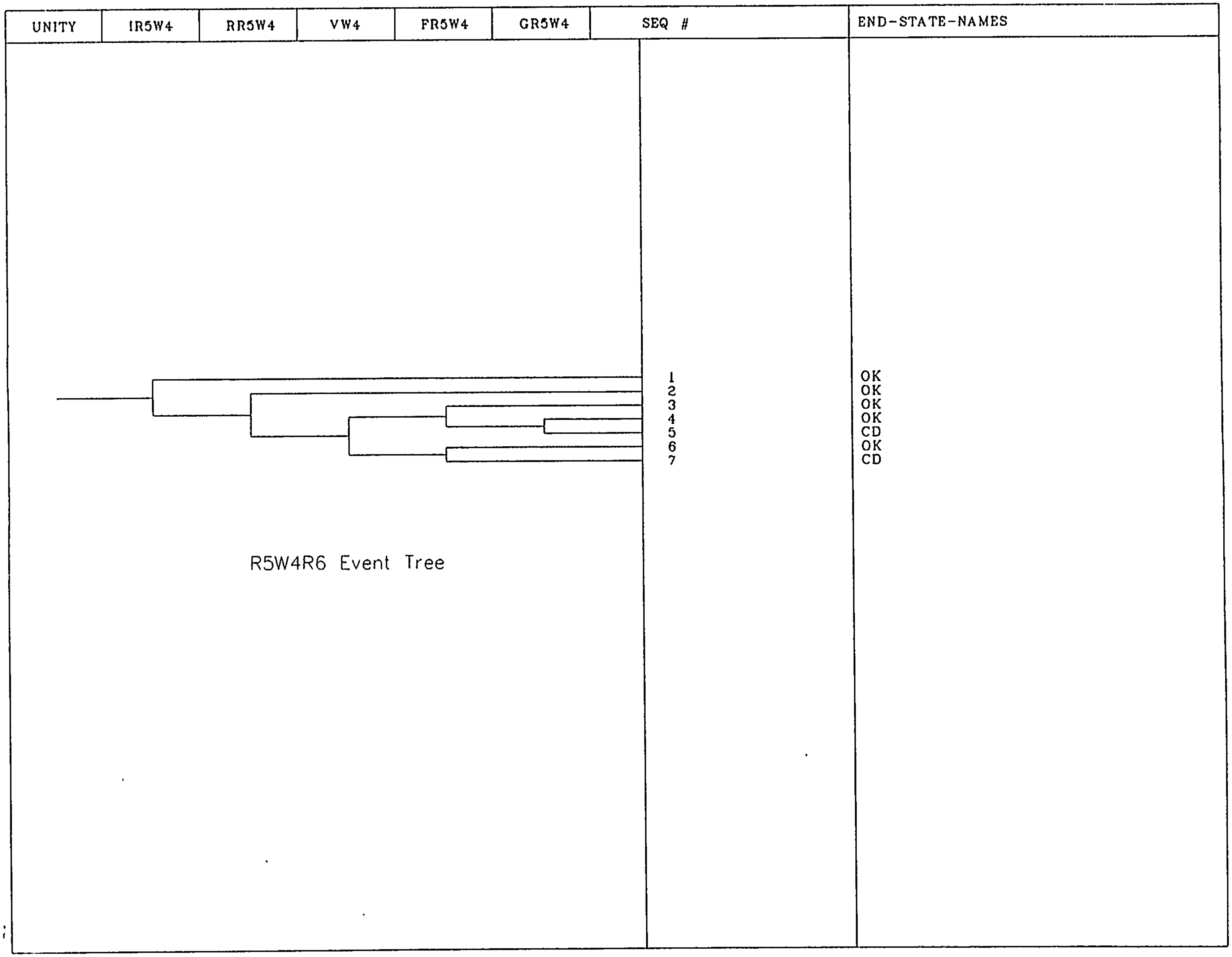


Feed and Bleed the RCS with V failed in RHR5, Window 3

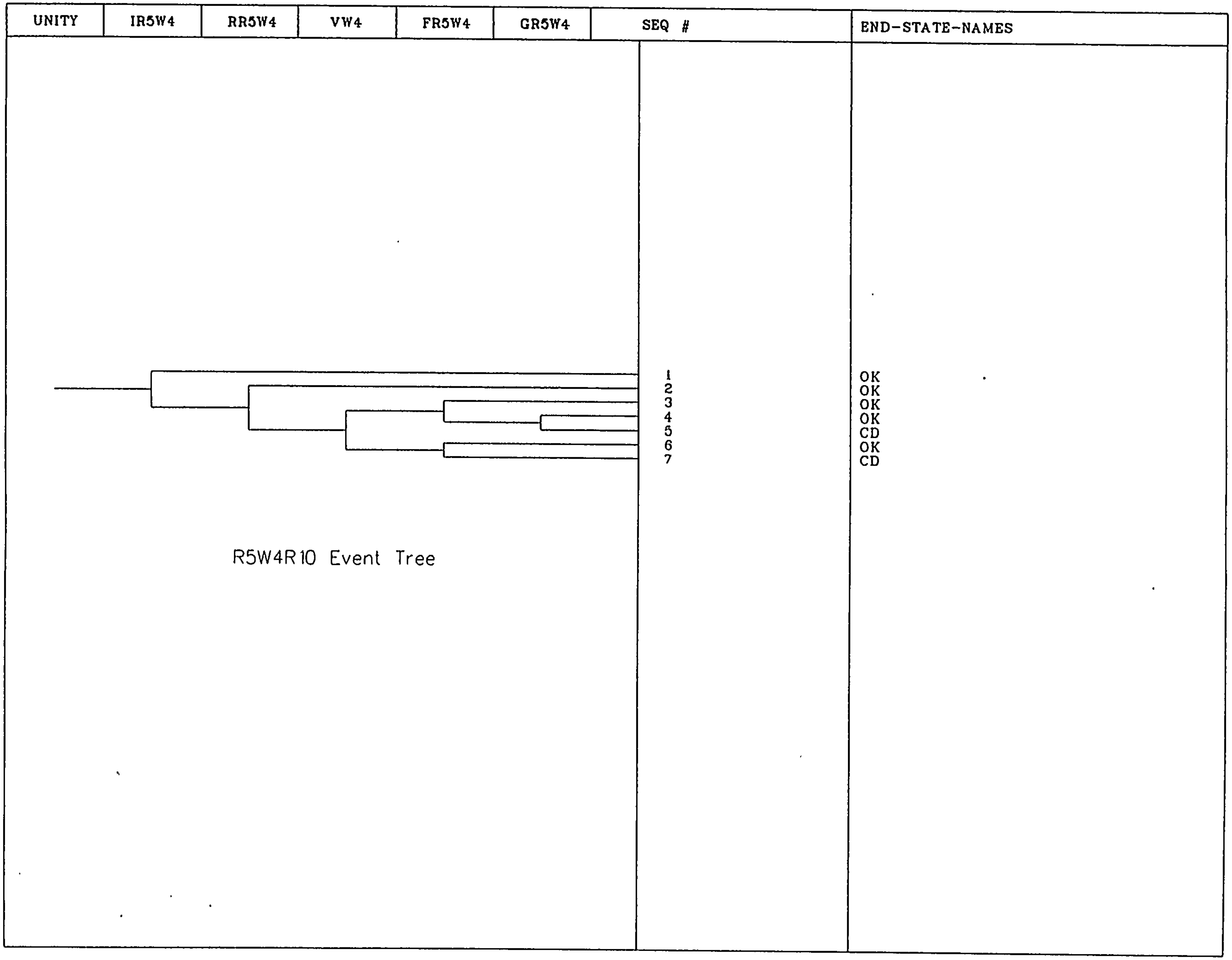


Gravity from RWST in RHR5, Window 3

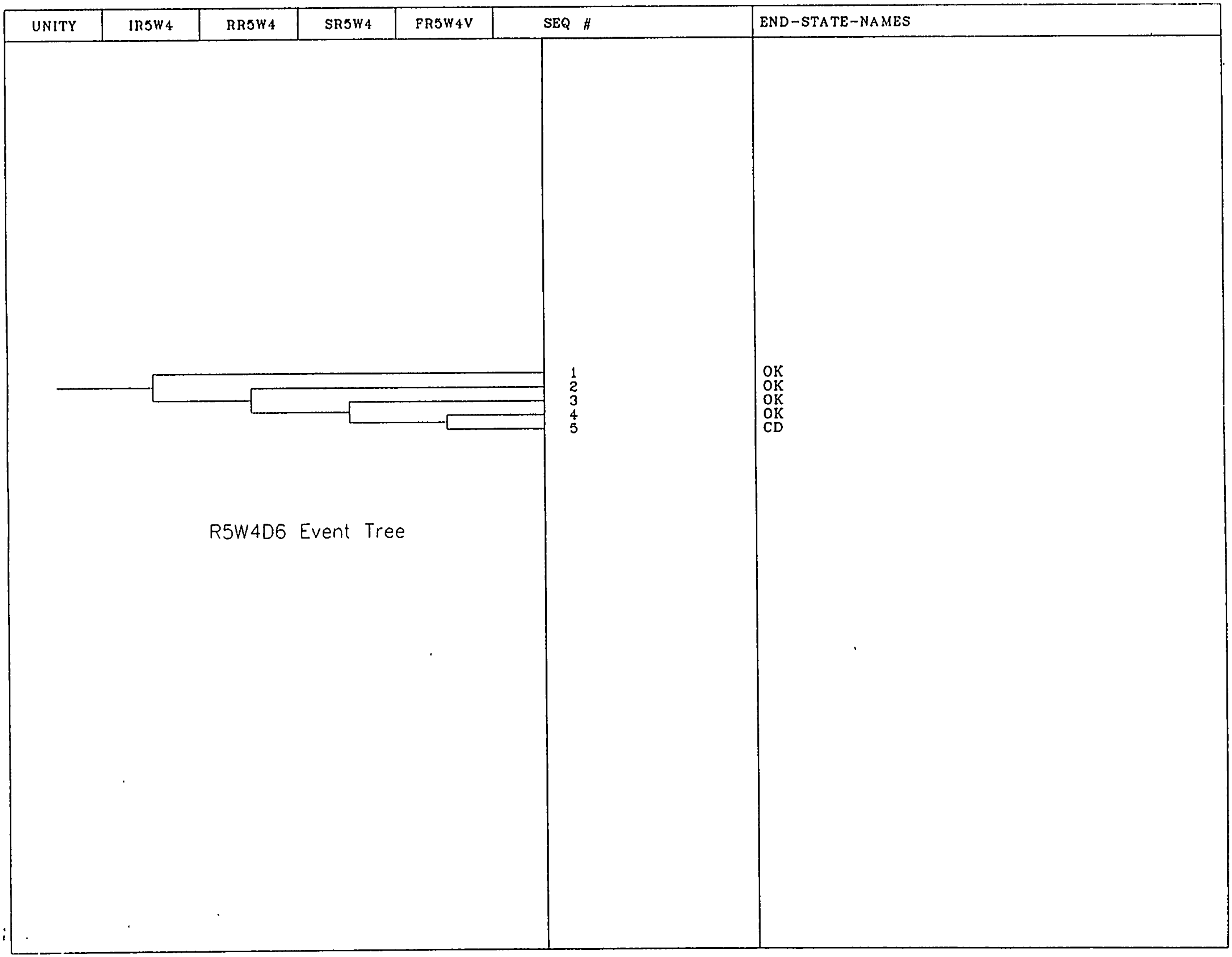




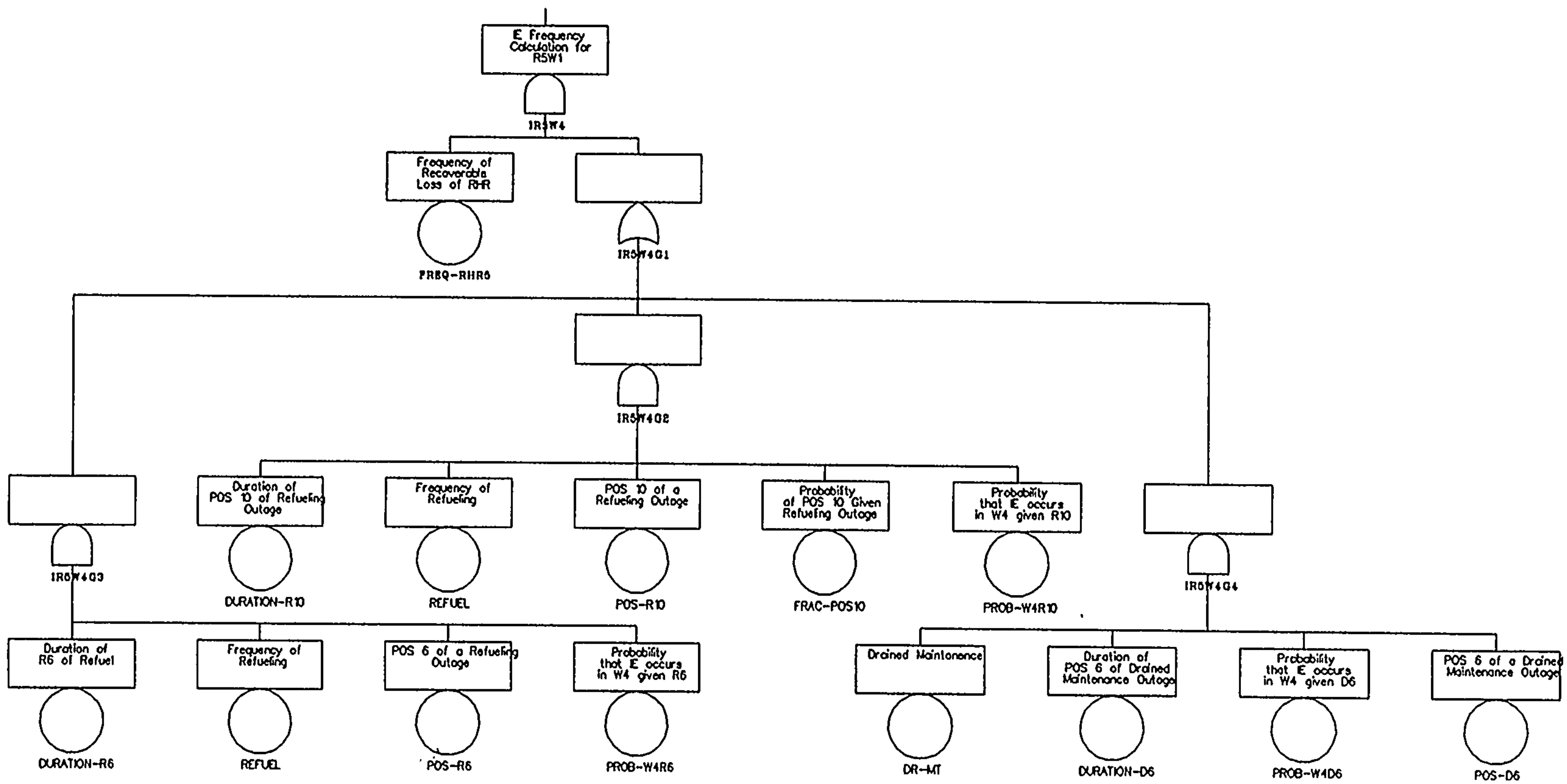
R5W4R6 Event Tree



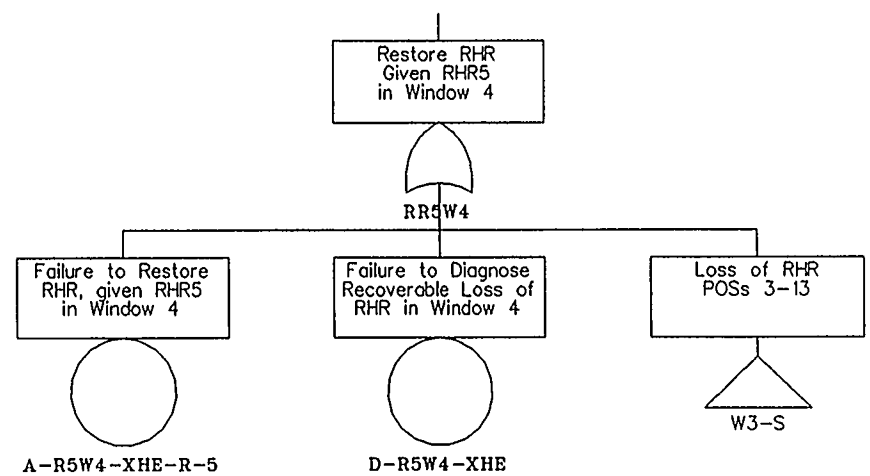
R5W4R10 Event Tree


UNITY
IR5W4
RR5W4
SR5W4
FR5W4V
SEQ #
END-STATE-NAMES
1
2
3
4
5
OK
OK
OK
OK
CD
R5W4D6 Event Tree

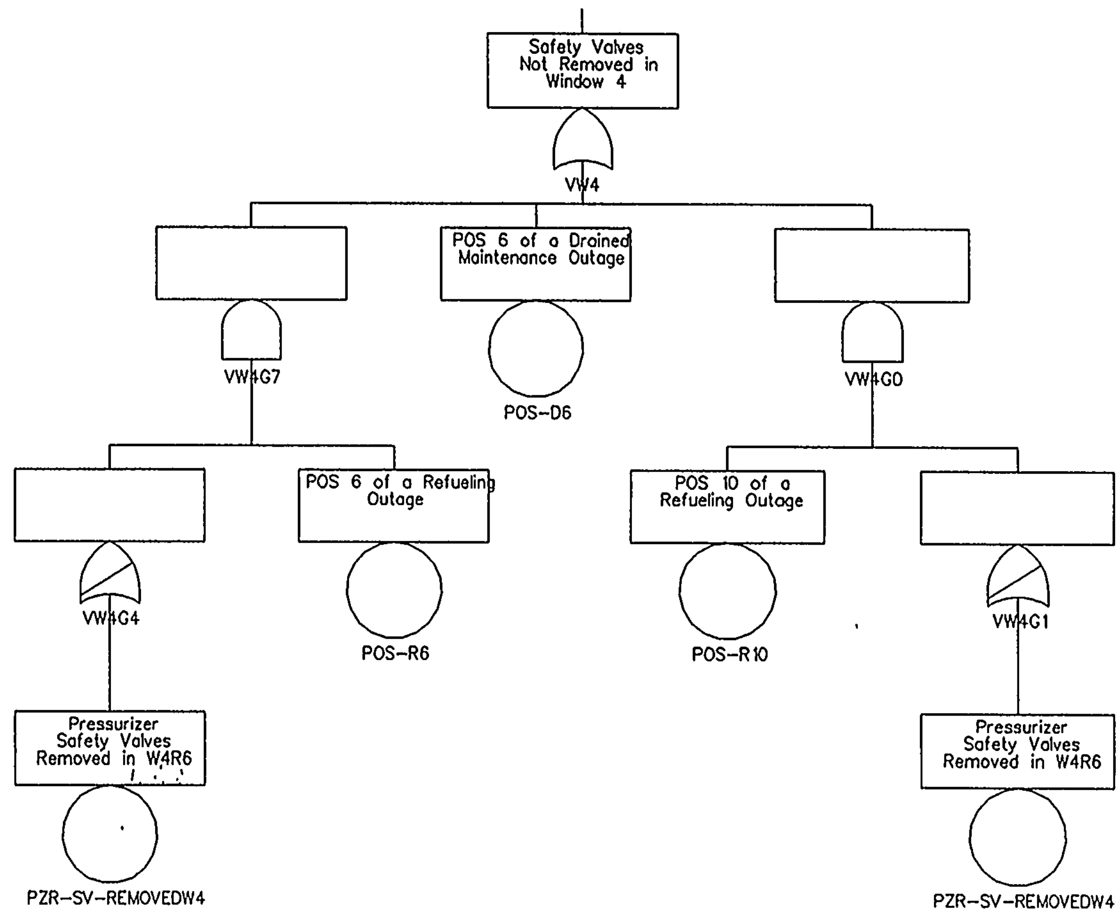
I Top Event for Loss of RHR-5 in Window 4



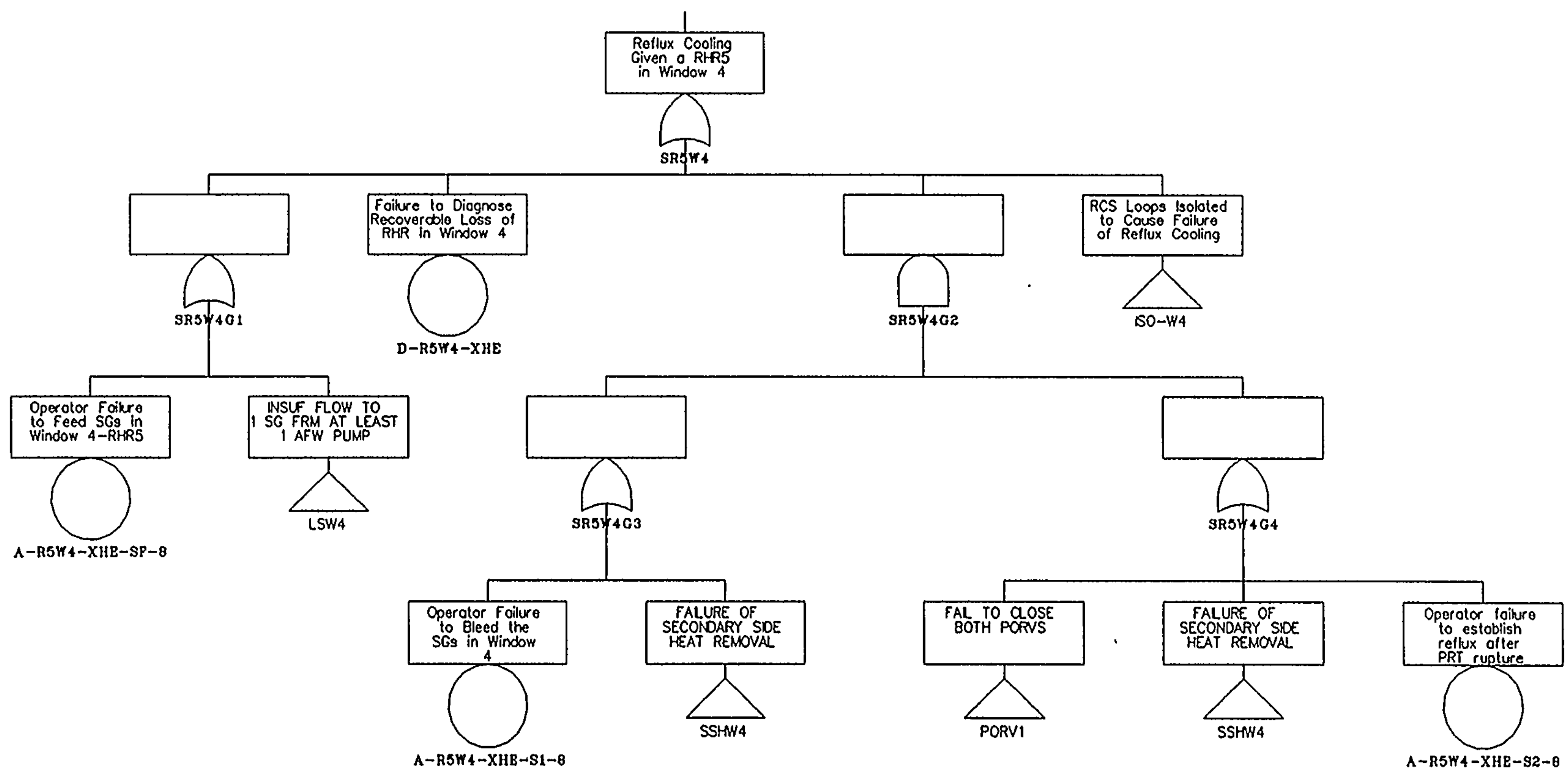
Restore RHR given RHR5 in Window 4



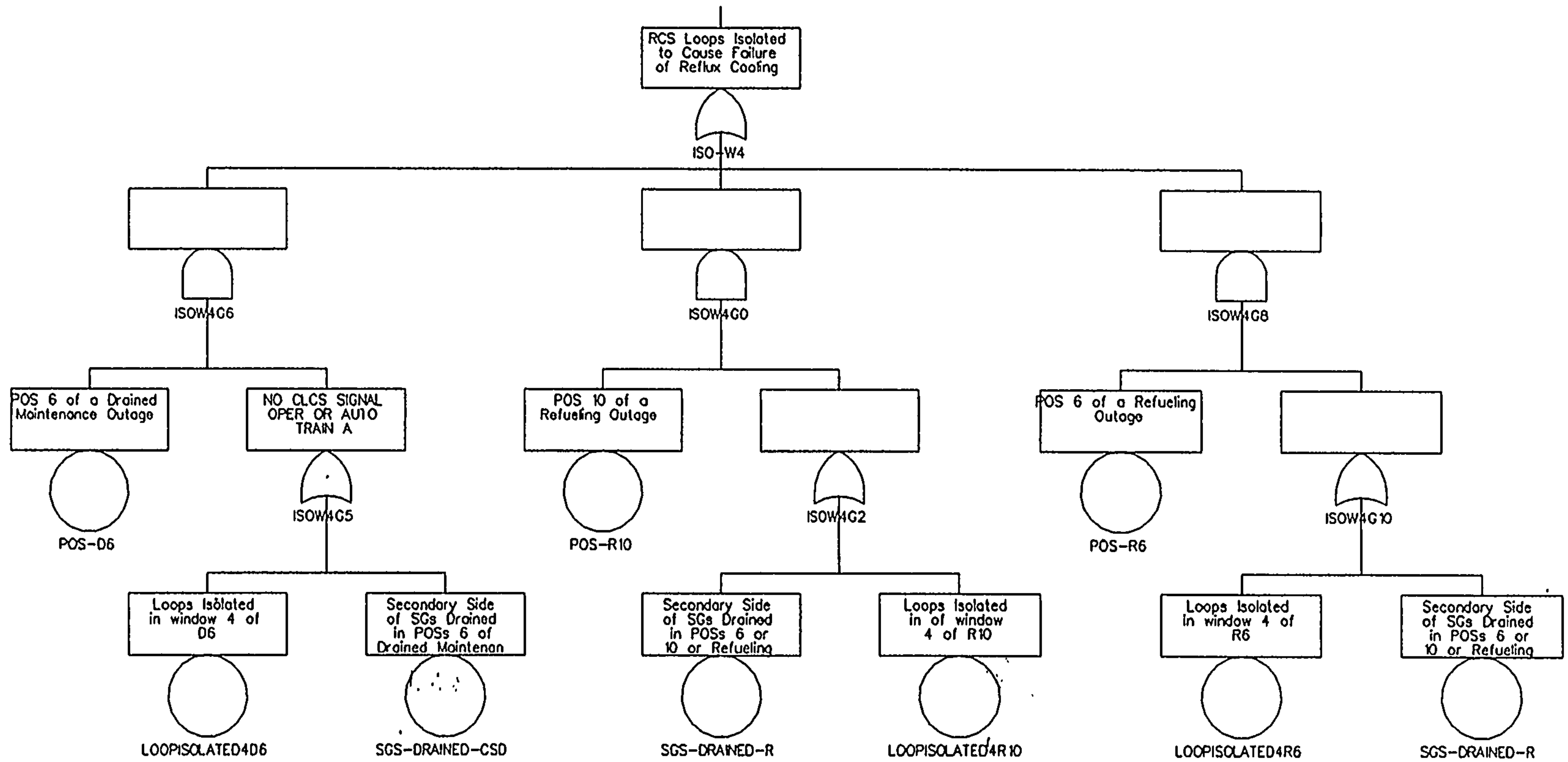
Safety Valves Not Removed in Window 4



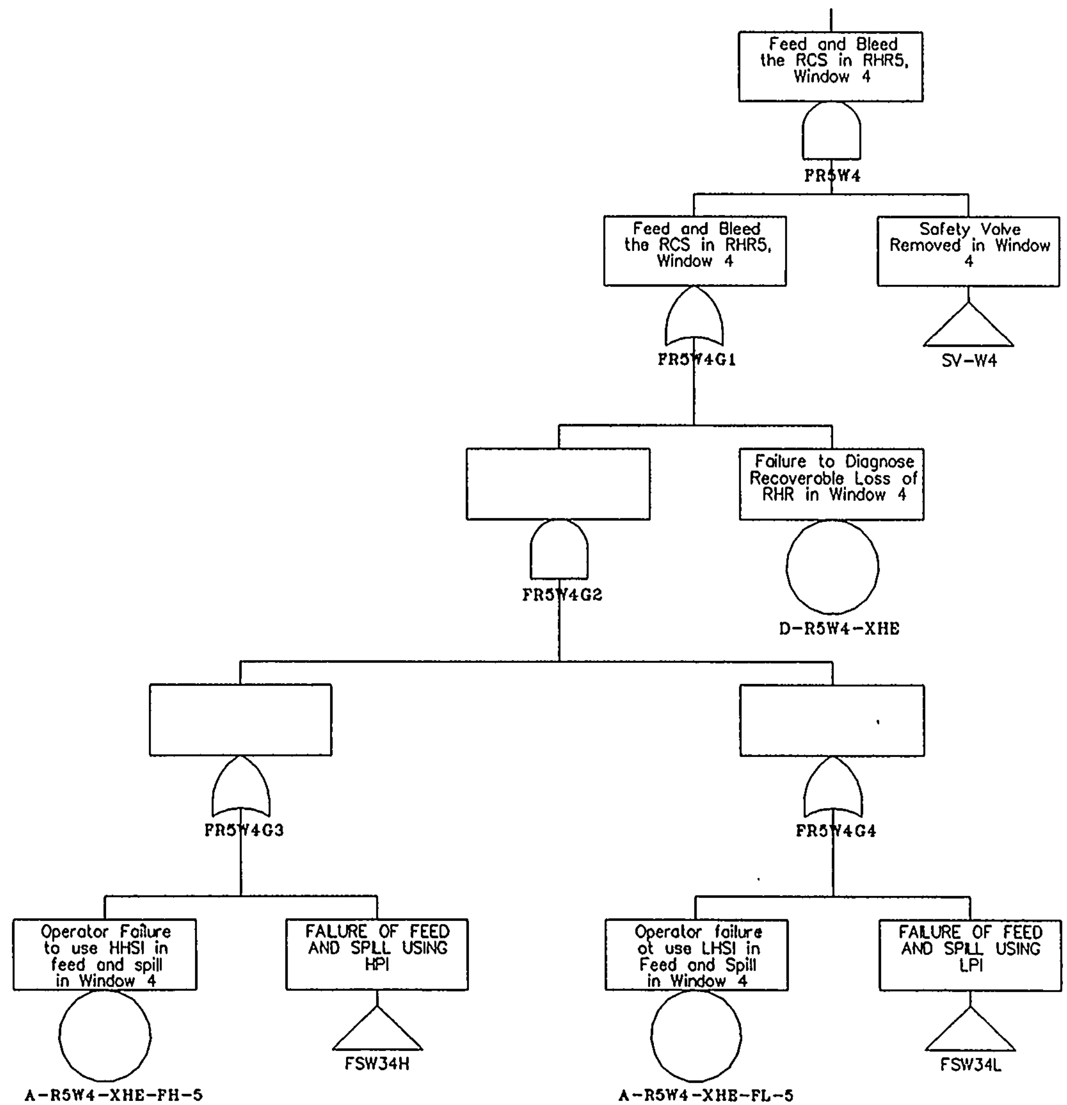
Reflux Cooling Given RHR5 in Window 4



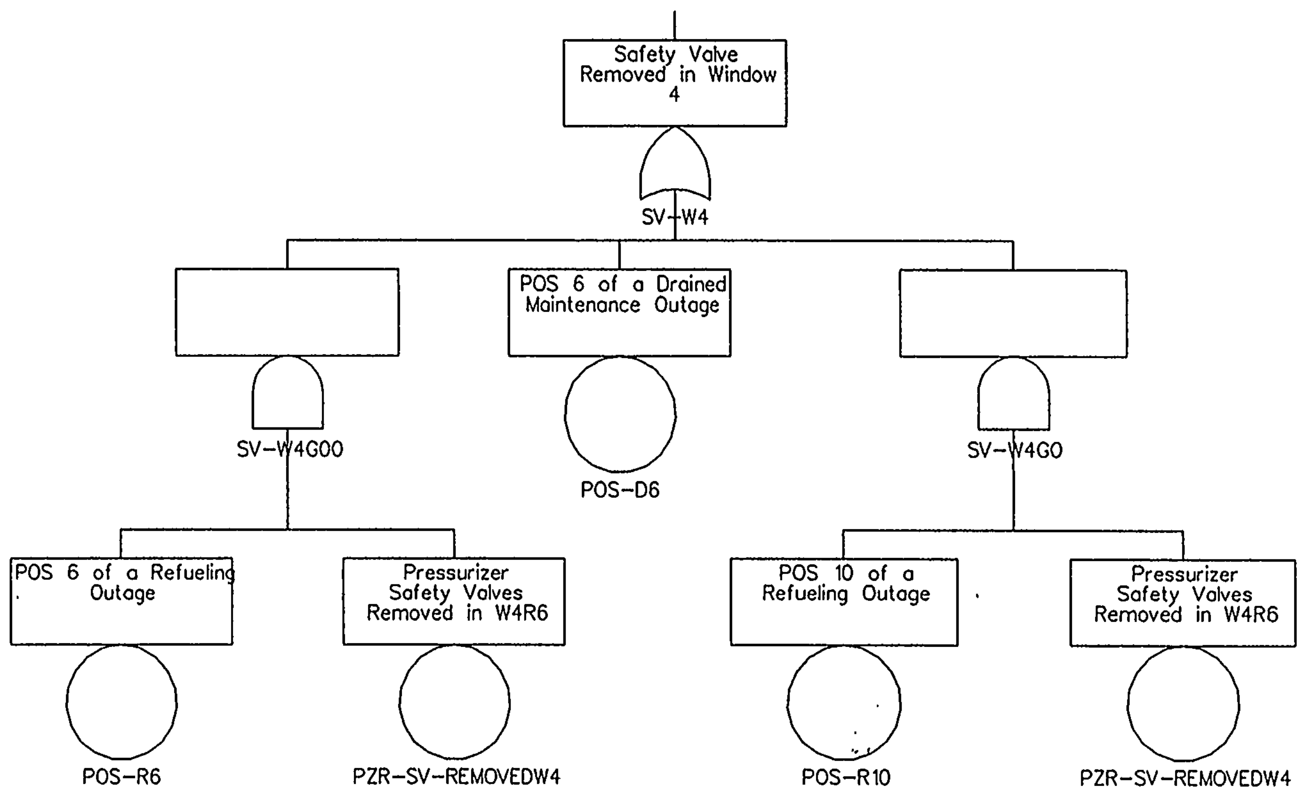
RCS Loops Isolated to Cause Failure of Reflux in Window 4



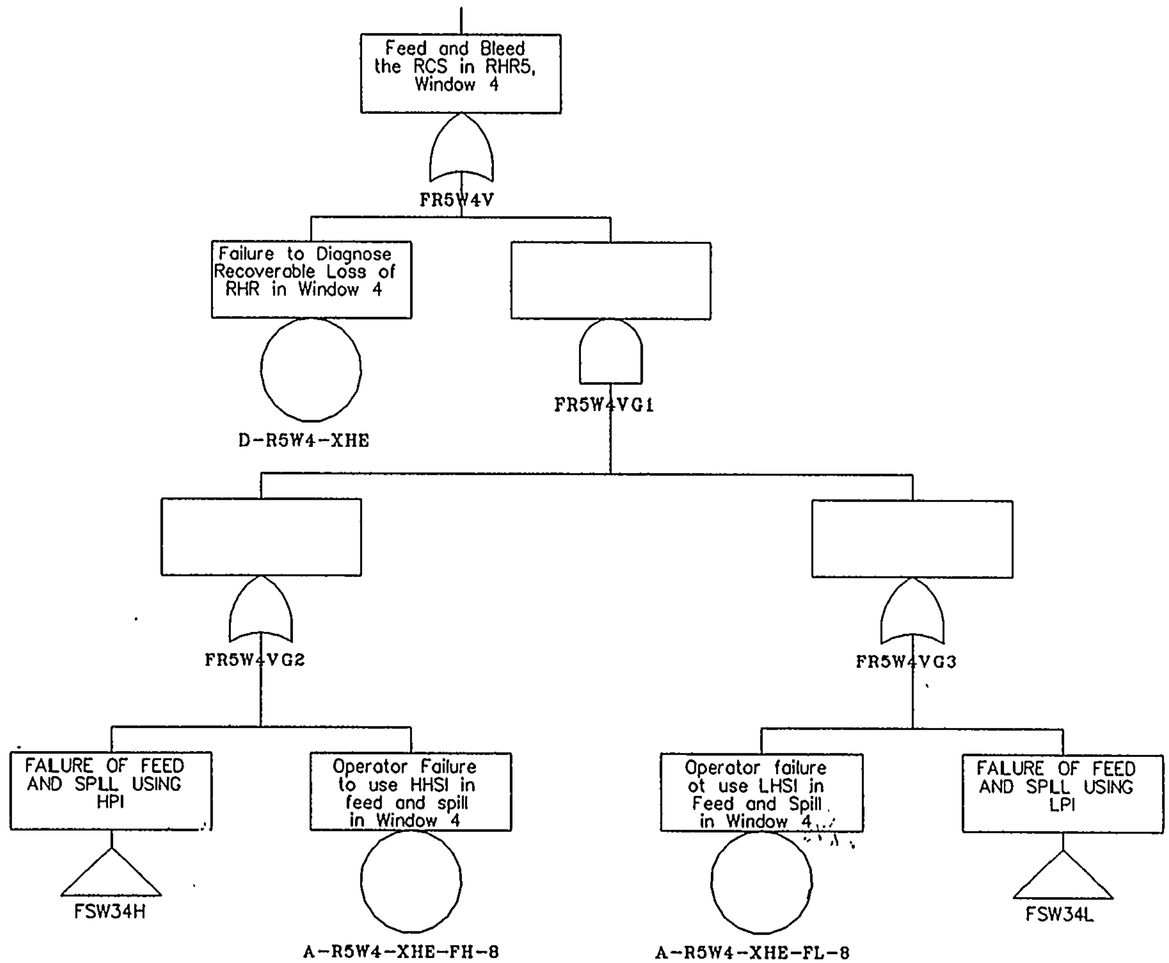
Feed and Bleed the RCS in RHR5, Window 4



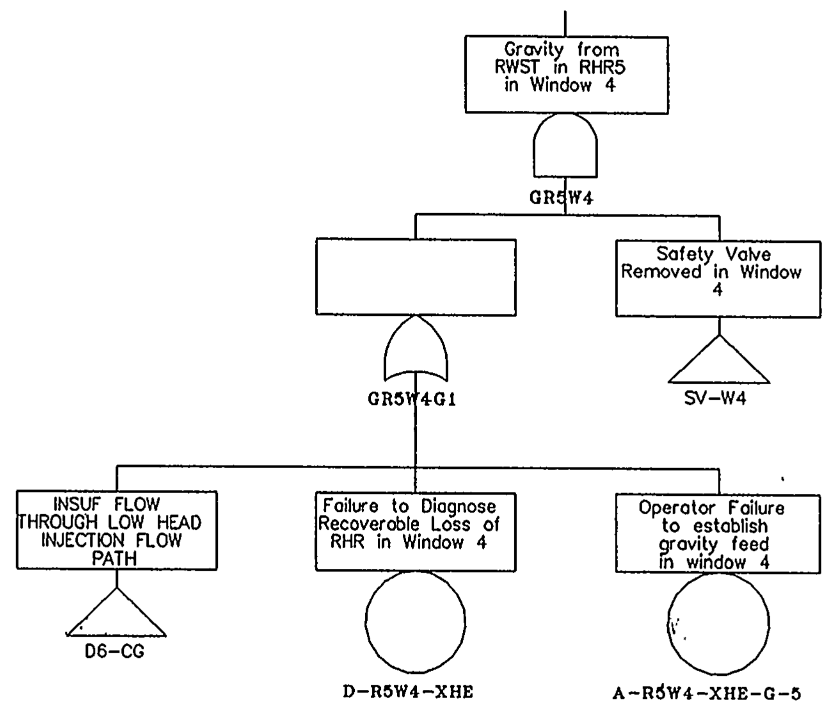
Safety Valves Removed in Window 4



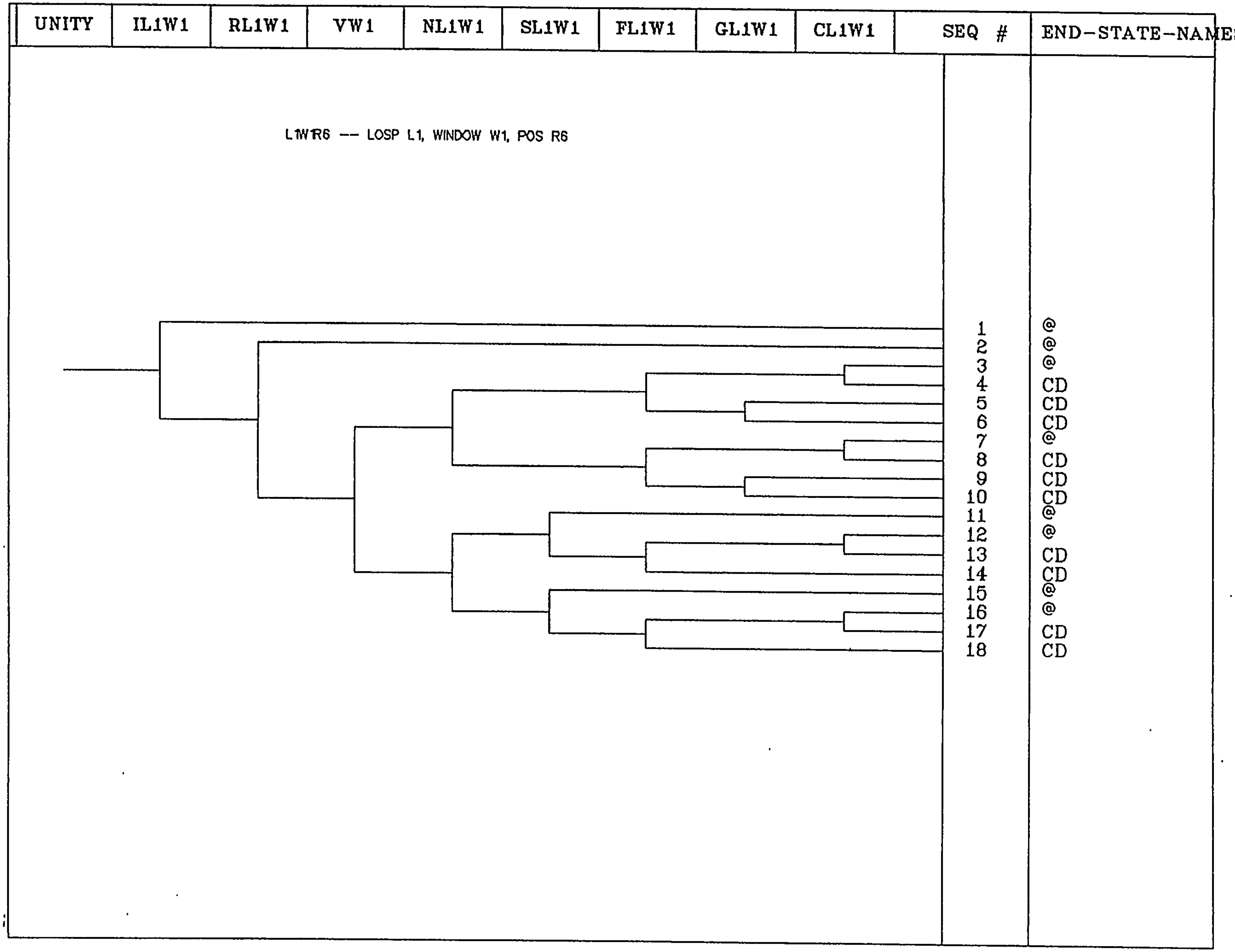
Feed and Bleed the RCS with V failed in RHR5, Window 4

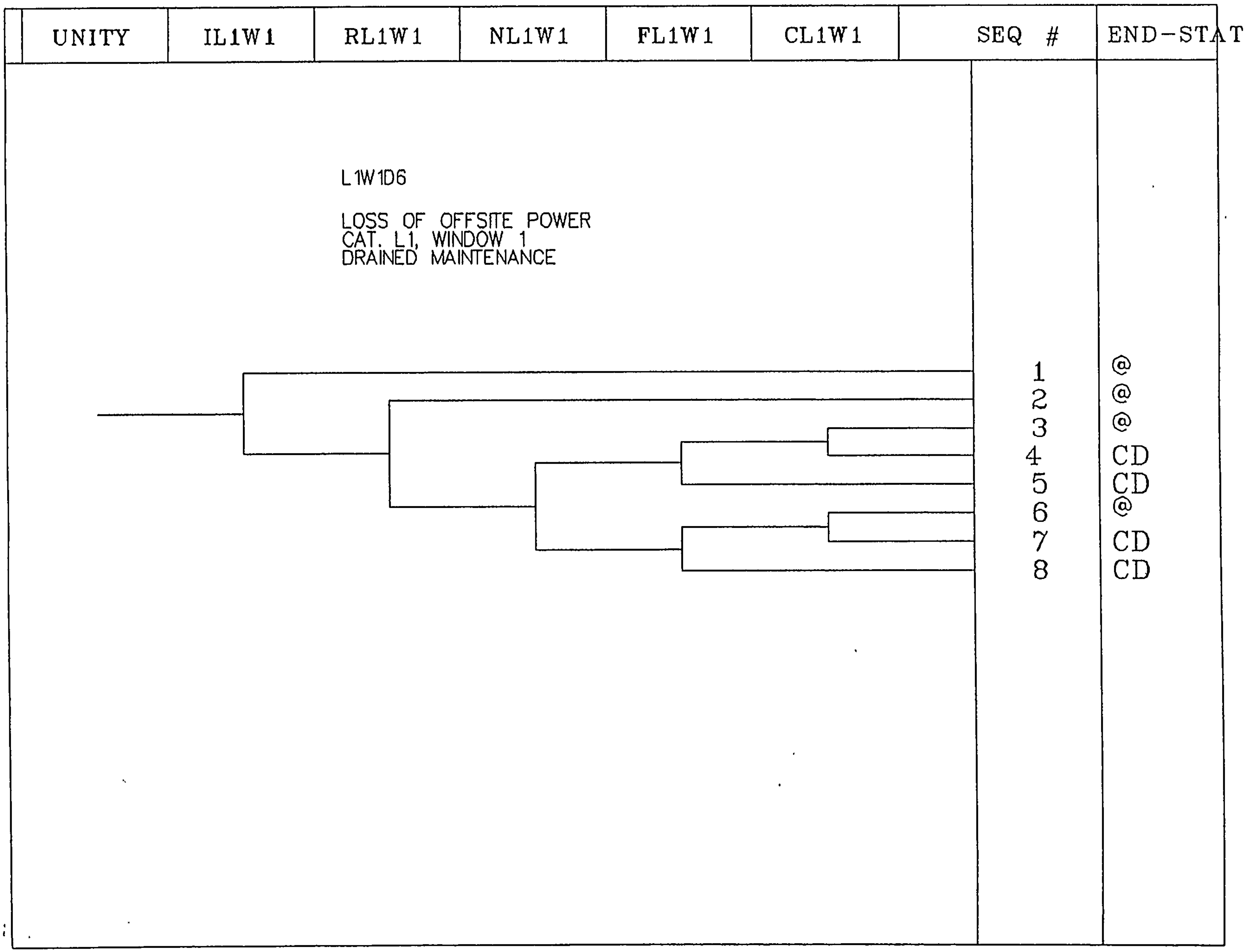


Gravity from RWST in RHR5, Window 4



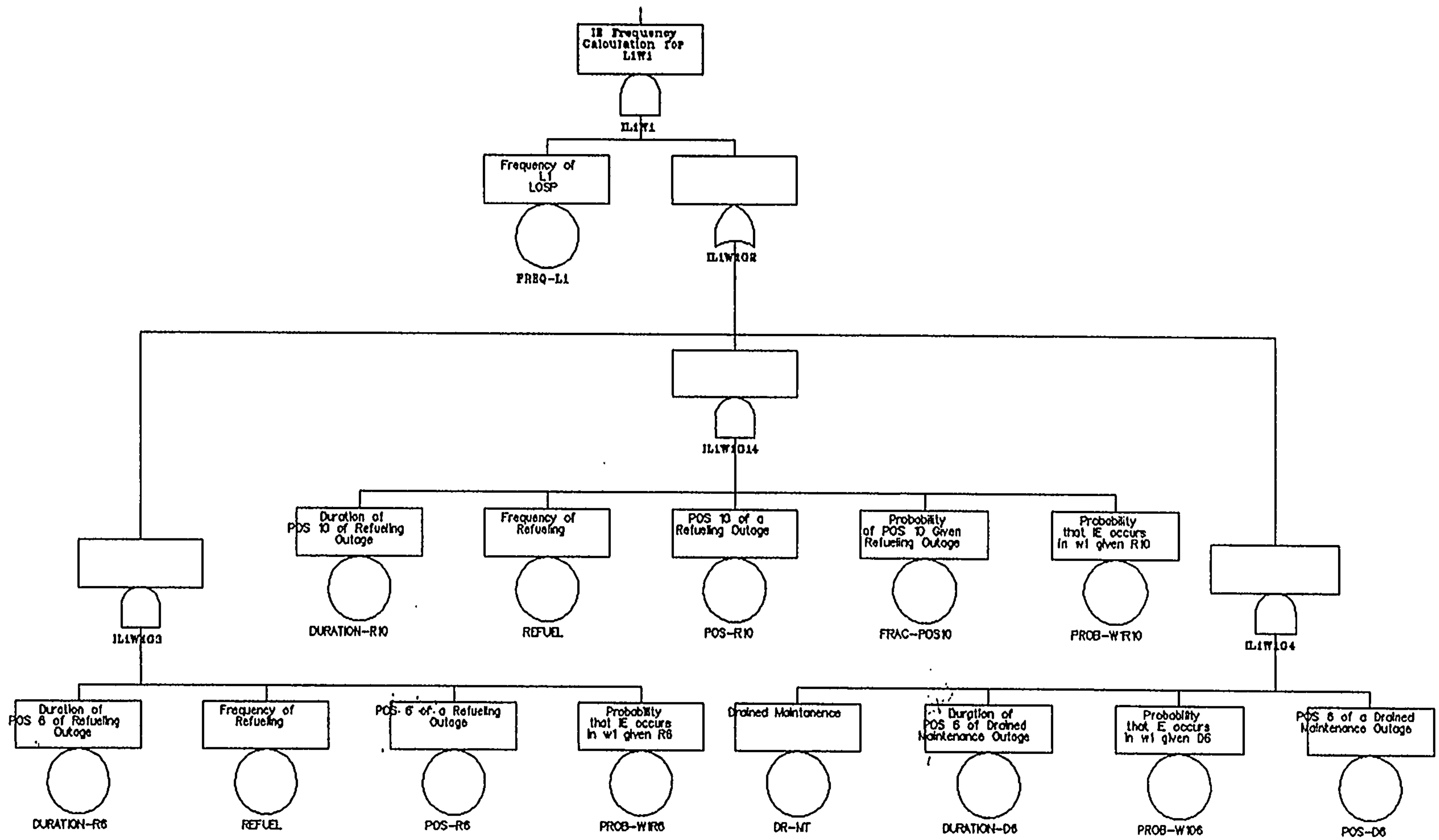
Appendix E.6 Event Trees and High Level Fault Trees for Loss of Offsite Power (L1)


UNITY
IL1W1
RL1W1
VW1
NL1W1
SL1W1
FL1W1
GL1W1
CL1W1
SEQ #
END-STATE-NAMES
L1WR6 -- LOSP L1, WINDOW W1, POS R6
1 @
2 @
3 @
4 CD
5 CD
6 CD
7 @
8 CD
9 CD
10 CD
11 @
12 @
13 CD
14 CD
15 @
16 @
17 CD
18 CD

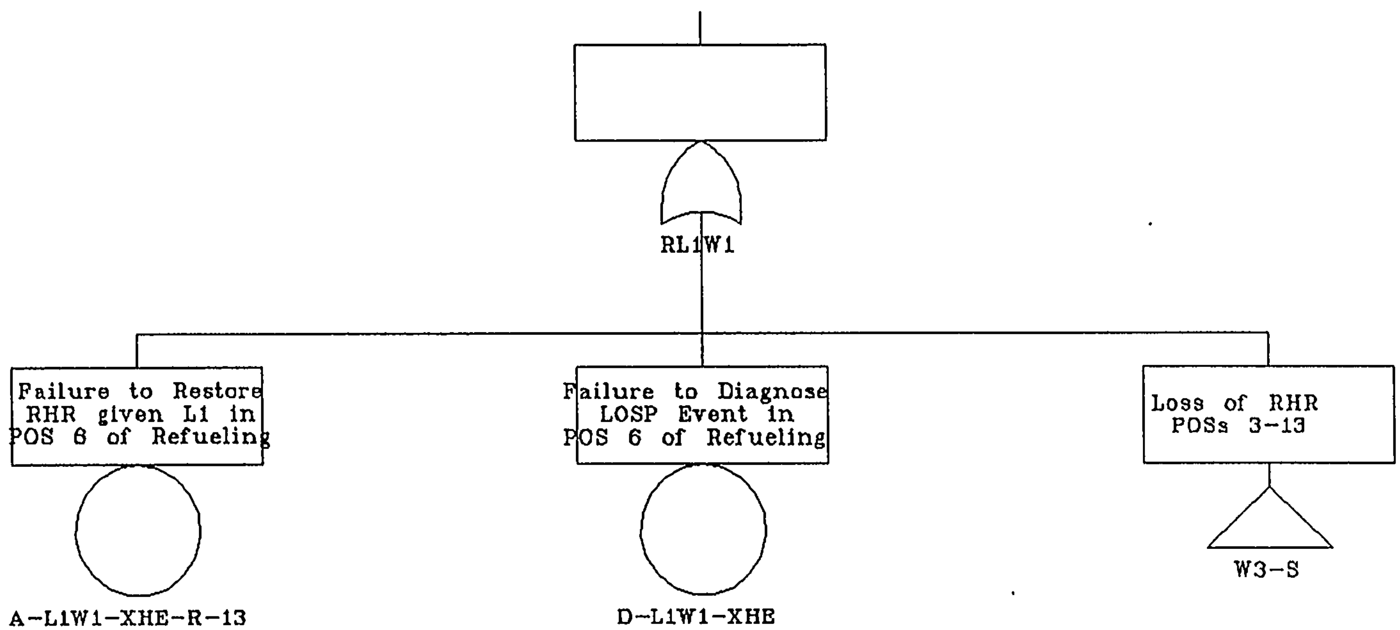


UNITY
IL1W1
RL1W1
NL1W1
FL1W1
CL1W1
SEQ #
END-STATE
L1W1D6
LOSS OF OFFSITE POWER
CAT. L1, WINDOW 1
DRAINED MAINTENANCE
1 @
2 @
3 @
4 CD
5 CD
6 @
7 CD
8 CD

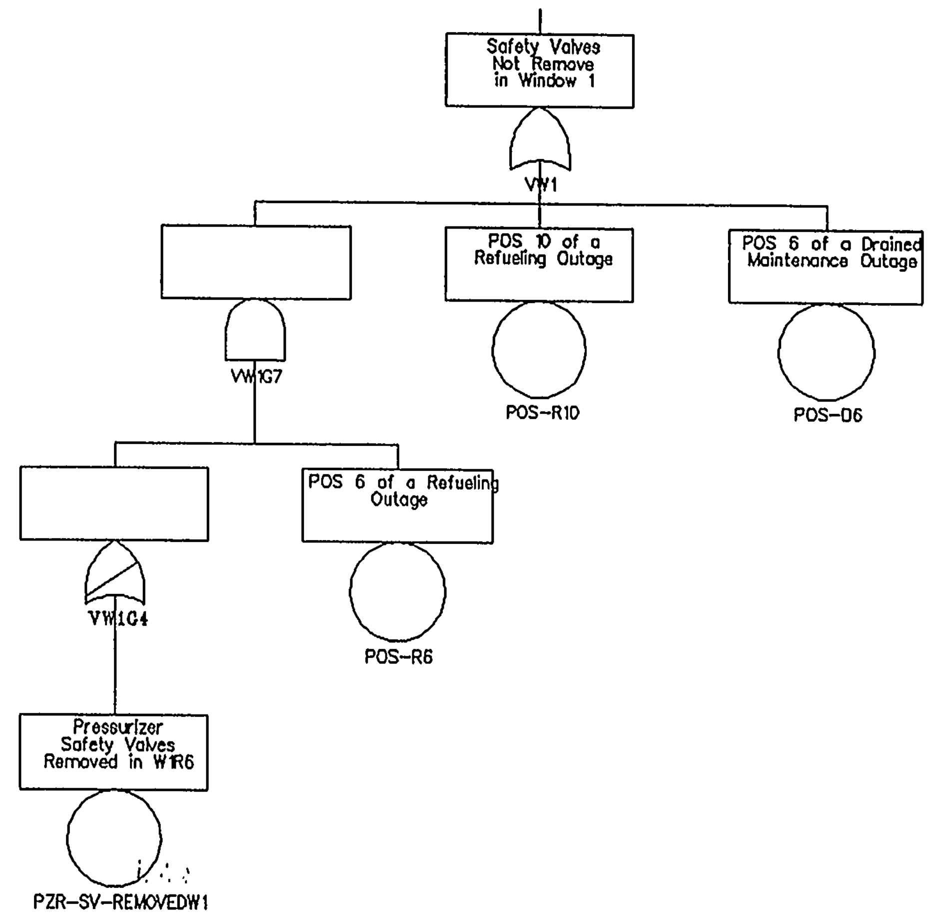
I top event for L1 LOSP – L1 in window 1



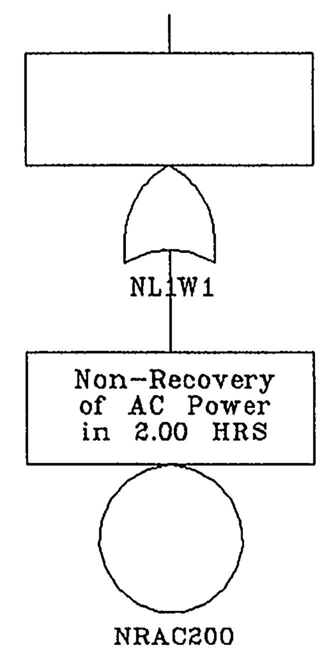
Restore RHR given L1 in POS 6 – Refueling



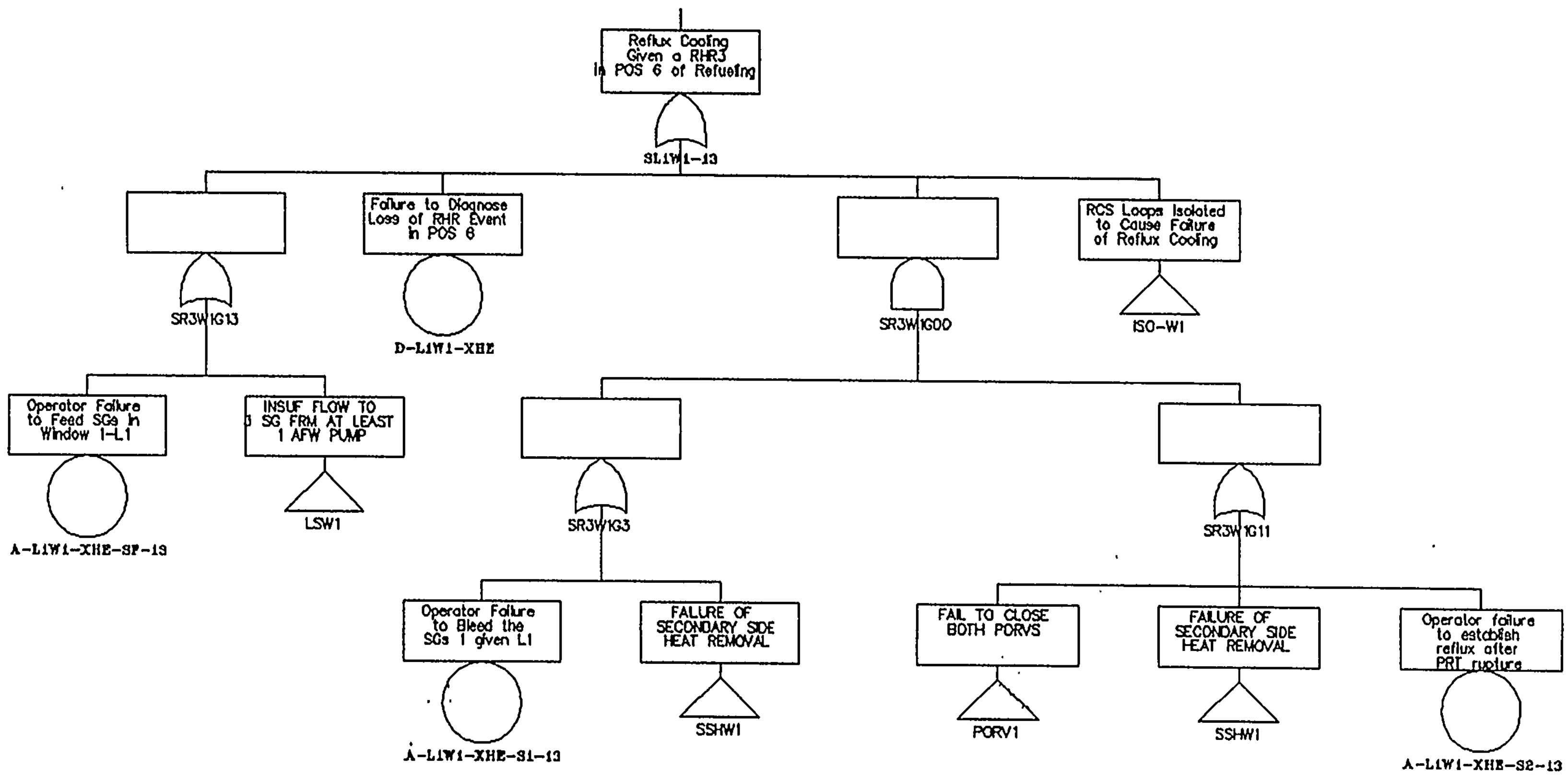
Safety valves Not Removed in Window 1



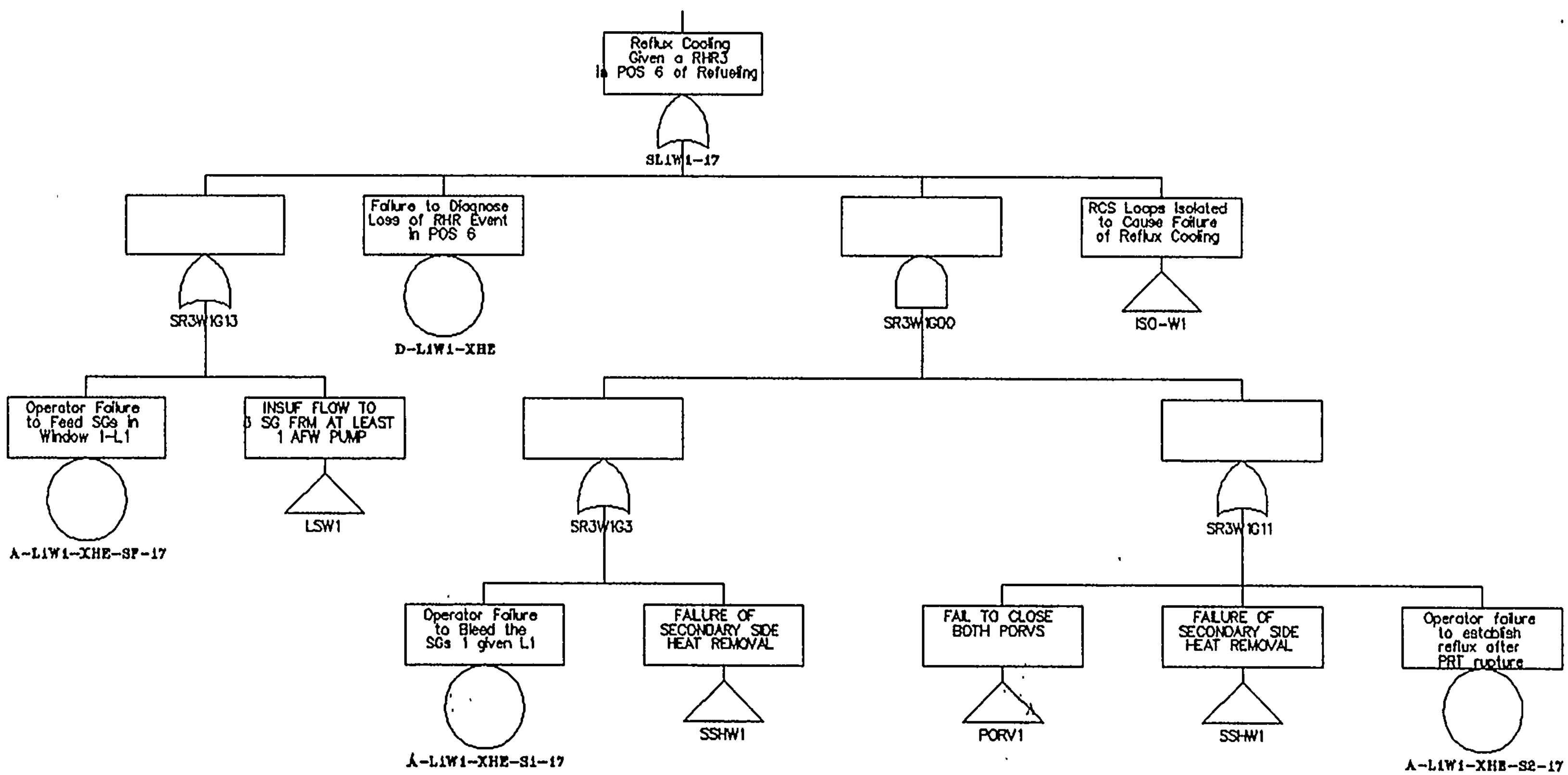
Non-Recovery of AC Power in 144 min. of LOOP



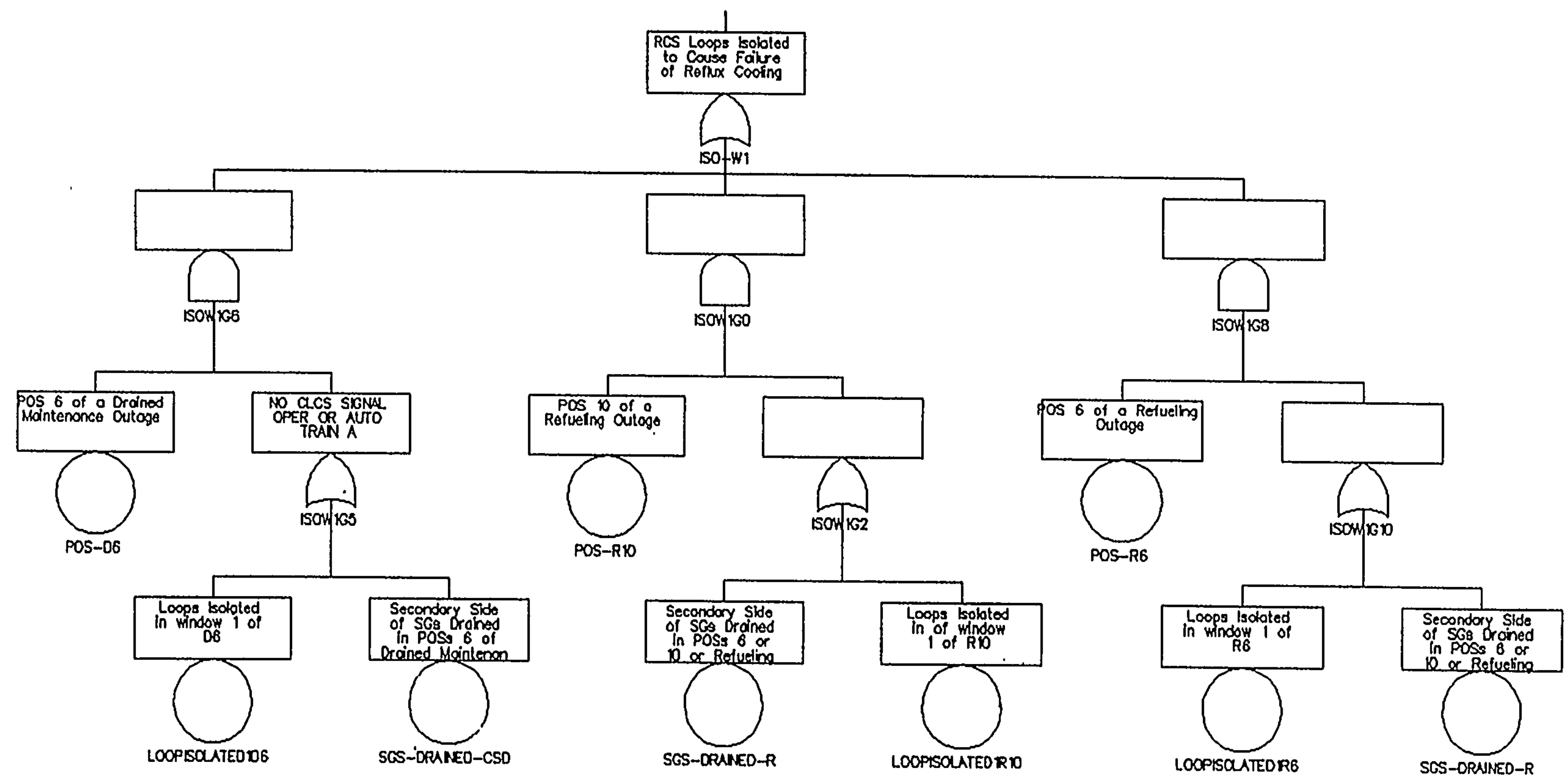
Reflux Cooling in window 1



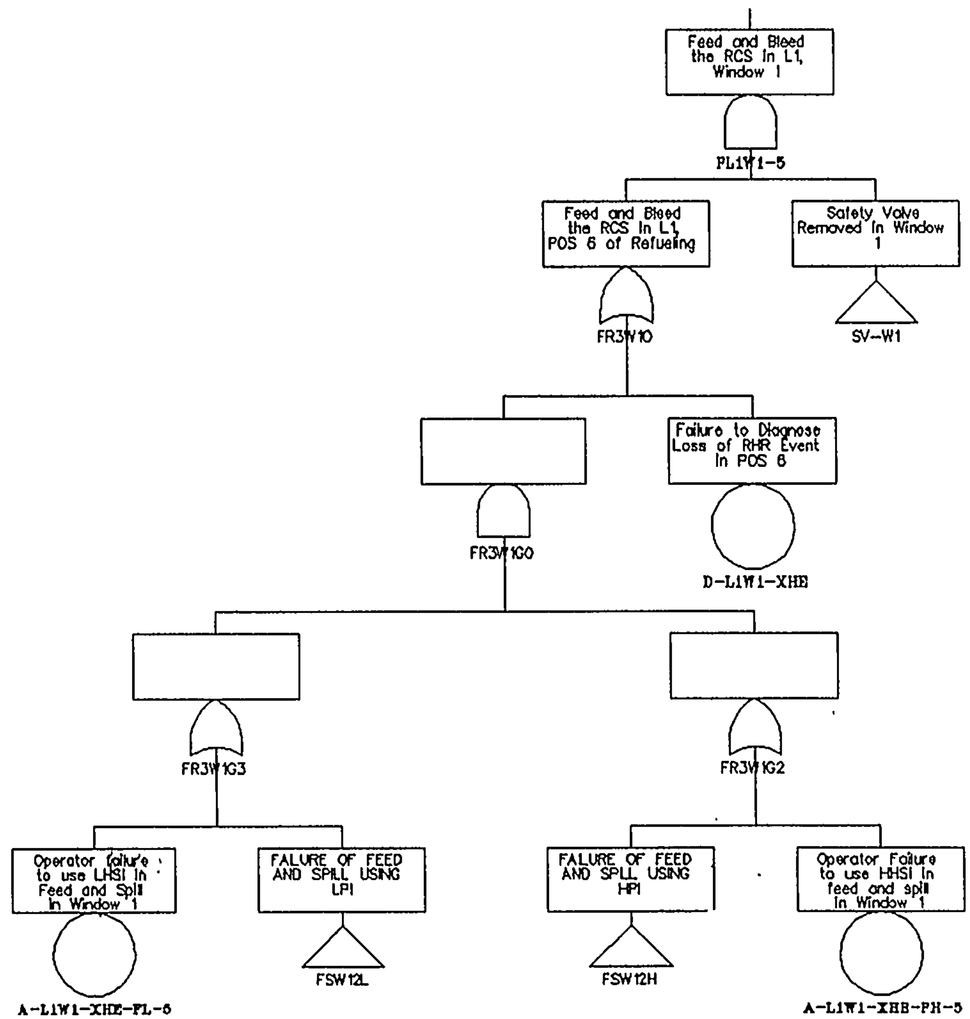
Reflux Cooling in window 1



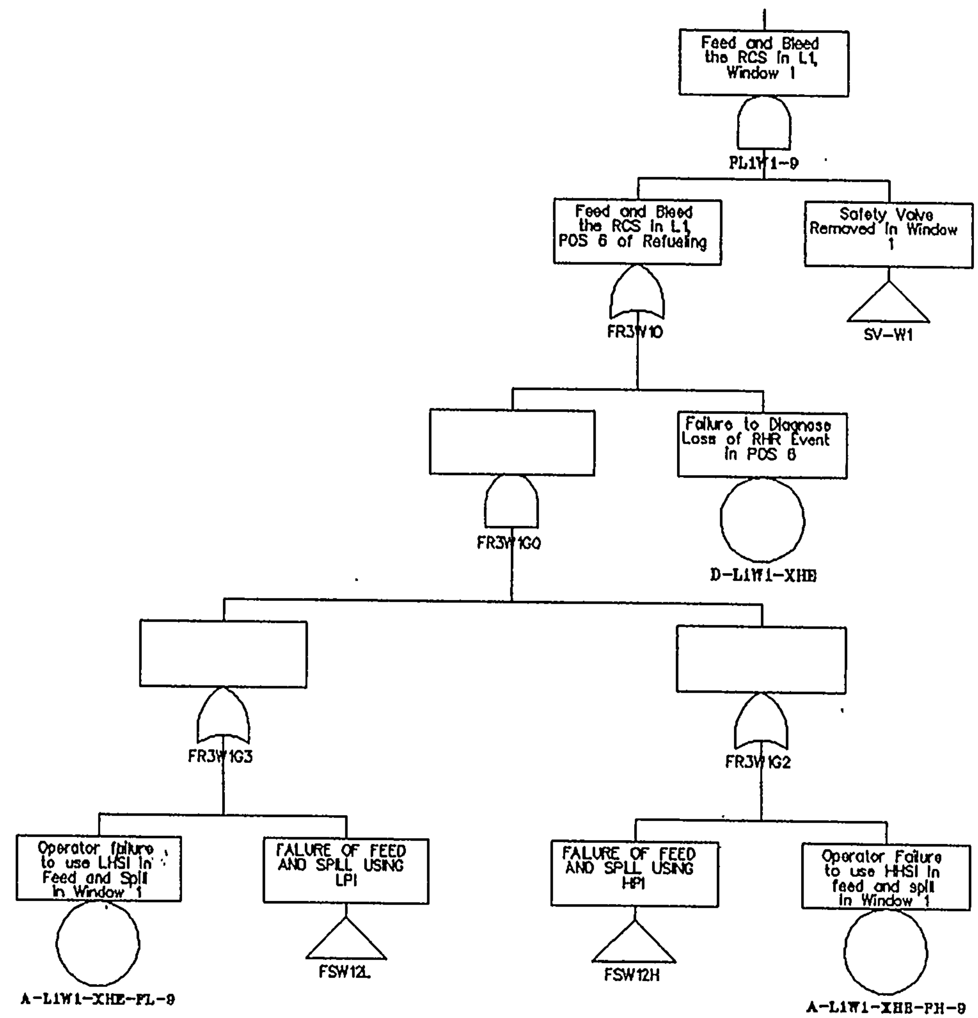
RCS Loops isolated to cause failure of reflux in window 1

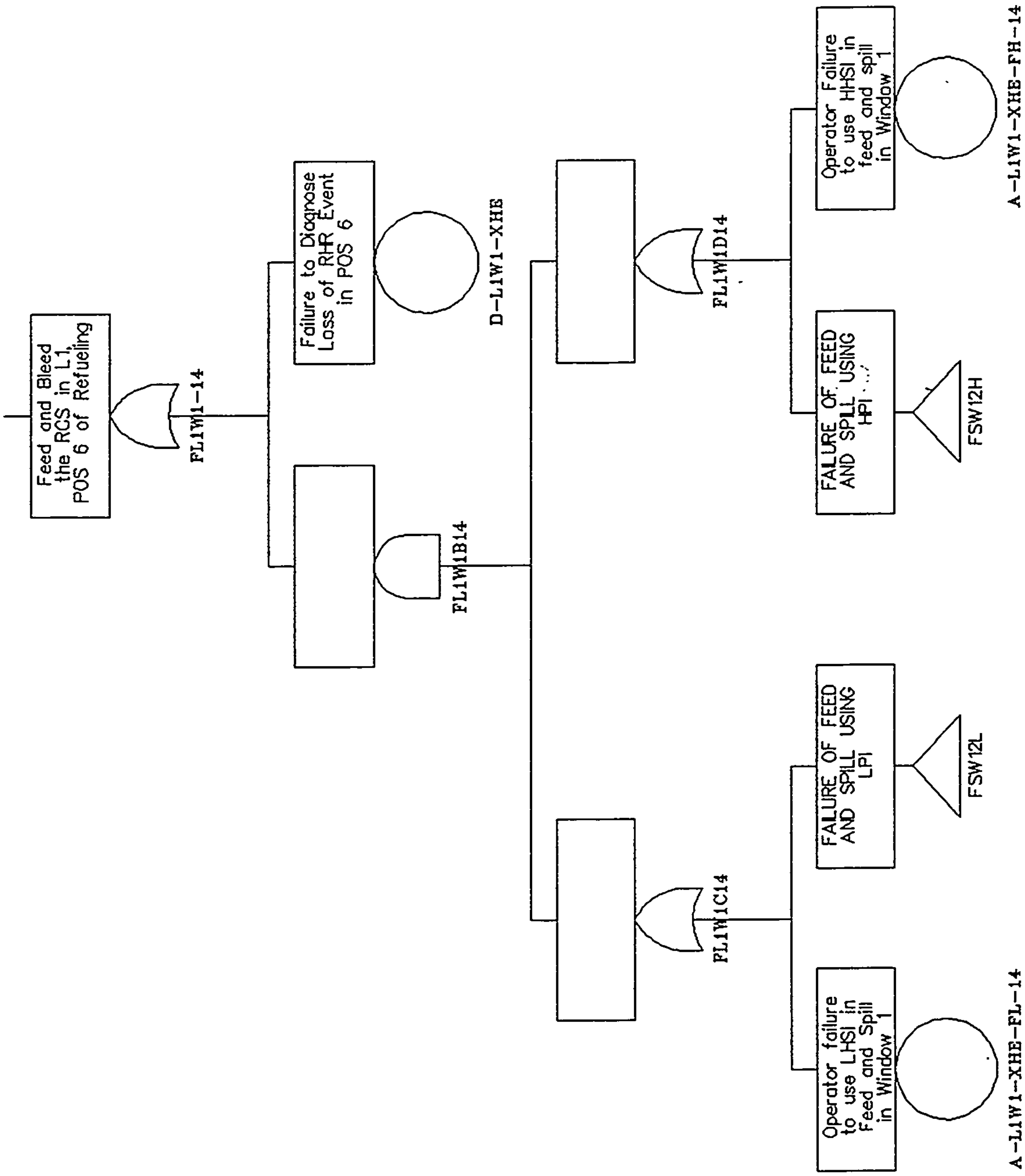


Feed and Bleed the RCS in L1, Window 1

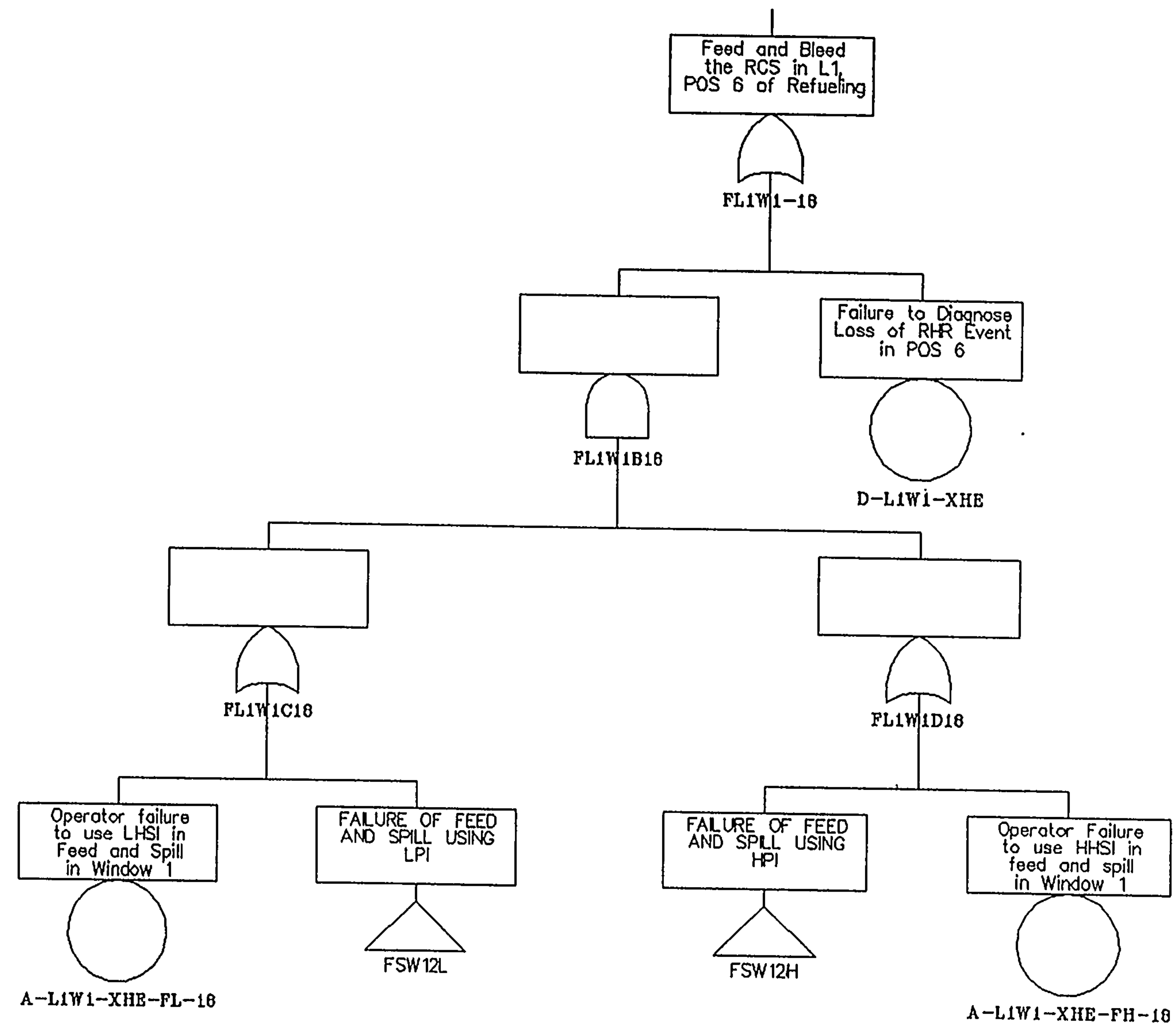


Feed and Bleed the RCS in L1, Window 1

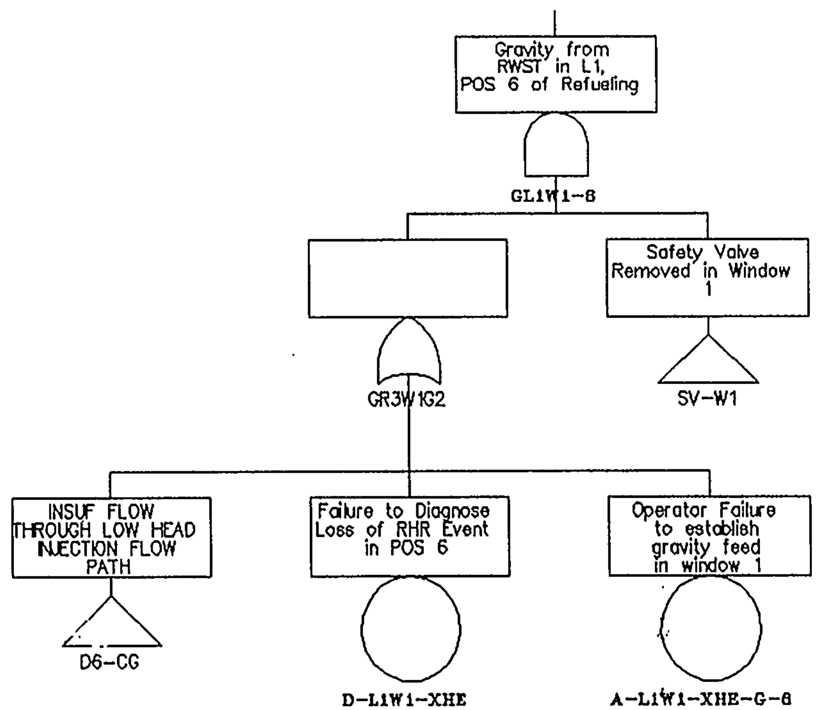




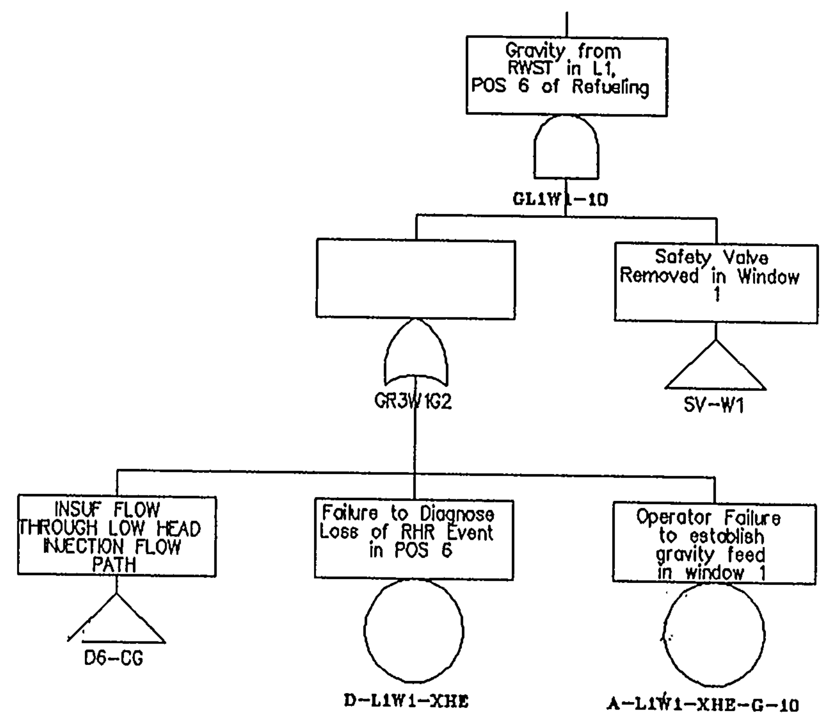
Feed and Bleed the RCS in L1, POS 6 of Refueling
FL1W1-14
Failure to Diagnose Loss of RHR Event in POS 6
D-L1W1-XHE
FL1W1B14
FL1W1D14
FL1W1C14
Operator Failure to use HHSI in feed and spill in Window 1
A-L1W1-XHE-FH-14
FALURE OF FEED AND SPLL USING HPI
FSW12H
FALURE OF FEED AND SPILL USING LPI
FSW12L
Operator failure to use LHSI in Feed and Spill in Window 1
A-L1W1-XHE-FL-14


Feed and Bleed the RCS in L1, POS 6 of Refueling
FL1W1-18
Failure to Diagnose Loss of RHR Event in POS 6
D-L1W1-XHE
FL1W1B18
FL1W1C18
FL1W1D18
Operator failure to use LHSI in Feed and Spill in Window 1
A-L1W1-XHE-FL-18
FAILURE OF FEED AND SPILL USING LPI
FSW12L
FAILURE OF FEED AND SPILL USING HPI
FSW12H
Operator Failure to use HHSI in feed and spill in Window 1
A-L1W1-XHE-FH-18

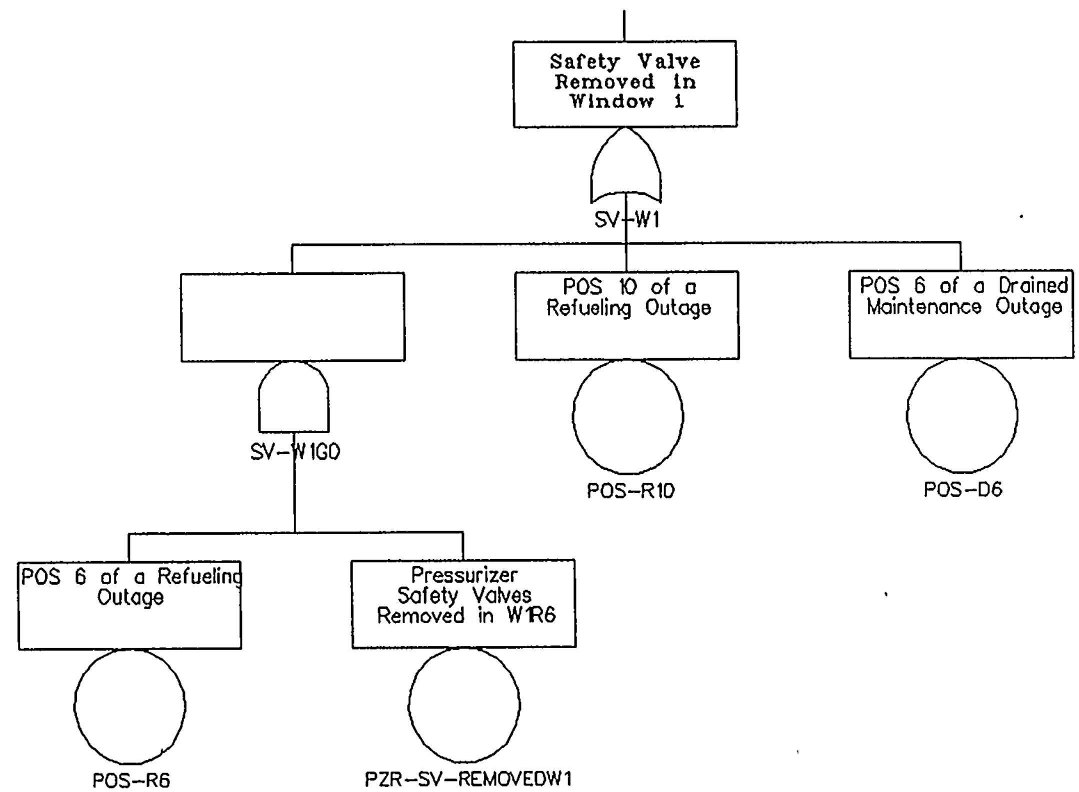
Gravity from RWST in L1, Window 1



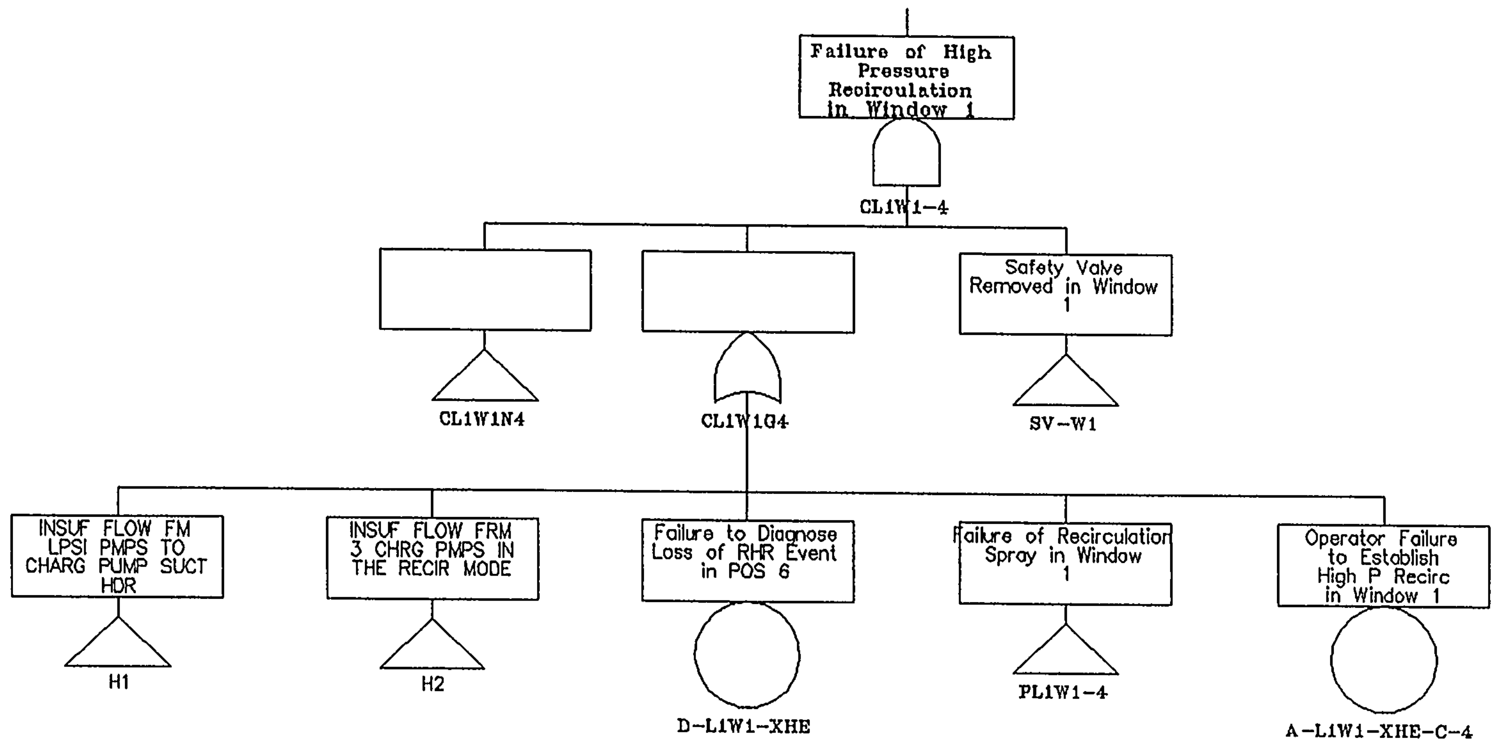
Gravity from RWST in L1, Window 1



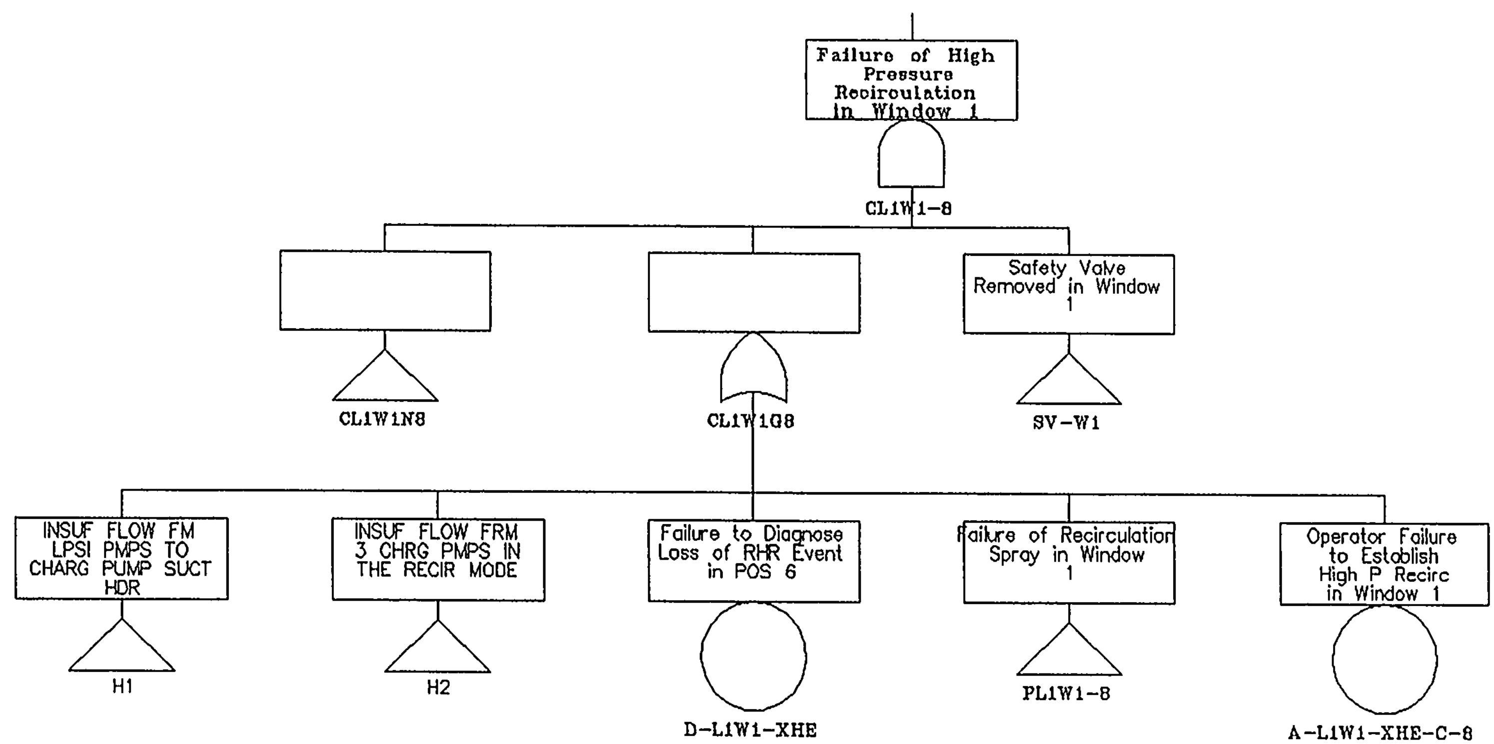
Safety Valves Removed in Window 1



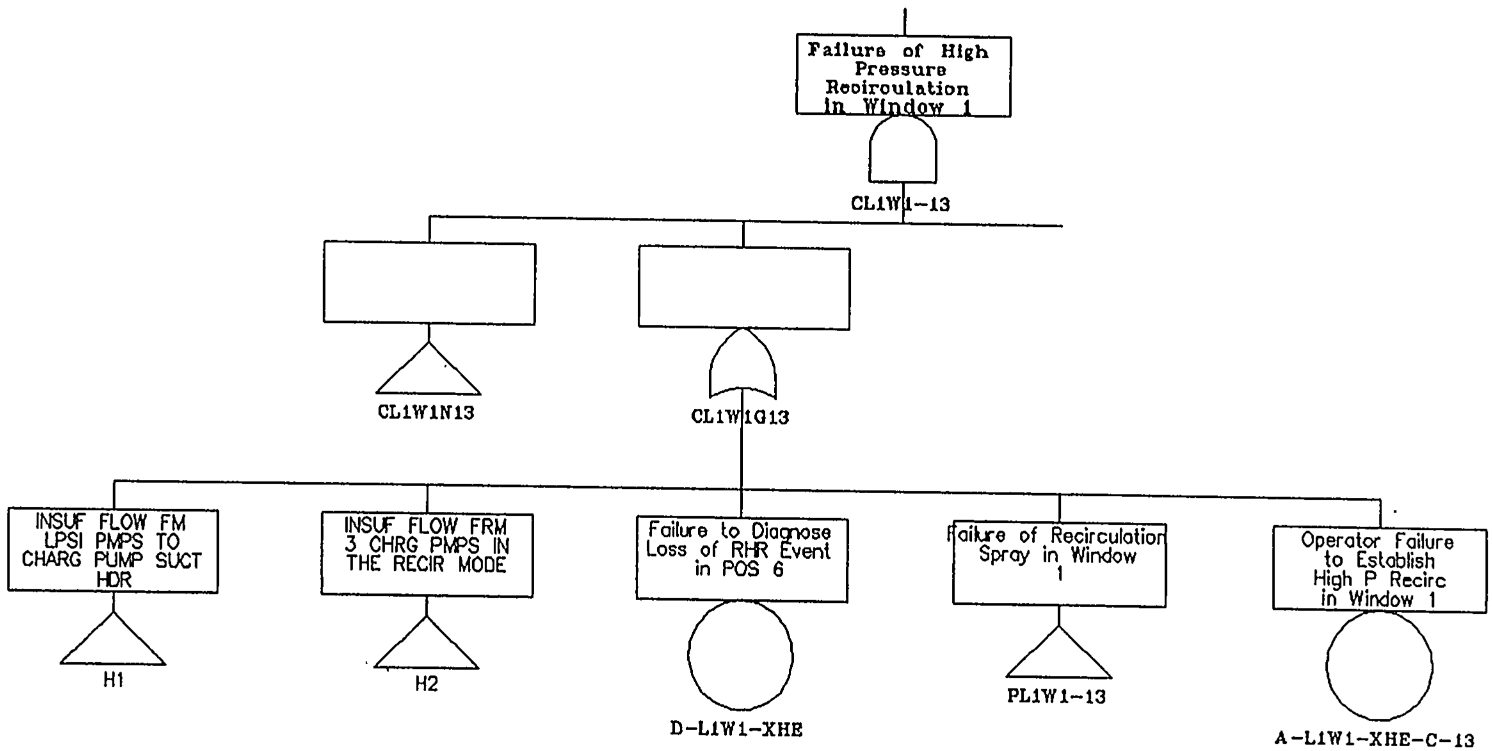
Failure of High Pressure Recirculation in Window 1



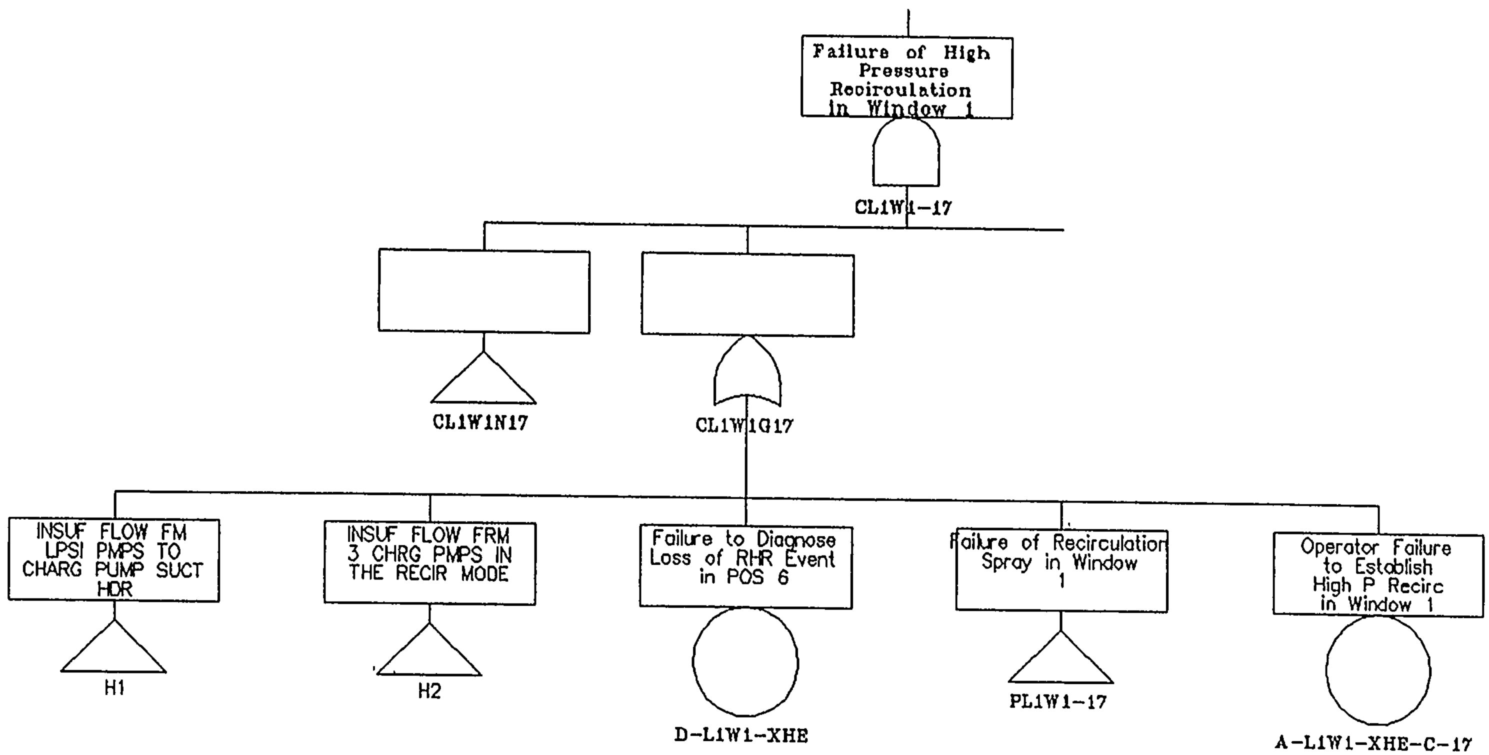
Failure of High Pressure Recirculation in Window 1

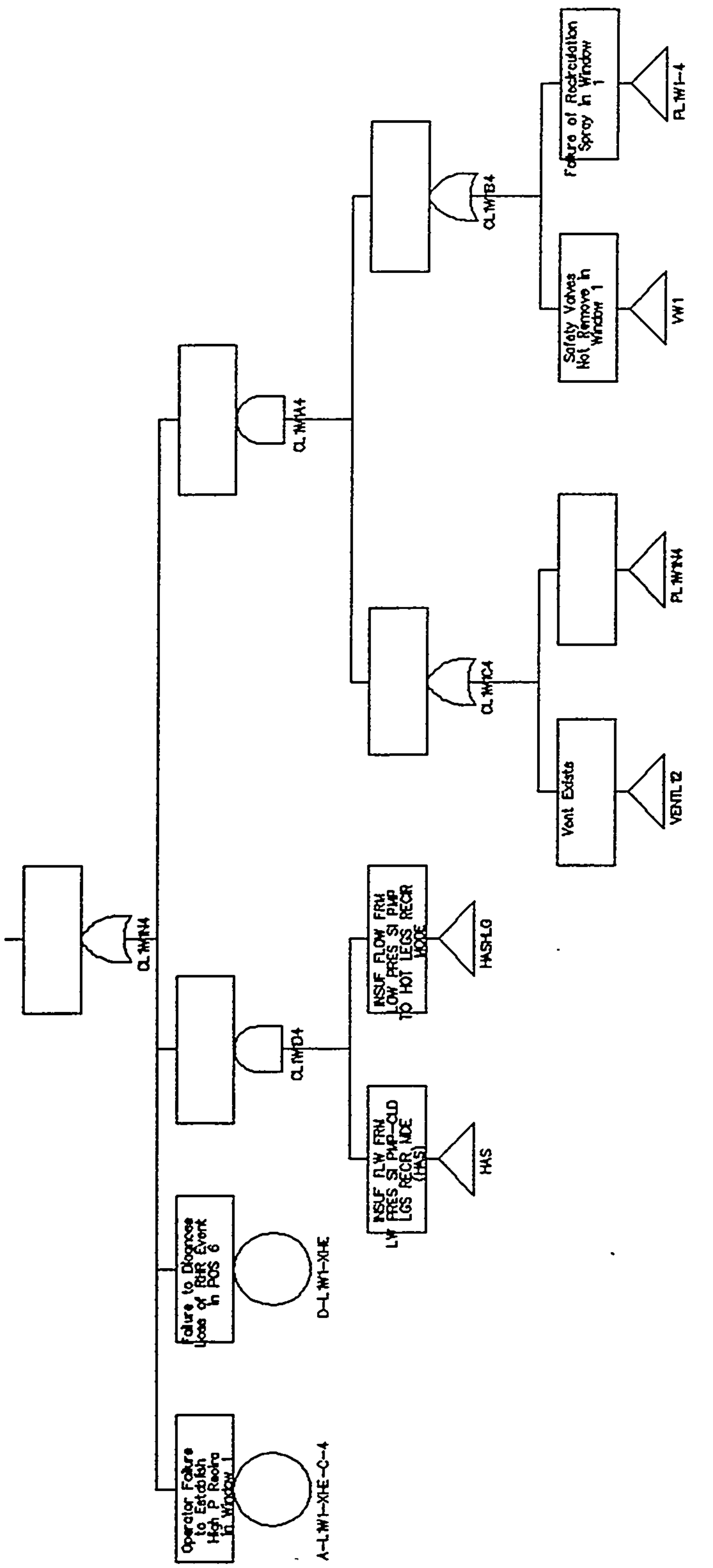


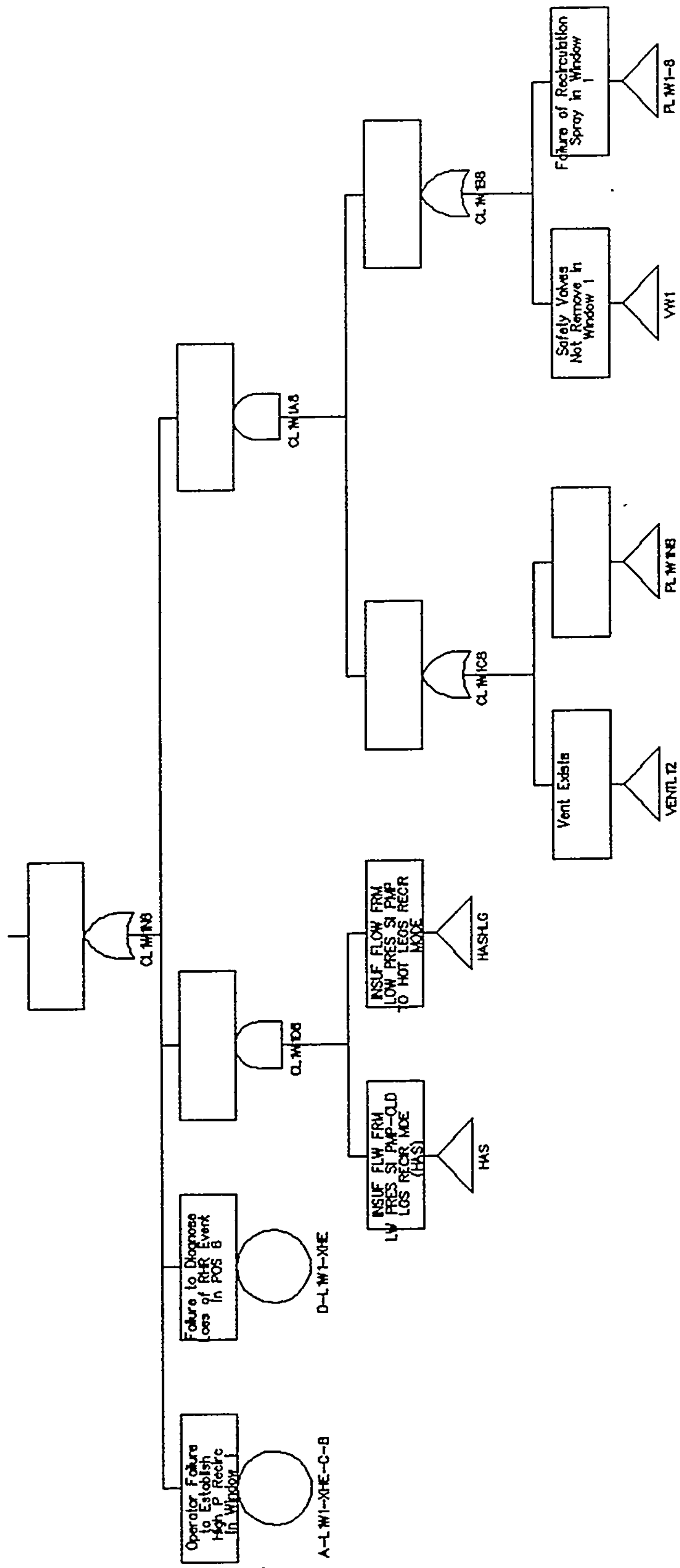
Failure of High Pressure Recirculation in Window 1

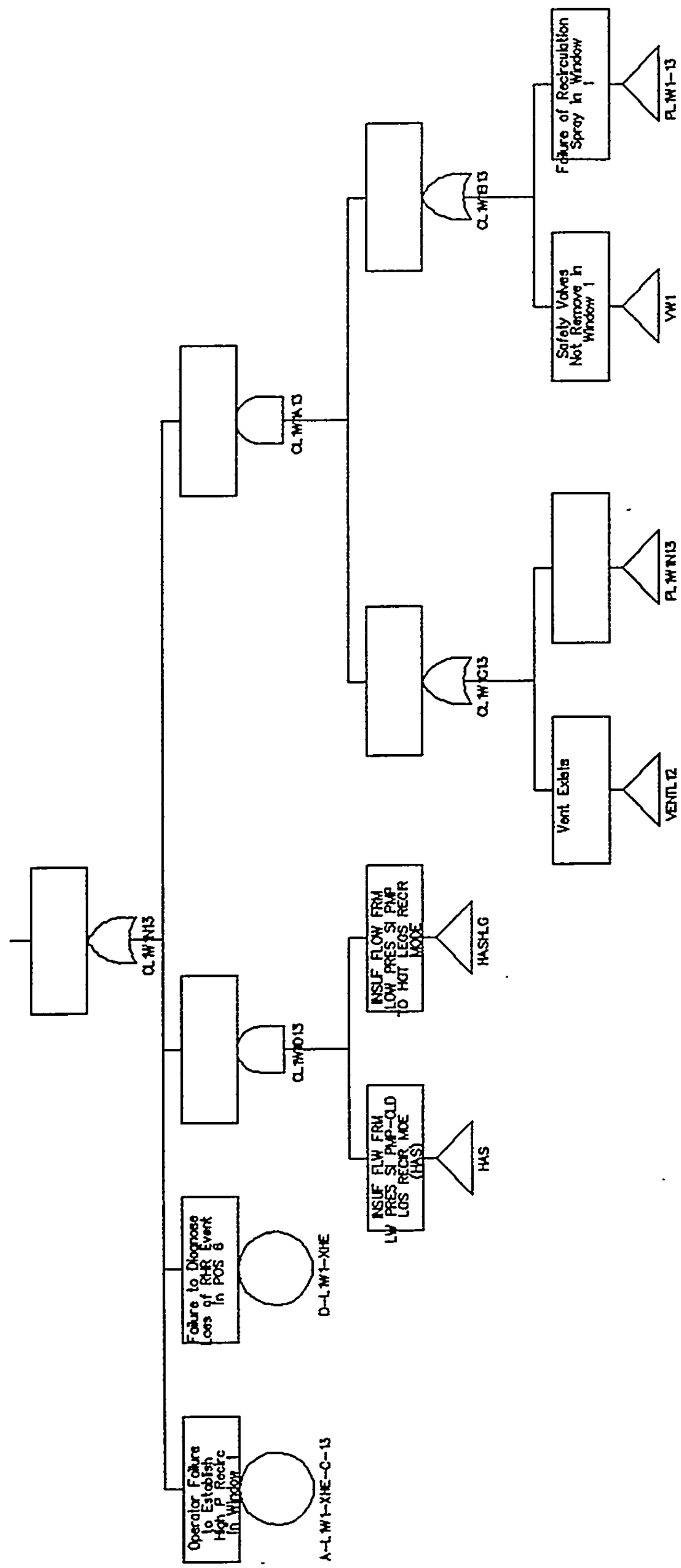


Failure of High Pressure Recirculation in Window 1

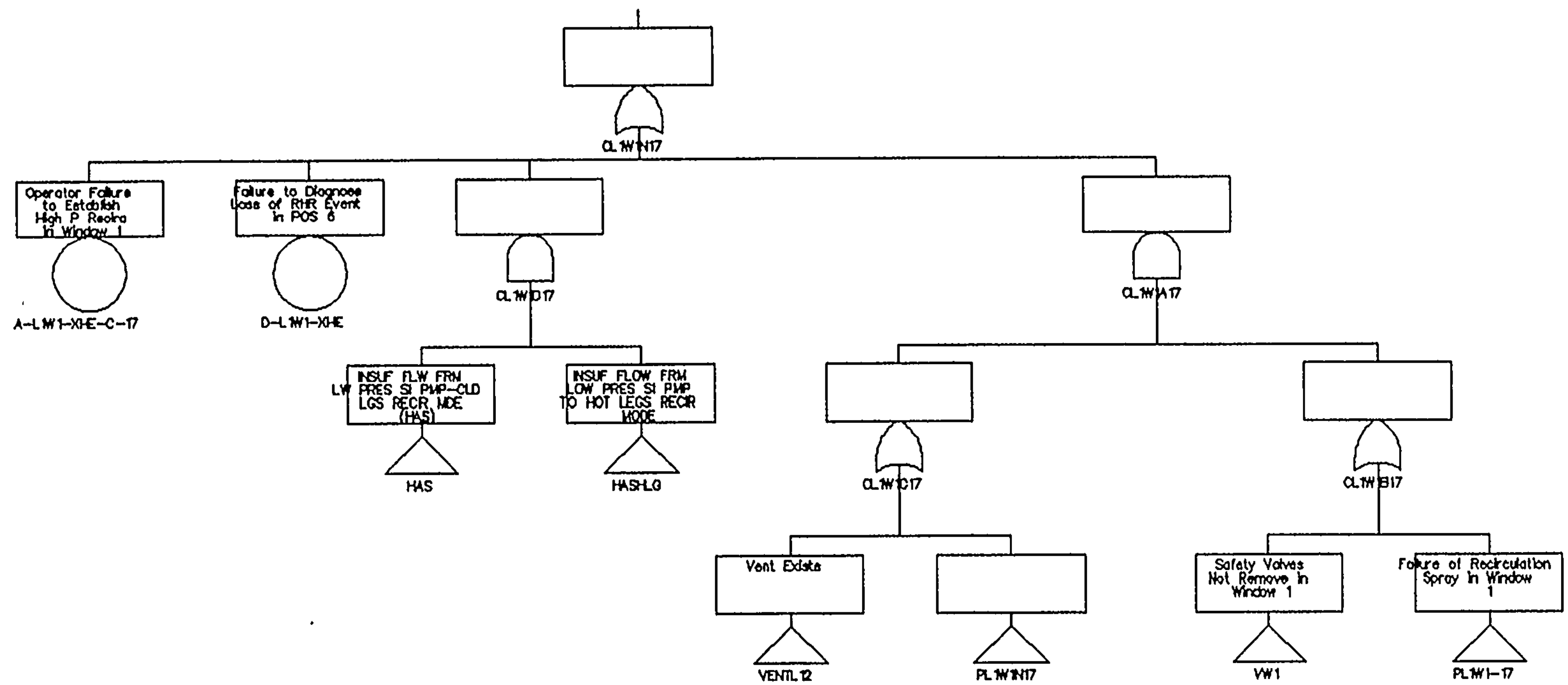


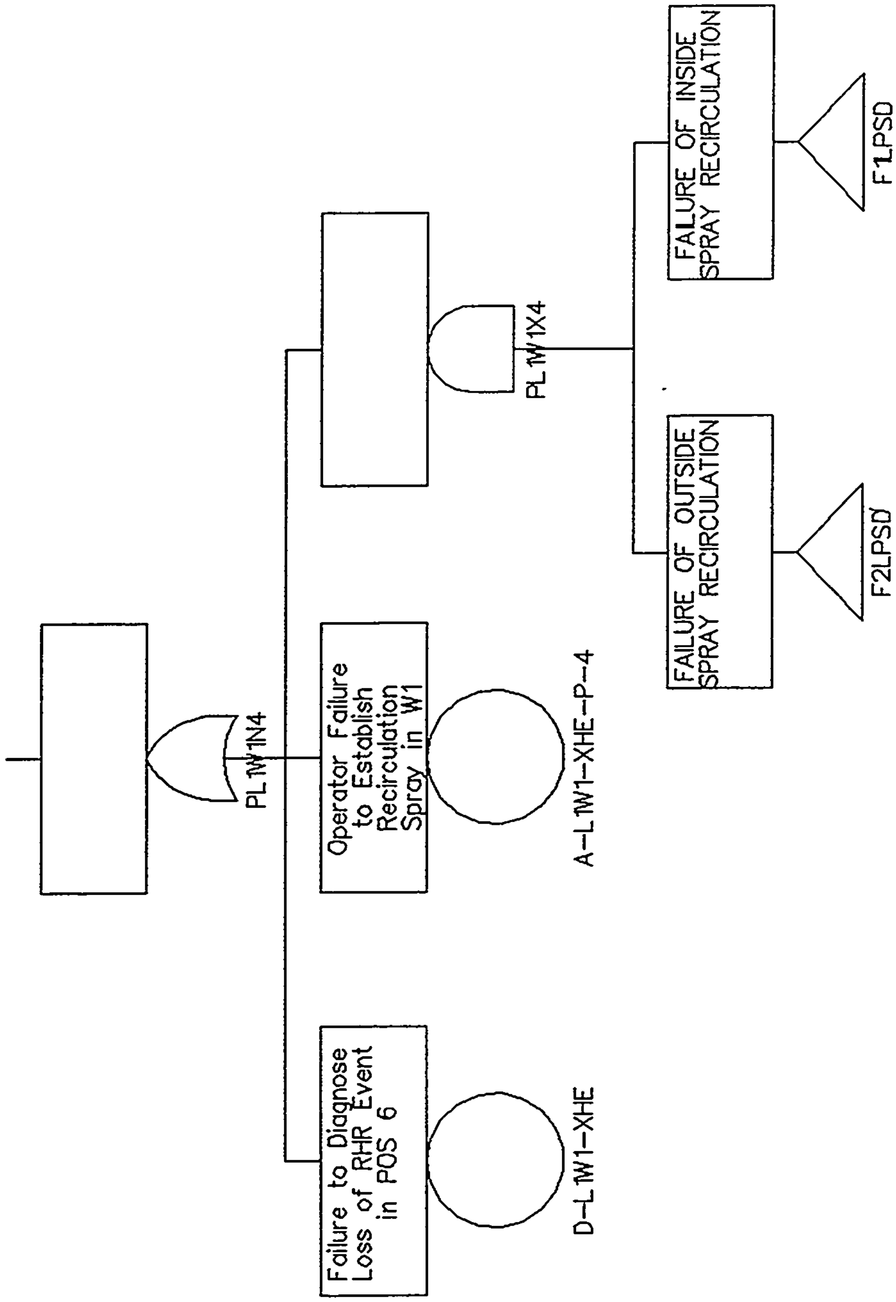

CL1WN4
CL1WA4
CL1WB4
Safety Valves Not Remove In Window 1
VW1
Failure of Recirculation Spray in Window 1
PL1W1-4
CL1WC4
Vent Exists
VENTL12
PL1WN4
CL1WD4
INSUF FLOW FRM LOW PRES SI PMP TO HOT LEGS RECIR MODE
HASHLG
INSUF FLW FRM LW PRES SI PMP-CLD LGS RECIR MDE (HAS)
HAS
Failure to Diagnose Loss of RHR Event in POS 6
D-LW1-XHE
Operator Failure to Establish High P Recirc In Window 1
A-LW1-XHE-C-4

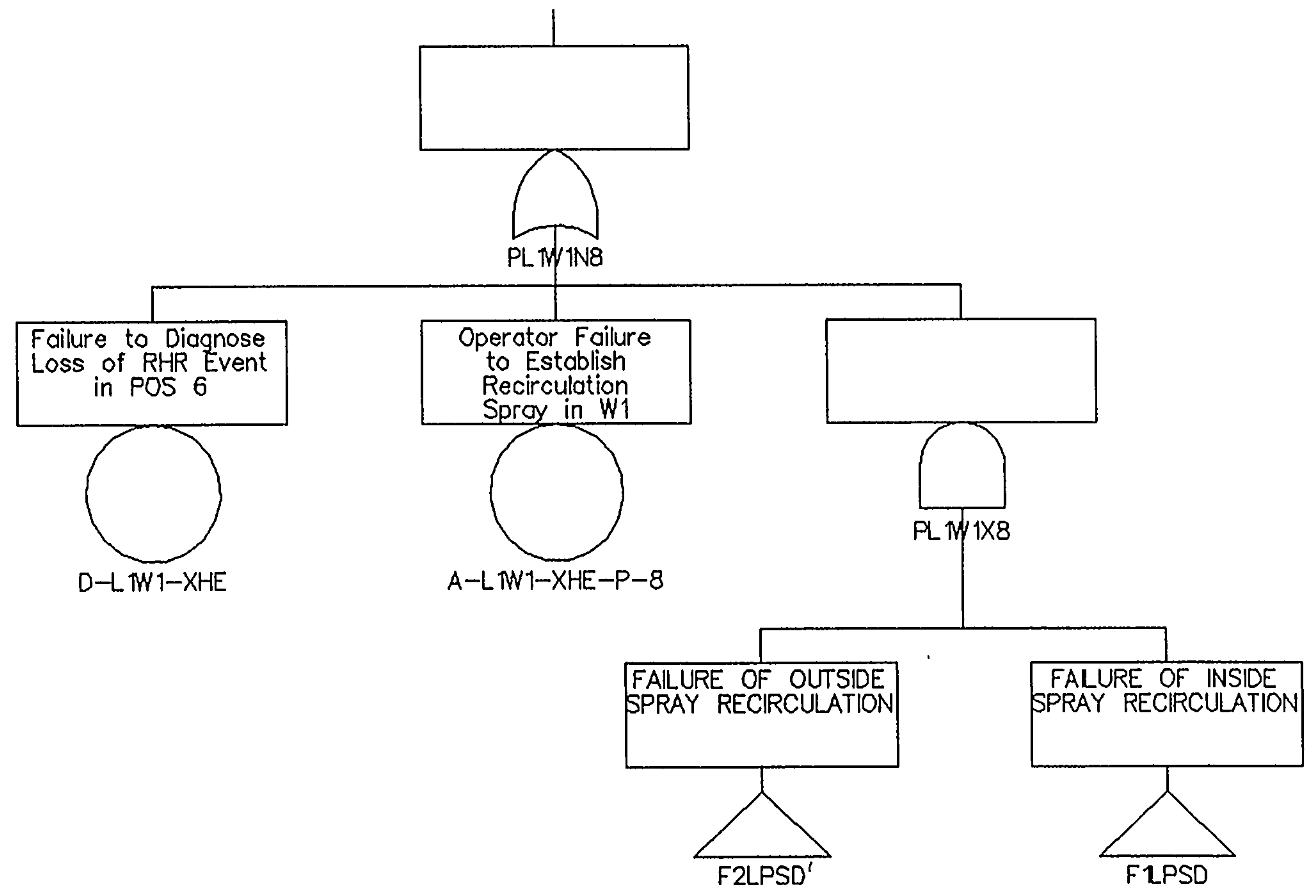

CL.1W1N8
CL.1W1A8
CL.1W1B8
Failure of Recirculation Spray in Window 1
PL.1W1-8
Safety Valves Not Remove in Window 1
VW1
CL.1W1C8
PL.1W1N8
Vent Exists
VENTLT2
CL.1W1D8
INSUF FLOW FRM LOW PRES SI PMP TO HOT LEGS RECR MODE
HASHLG
INSUF FLW FRM LW PRES SI PMP-CLD LGS RECR MDE (HAS)
HAS
Failure to Diagnose Loss of RHR Event In POS 8
D-L1W1-XHE
Operator Failure to Establish High P Recirc In Window 1
A-L1W1-XHE-C-8

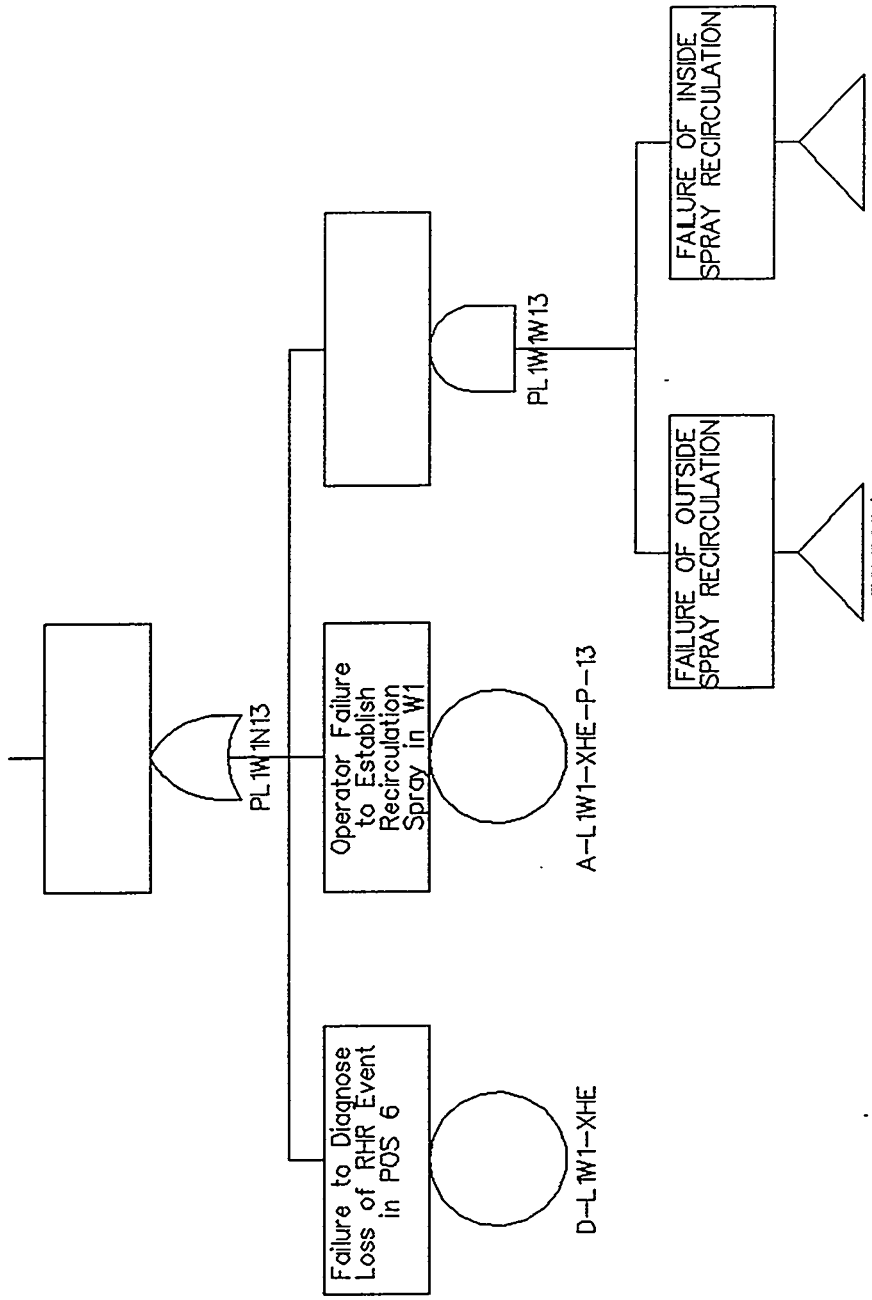


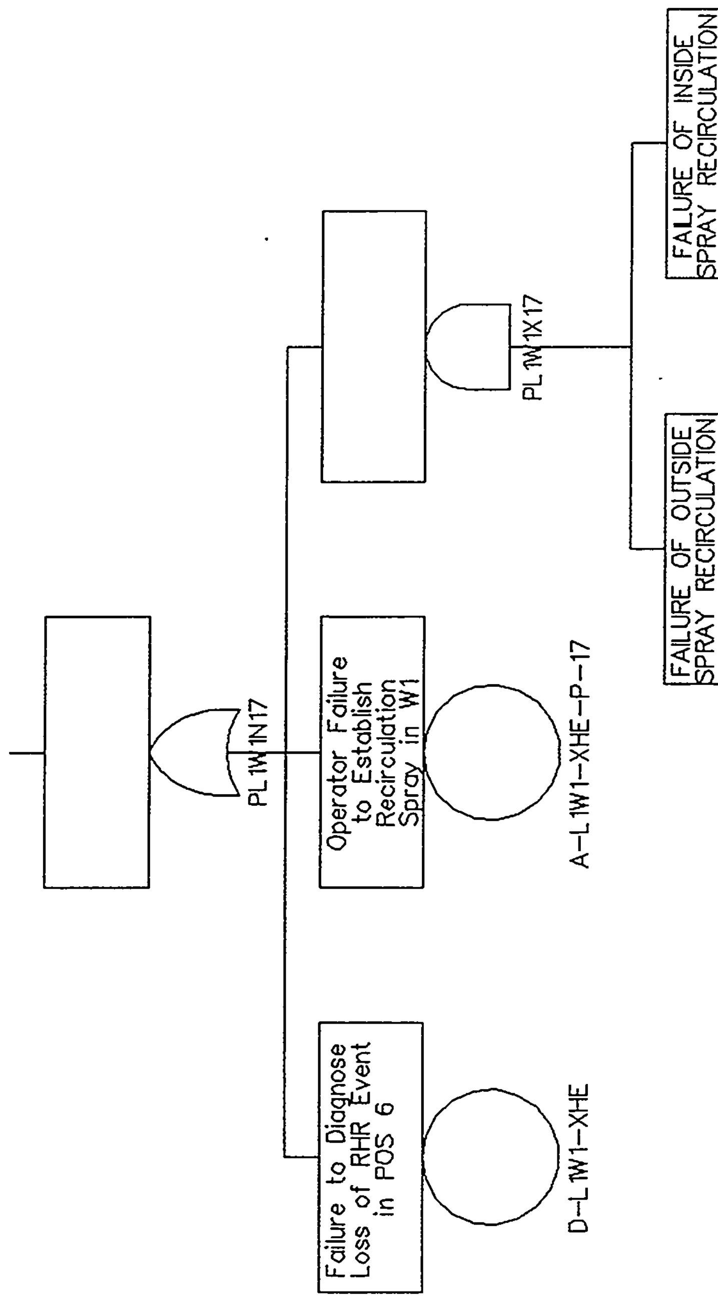
CL.1W1N13
CL.1W1A13
CL.1W1B13
CL.1W1C13
CL.1W1D13
Failure of Recirculation Spray In Window 1
FL.1W1-13
Safety Valves Not Remove in Window 1
VW1
FL.1W1N13
Vent Exists
VENTL12
INSUF FLOW FRM LOW PRES SI PMP TO HOT LEGS RECR MODE
HASHLG
INSUF FLW FRM LW PRES SI PMP-CLD LGS RECIR MOE (HAS)
HAS
Failure to Diagnose Loss of RHR Event In POS 8
D-L1W1-XHE
Operator Failure to Establish High P Recirc In Window 1
A-L1W1-XHE-C-13

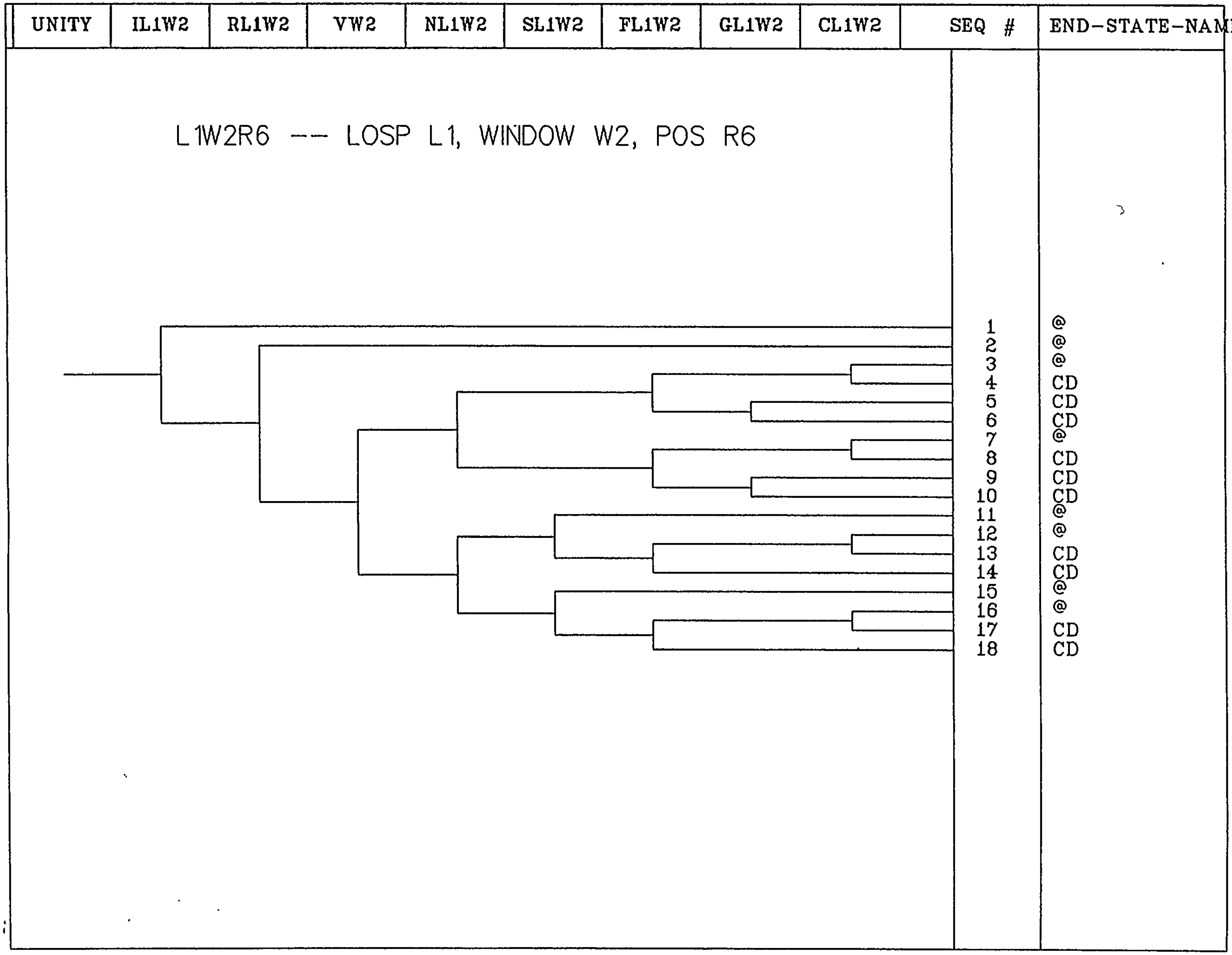

CL1W1N17
Operator Failure to Establish High P Recirc In Window 1
A-L1W1-XHE-C-17
Failure to Diagnose Loss of RHR Event In POS 6
D-L1W1-XHE
CL1W1D17
INSUF FLW FRM LW PRES SI PMP-CLD LGS RECR MDE (HAS)
HAS
INSUF FLOW FRM LOW PRES SI PMP TO HOT LEGS RECIR MODE
HASHLG
CL1W1A17
CL1W1C17
Vent Exists
VENTL12
PL1W1N17
CL1W1B17
Safety Valves Not Remove In Window 1
VW1
Failure of Recirculation Spray In Window 1
PL1W1-17


PL1W1N4
Operator Failure to Establish Recirculation Spray in W1
A-L1W1-XHE-P-4
Failure to Diagnose Loss of RHR Event in POS 6
D-L1W1-XHE
PL1W1X4
FAILURE OF INSIDE SPRAY RECIRCULATION
F1LPSD
FAILURE OF OUTSIDE SPRAY RECIRCULATION
F2LPSD

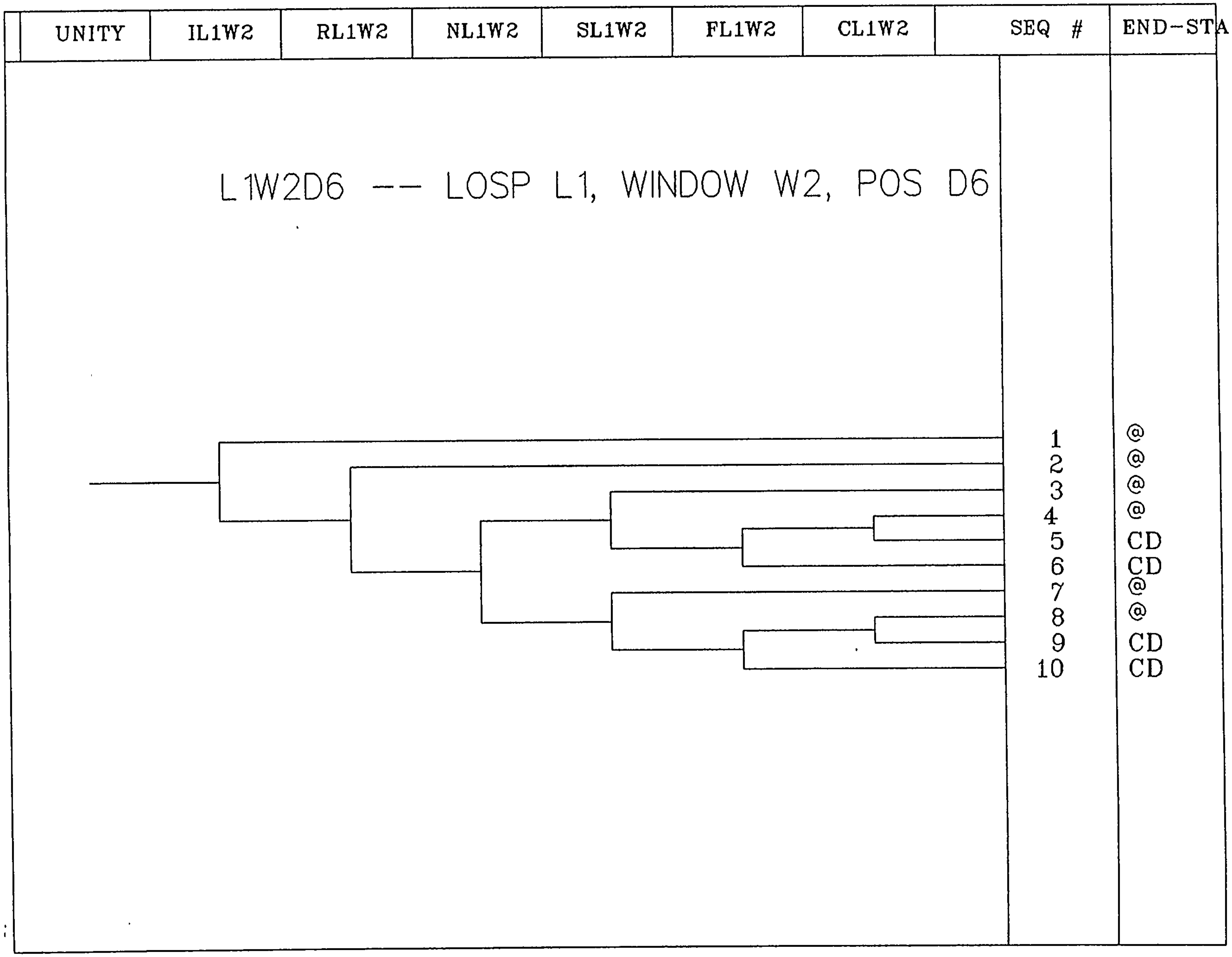

PL1W1N8
Failure to Diagnose Loss of RHR Event in POS 6
D-L1W1-XHE
Operator Failure to Establish Recirculation Spray in W1
A-L1W1-XHE-P-8
PL1W1X8
FAILURE OF OUTSIDE SPRAY RECIRCULATION
F2LPSD'
FAILURE OF INSIDE SPRAY RECIRCULATION
F1LPSD


PL1W1N13
Failure to Diagnose Loss of RHR Event in POS 6
D-L1W1-XHE
Operator Failure to Establish Recirculation Spray in W1
A-L1W1-XHE-P-13
PL1W1W13
FAILURE OF OUTSIDE SPRAY RECIRCULATION
F2LPSD'
FAILURE OF INSIDE SPRAY RECIRCULATION
F1LPSD


PL1W1N17
Operator Failure to Establish Recirculation Spray in W1
A-L1W1-XHE-P-17
Failure to Diagnose Loss of RHR Event in POS 6
D-L1W1-XHE
PL1W1X17
FAILURE OF OUTSIDE SPRAY RECIRCULATION
F2LPSD
FALURE OF INSIDE SPRAY RECIRCULATION
F1LPSD

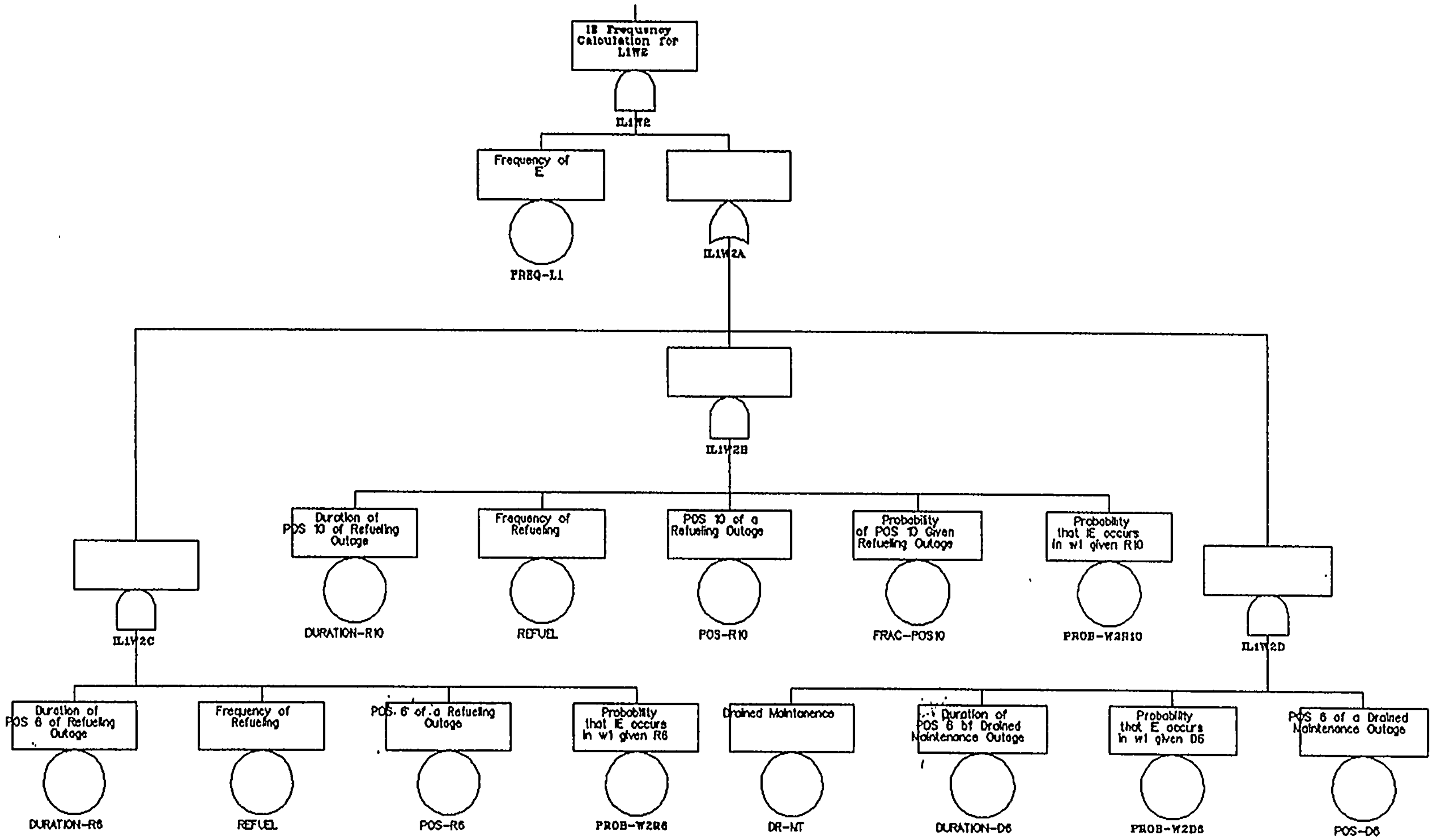


UNITY
IL1W2
RL1W2
VW2
NL1W2
SL1W2
FL1W2
GL1W2
CL1W2
SEQ #
END-STATE-NAMES
L1W2R6 -- LOSP L1, WINDOW W2, POS R6
1 @
2 @
3 @
4 CD
5 CD
6 CD
7 @
8 CD
9 CD
10 CD
11 @
12 @
13 CD
14 CD
15 @
16 @
17 CD
18 CD

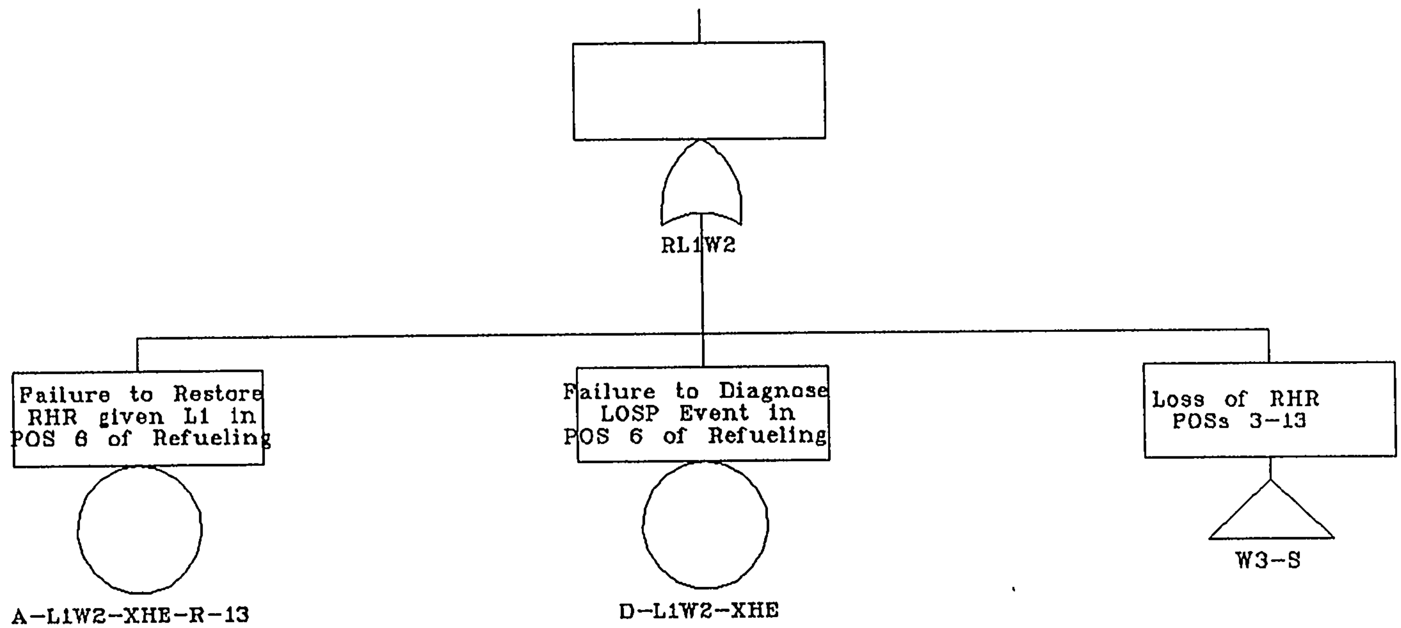


UNITY
IL1W2
RL1W2
NL1W2
SL1W2
FL1W2
CL1W2
SEQ #
END-STATI
L1W2D6 -- LOSP L1, WINDOW W2, POS D6
1 @
2 @
3 @
4 @
5 CD
6 CD
7 @
8 @
9 CD
10 CD

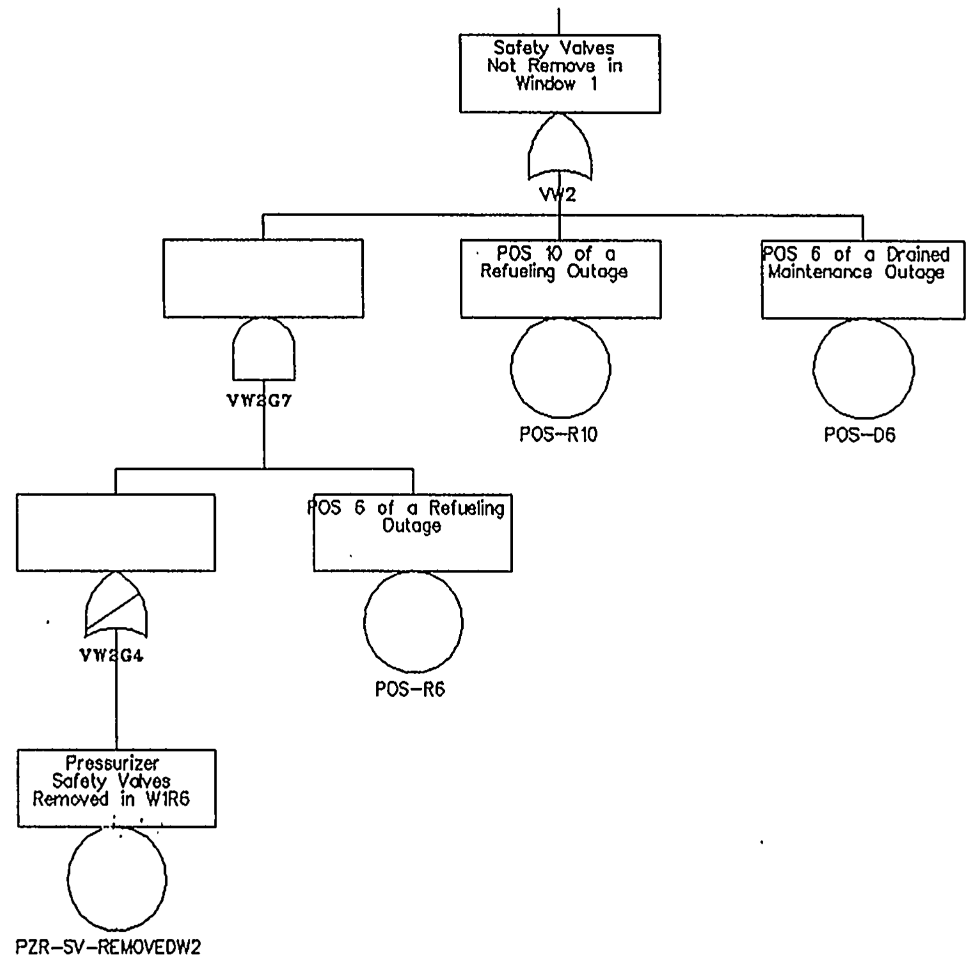
I top event for L1 In window 2



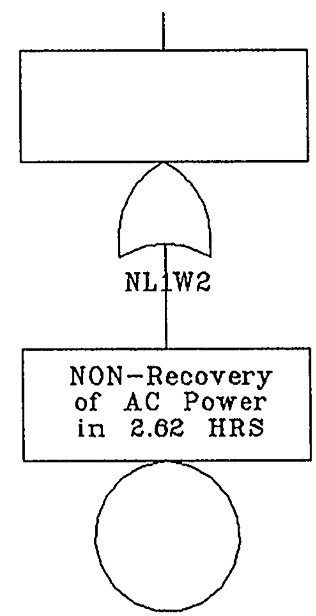
Restore RHR given L1 in POS 6 – Refueling



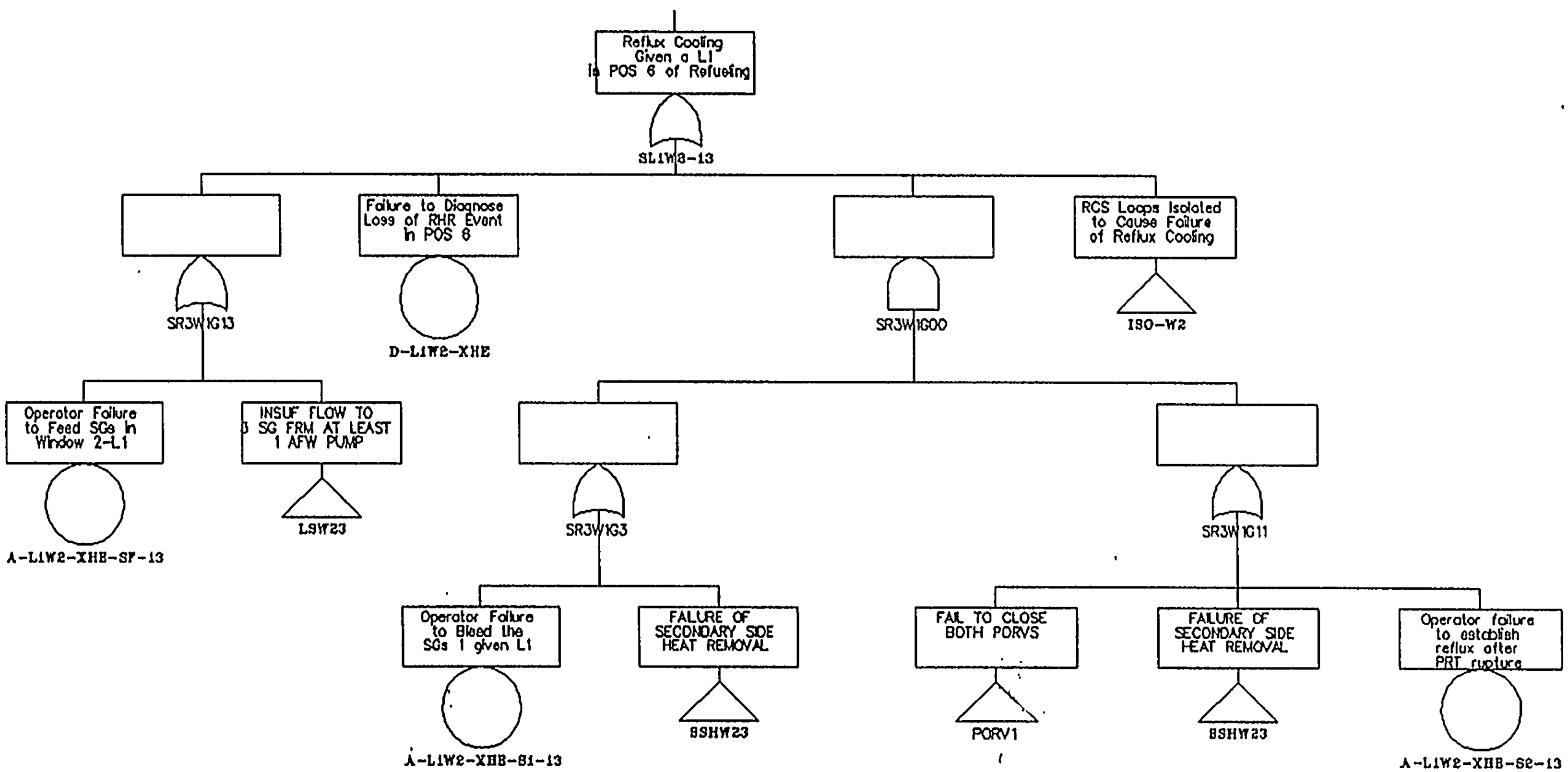
Safety valves Not Removed in Window 2



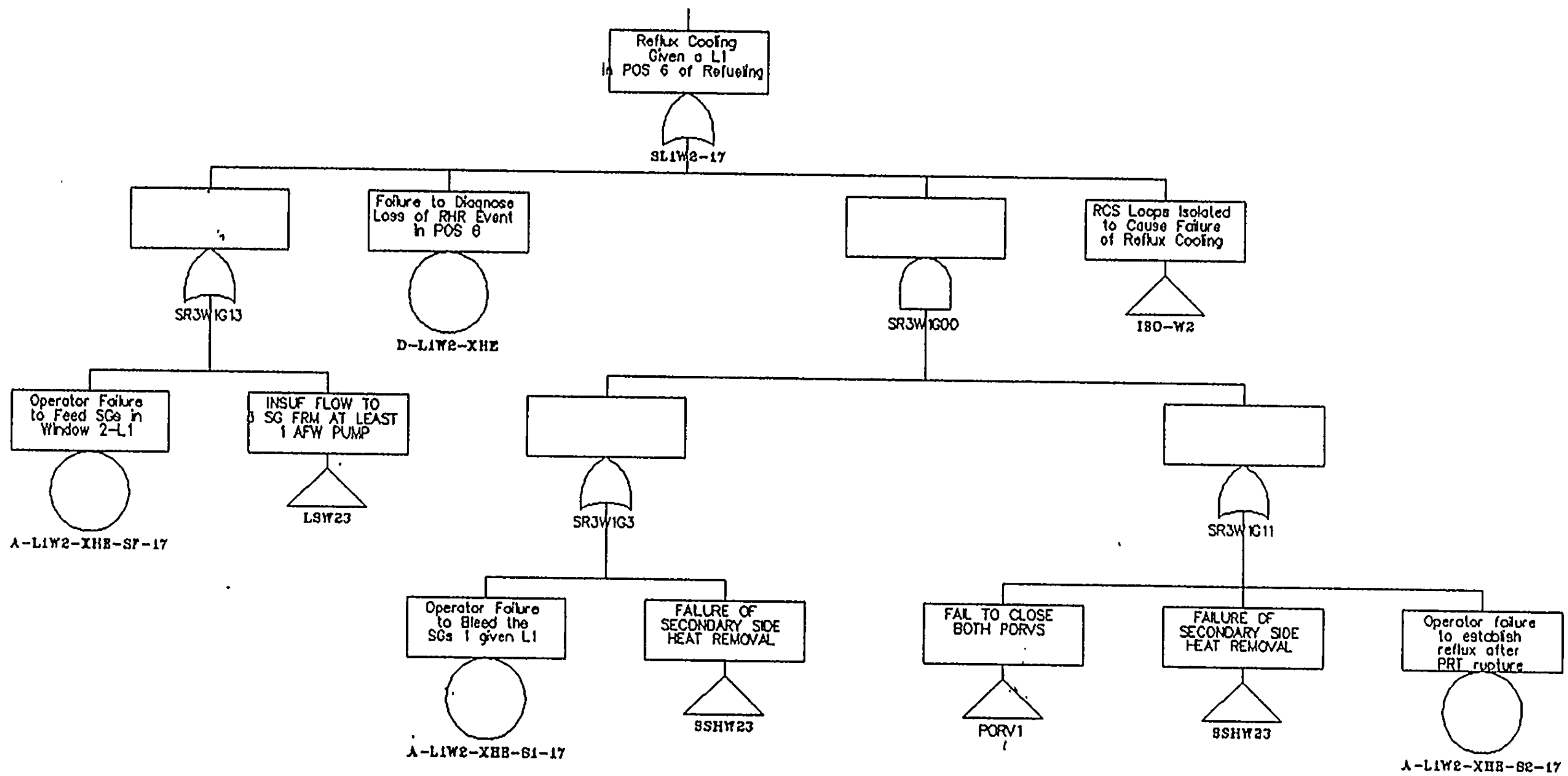
Non-Recovery of AC Power in W2



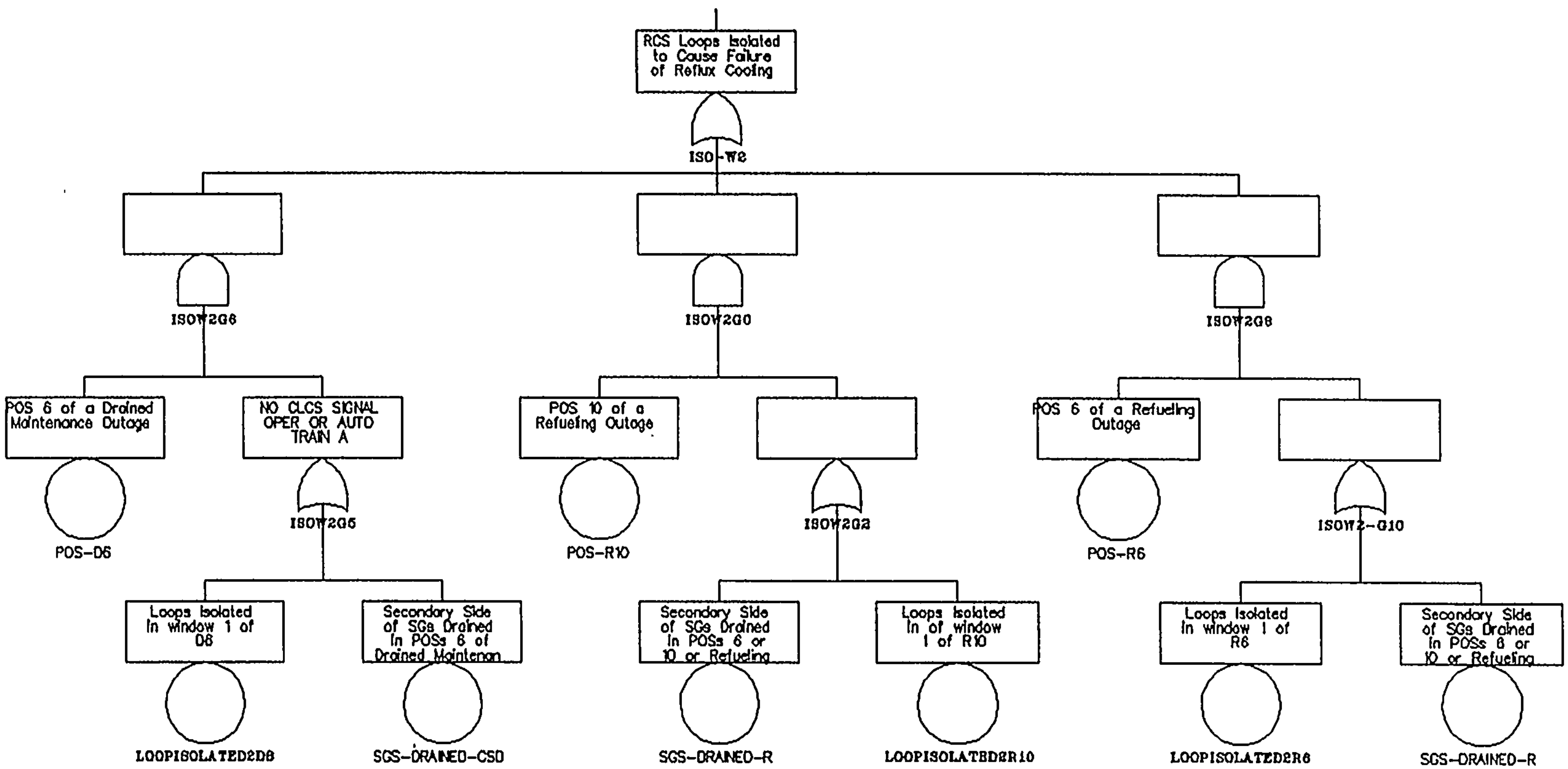
Reflux Cooling in window 2



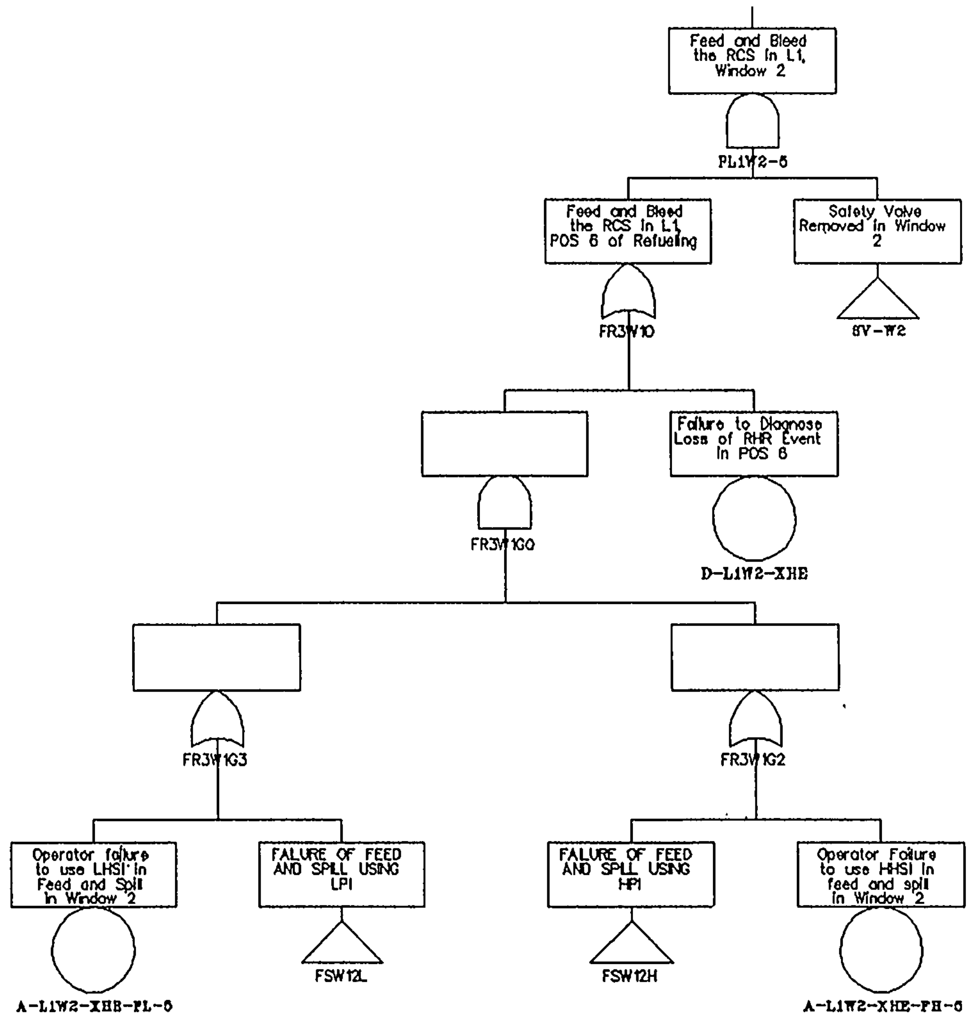
Reflux Cooling in window 2



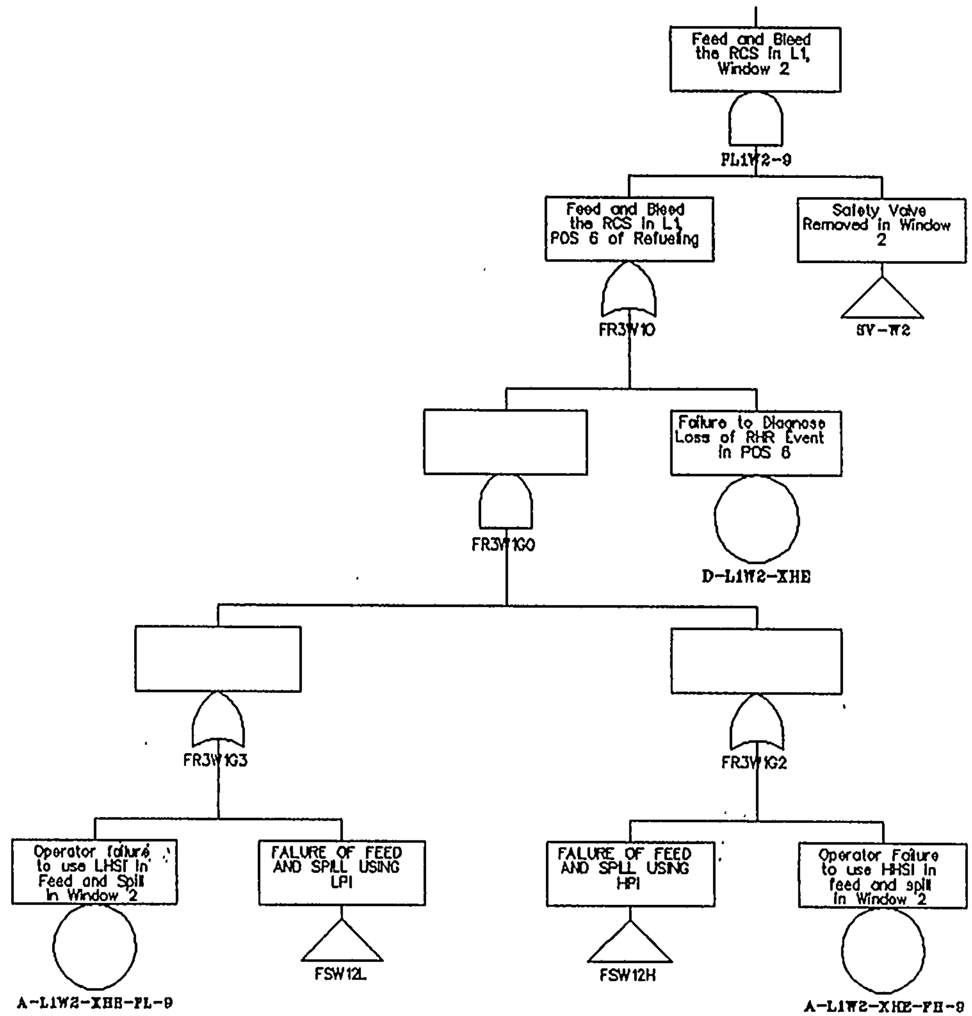
RCS Loops isolated to cause failure of reflux in window 1

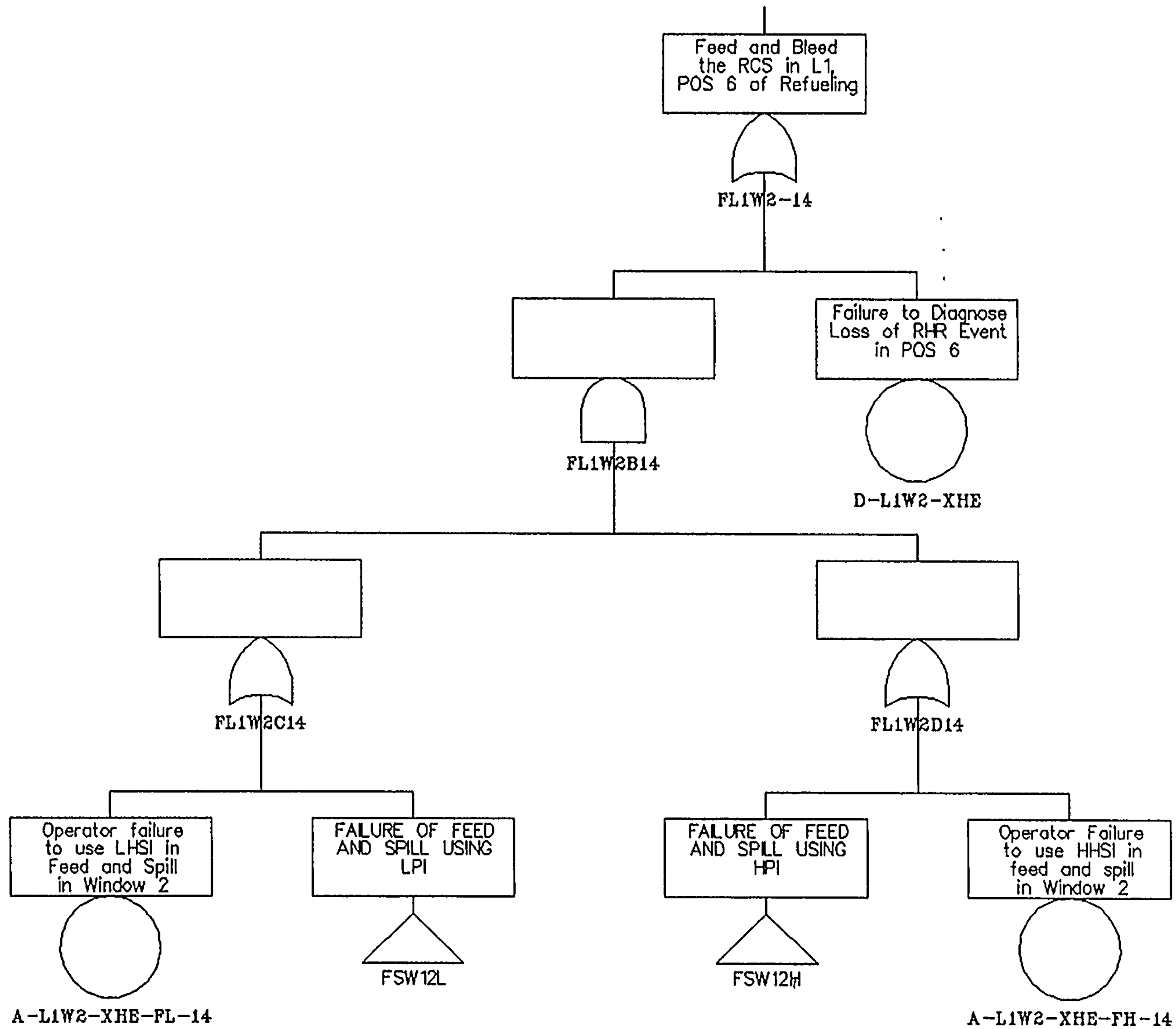


Feed and Bleed the RCS in L1, Window 2

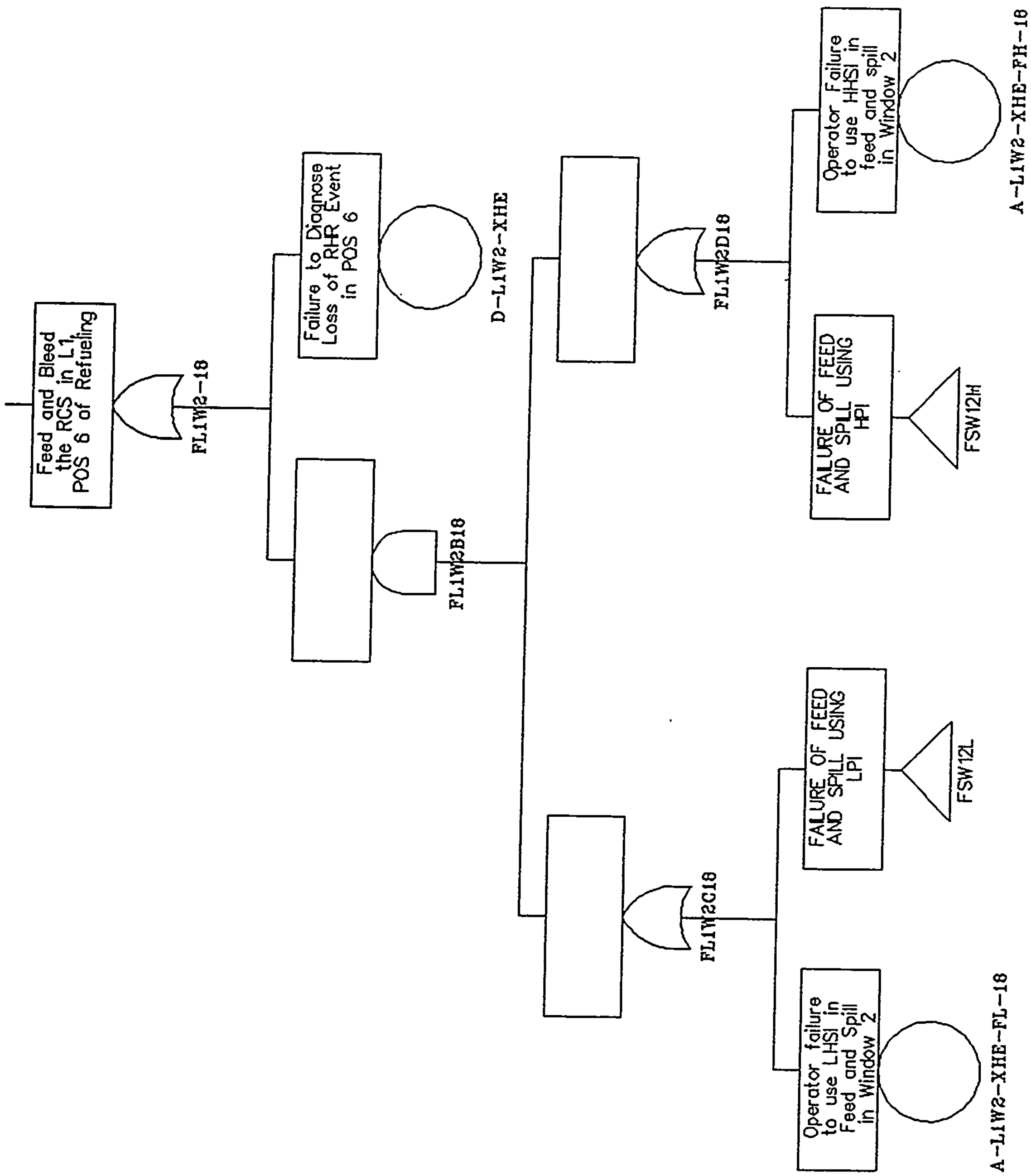


Feed and Bleed the RCS in L1, Window 2

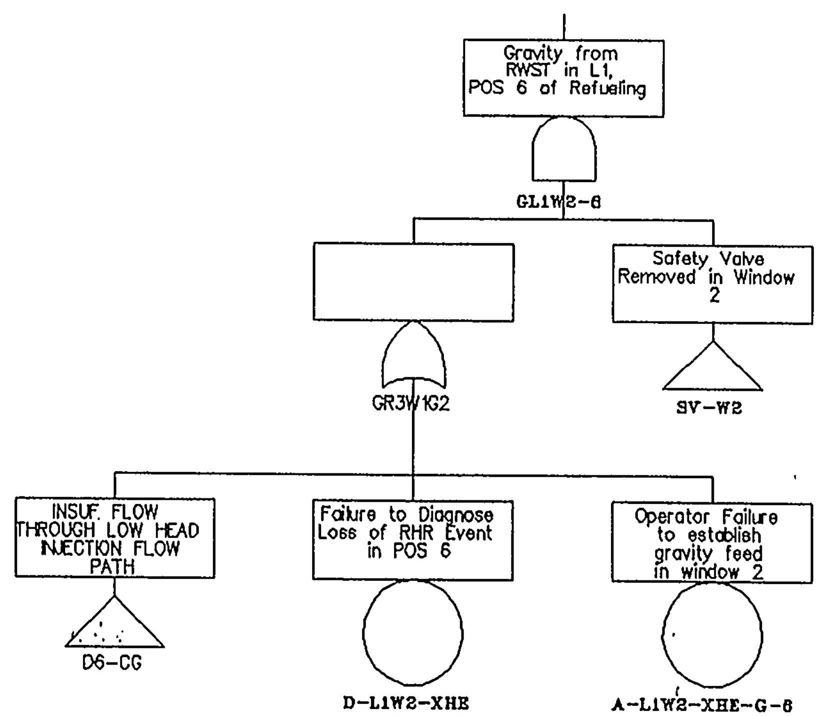




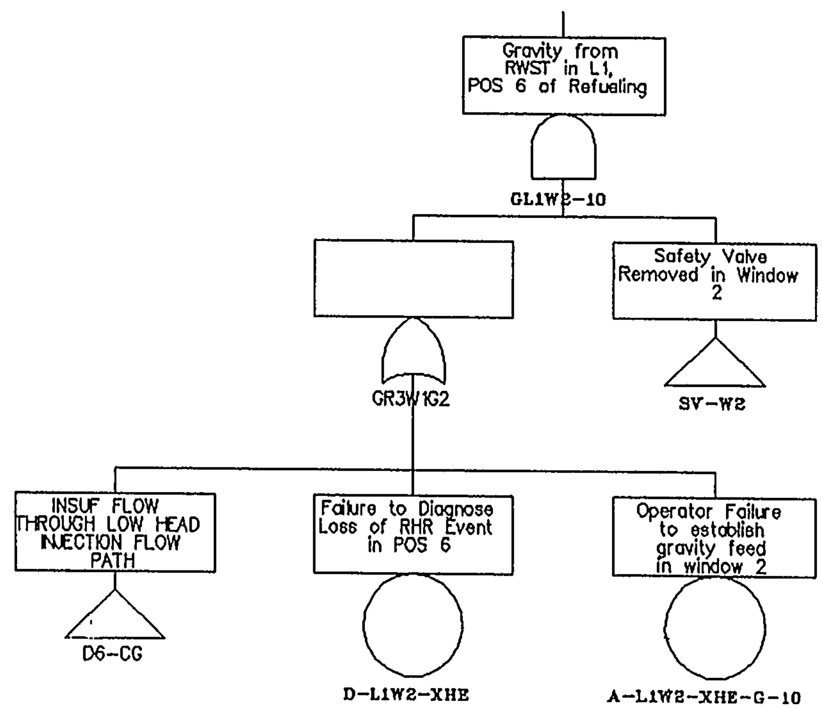
Feed and Bleed the RCS in L1, POS 6 of Refueling
FL1W2-14
Failure to Diagnose Loss of RHR Event in POS 6
D-L1W2-XHE
FL1W2B14
FL1W2C14
FL1W2D14
Operator failure to use LHSI in Feed and Spill in Window 2
A-L1W2-XHE-FL-14
FAILURE OF FEED AND SPILL USING LPI
FSW12L
FAILURE OF FEED AND SPILL USING HPI
FSW12H
Operator Failure to use HHSI in feed and spill in Window 2
A-L1W2-XHE-FH-14


Feed and Bleed the RCS in L1, POS 6 of Refueling
FL1W2-18
Failure to Diagnose Loss of RHR Event in POS 6
D-L1W2-XHE
FL1W2B18
FL1W2D18
Operator Failure to use HHSI in feed and spill in Window 2
A-L1W2-XHE-FH-18
FAILURE OF FEED AND SPILL USING HPI
FSW12H
FL1W2C18
FAILURE OF FEED AND SPILL USING LPI
FSW12L
Operator failure to use LHSI in Feed and Spill in Window 2
A-L1W2-XHE-FL-18

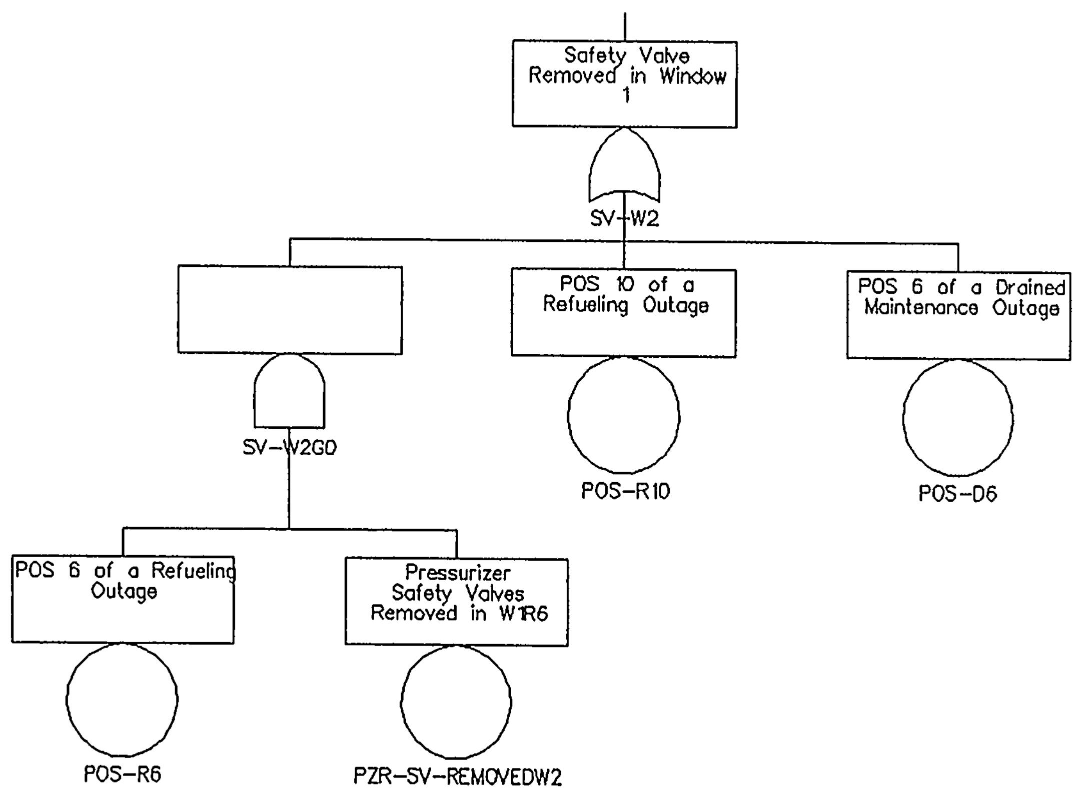
Gravity from RWST in L1, Window 2



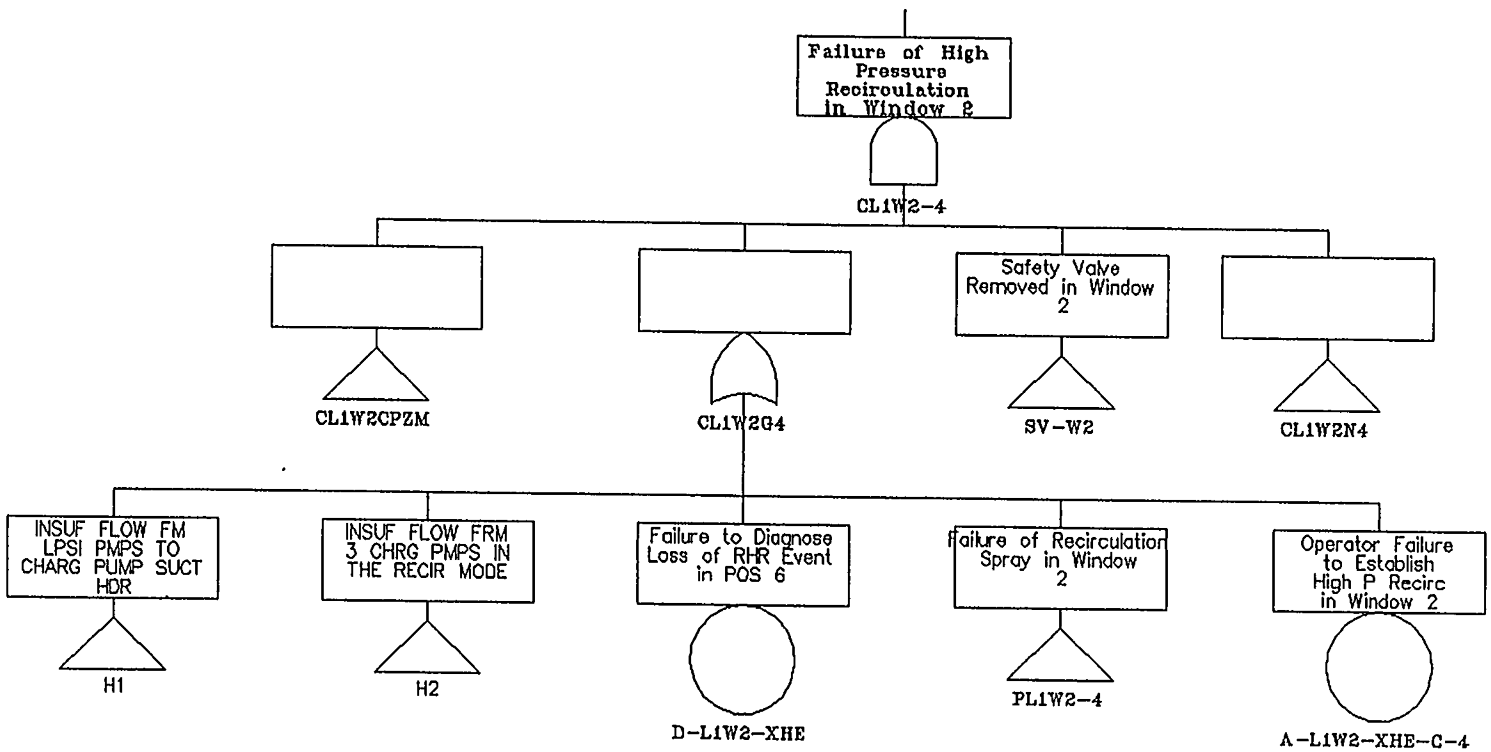
Gravity from RWST in L1, Window 2



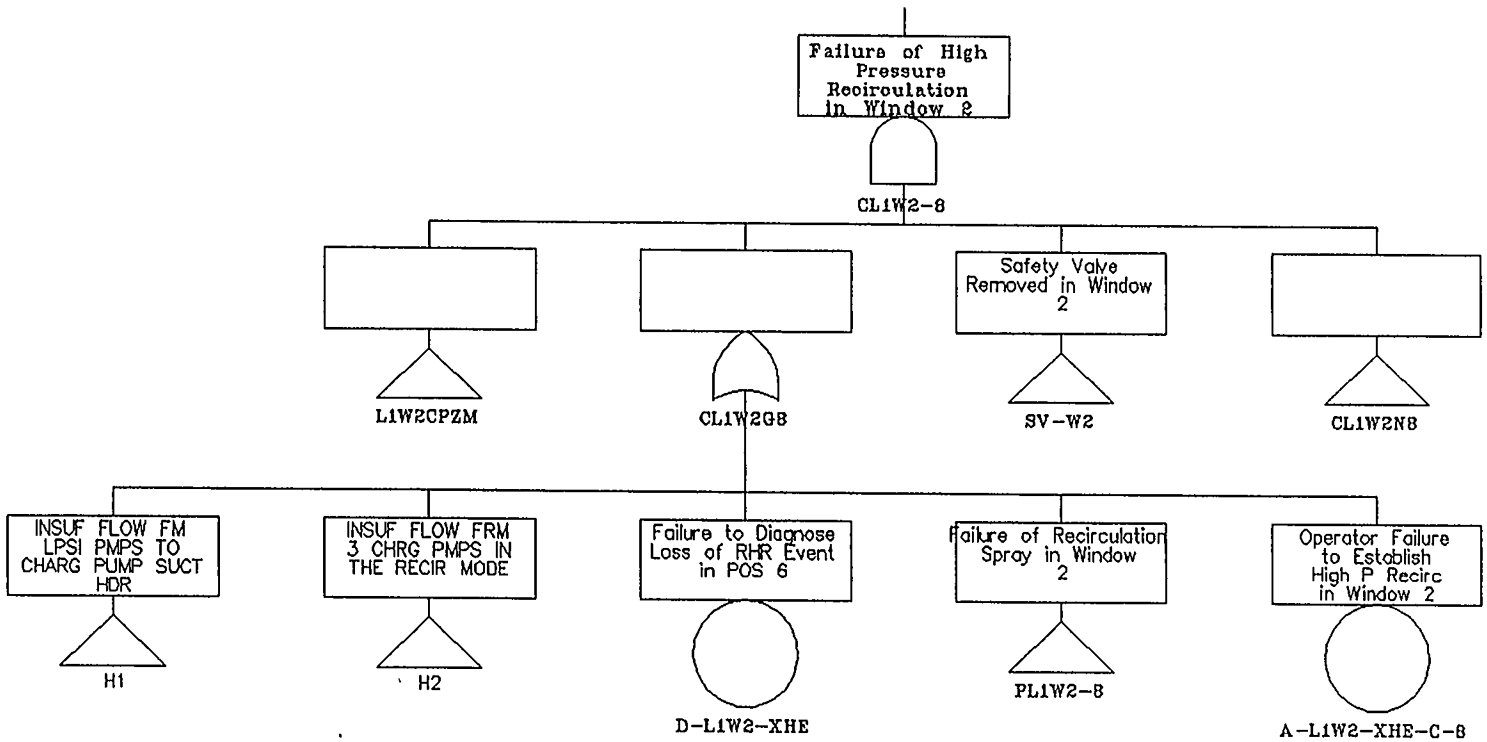
Safety Valves Removed in Window 2



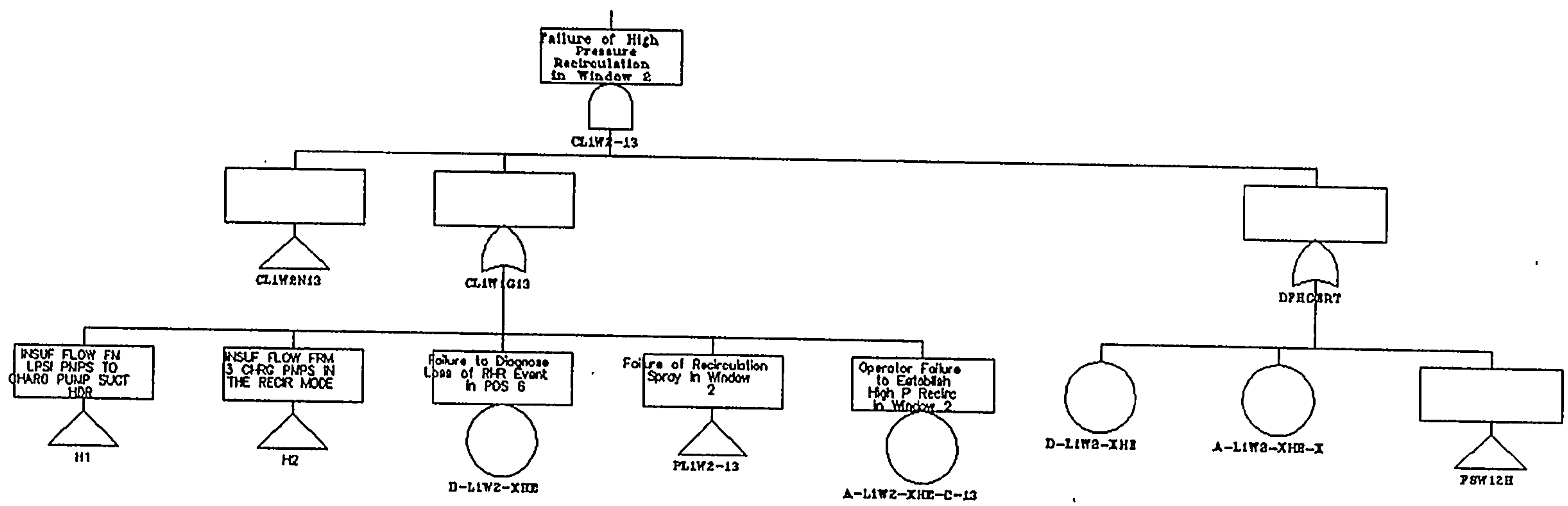
Failure of High Pressure Recirculation in Window 2



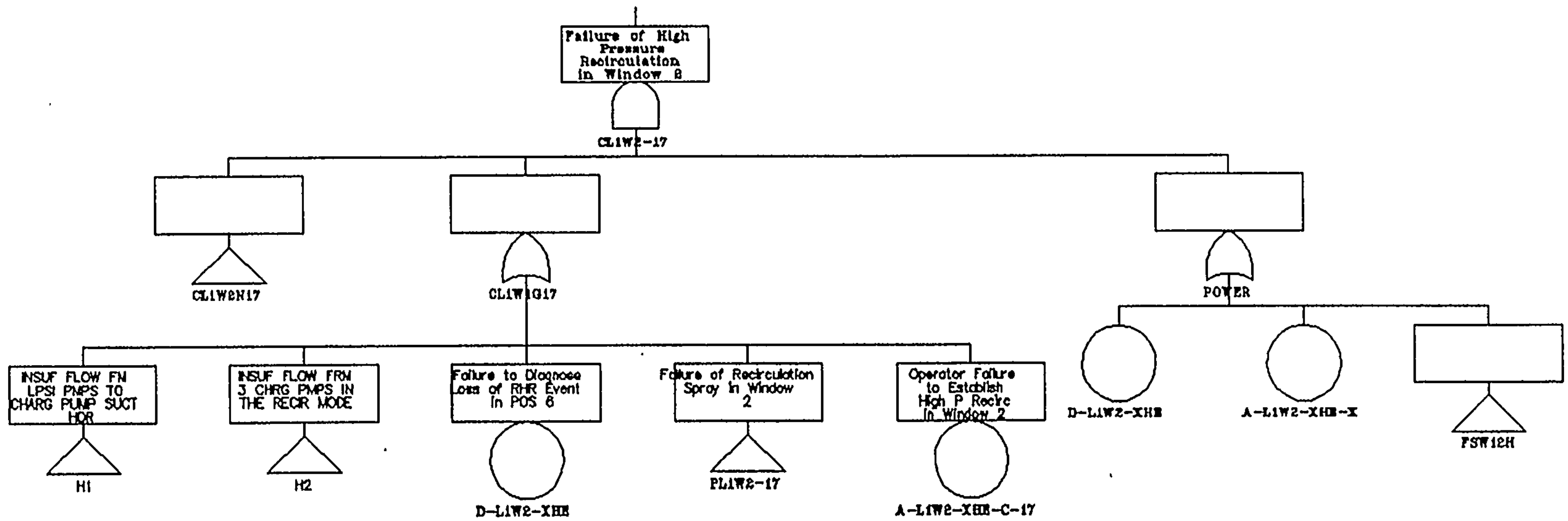
Failure of High Pressure Recirculation in Window 2



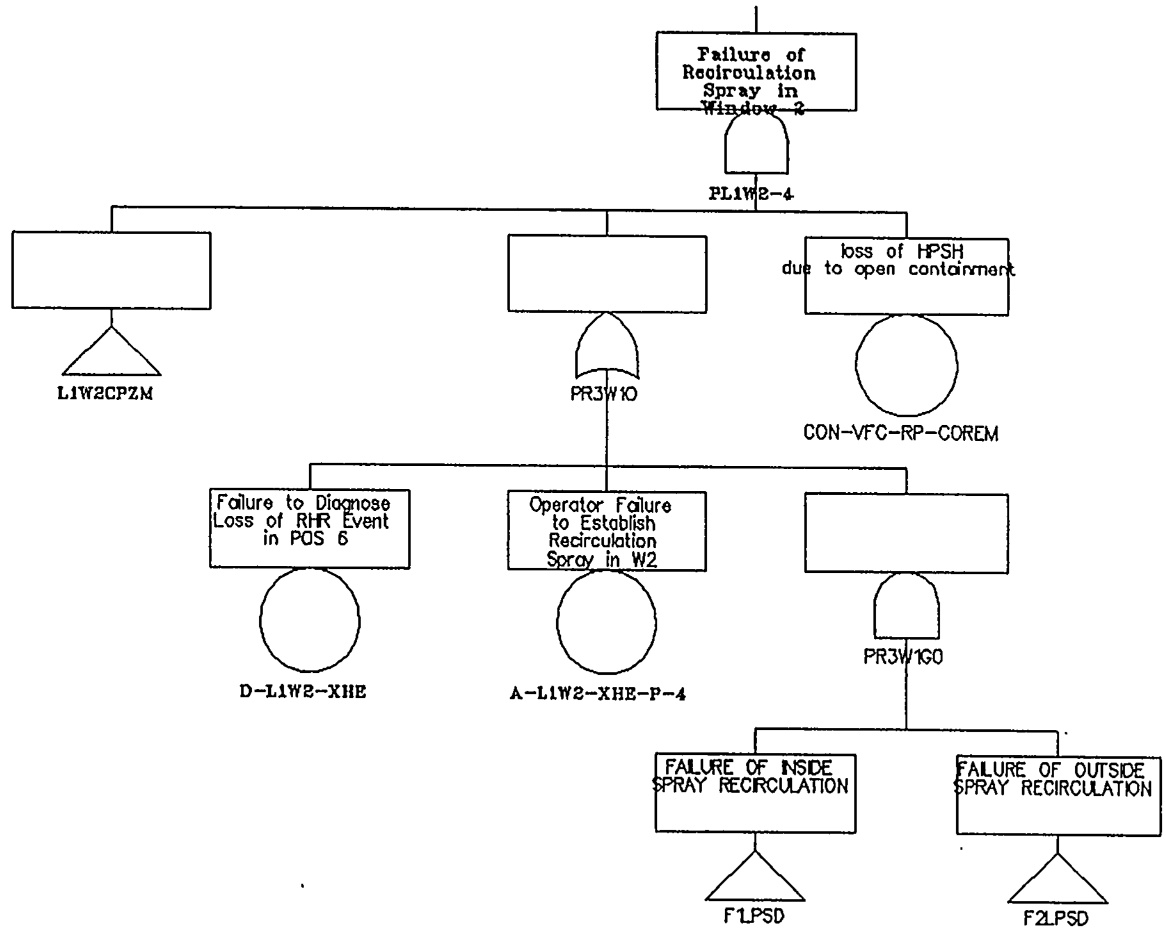
Failure of High Pressure Recirculation in Window 2



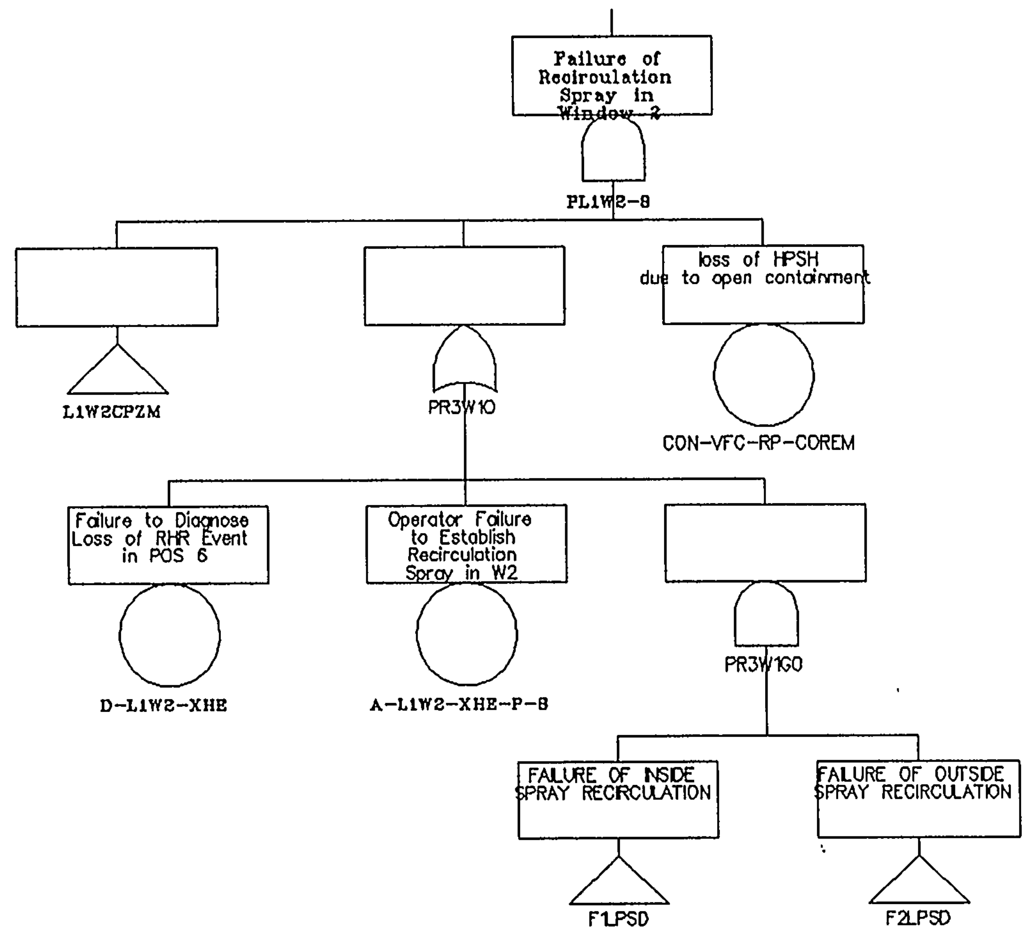
Failure of High Pressure Recirculation in Window 2



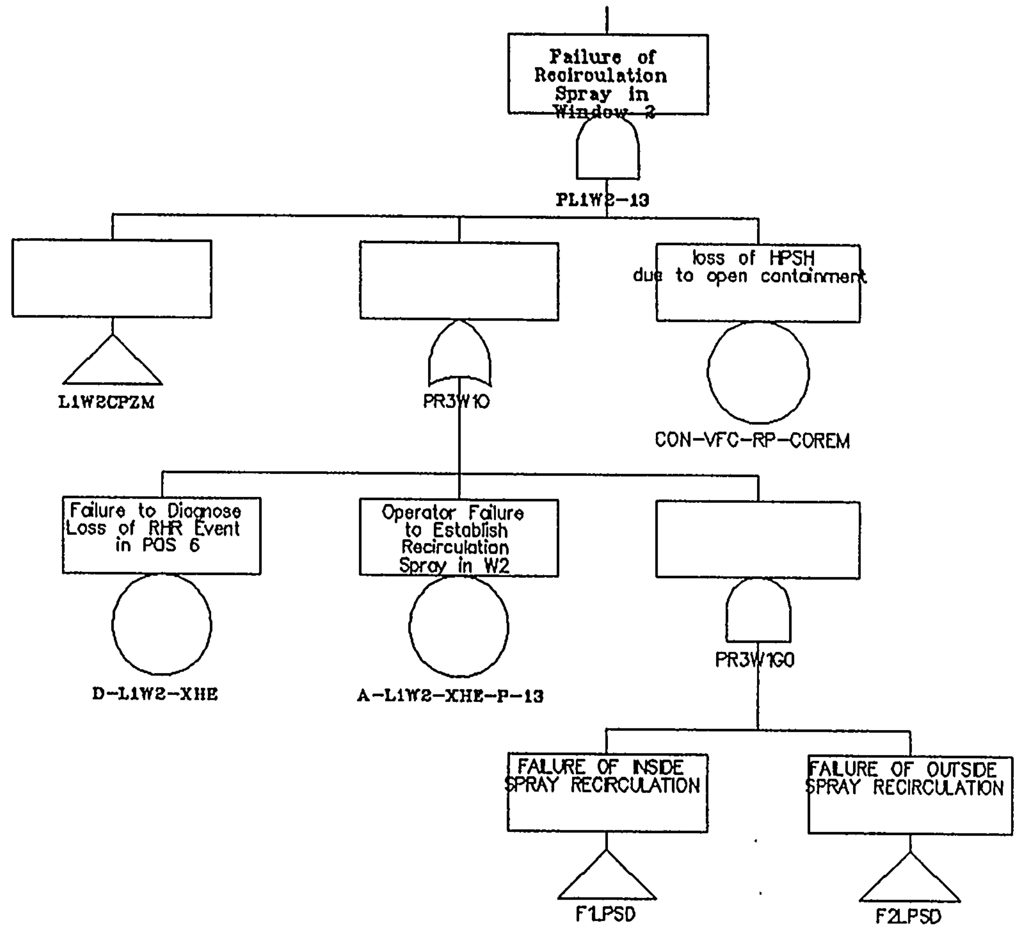
Failure of Recirculation Spray in Window 2-cause HPR failure



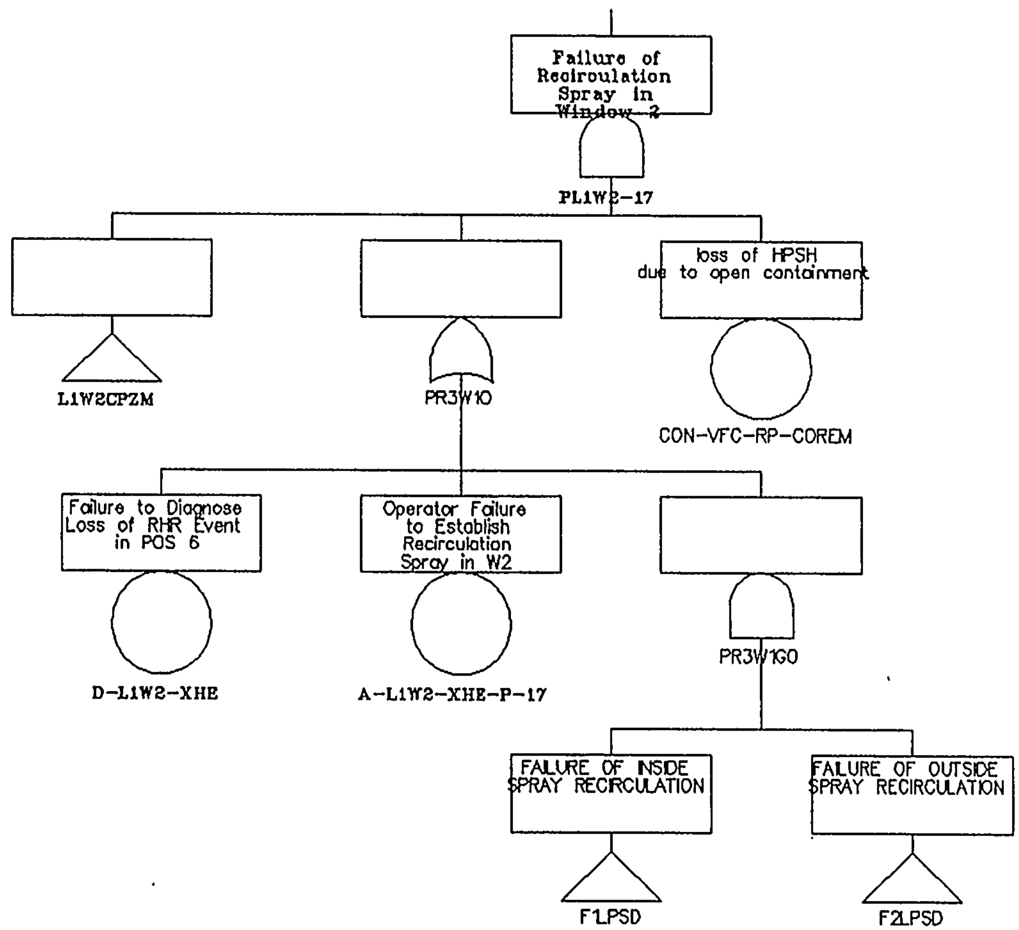
Failure of Recirculation Spray in Window 2-cause HPR failure

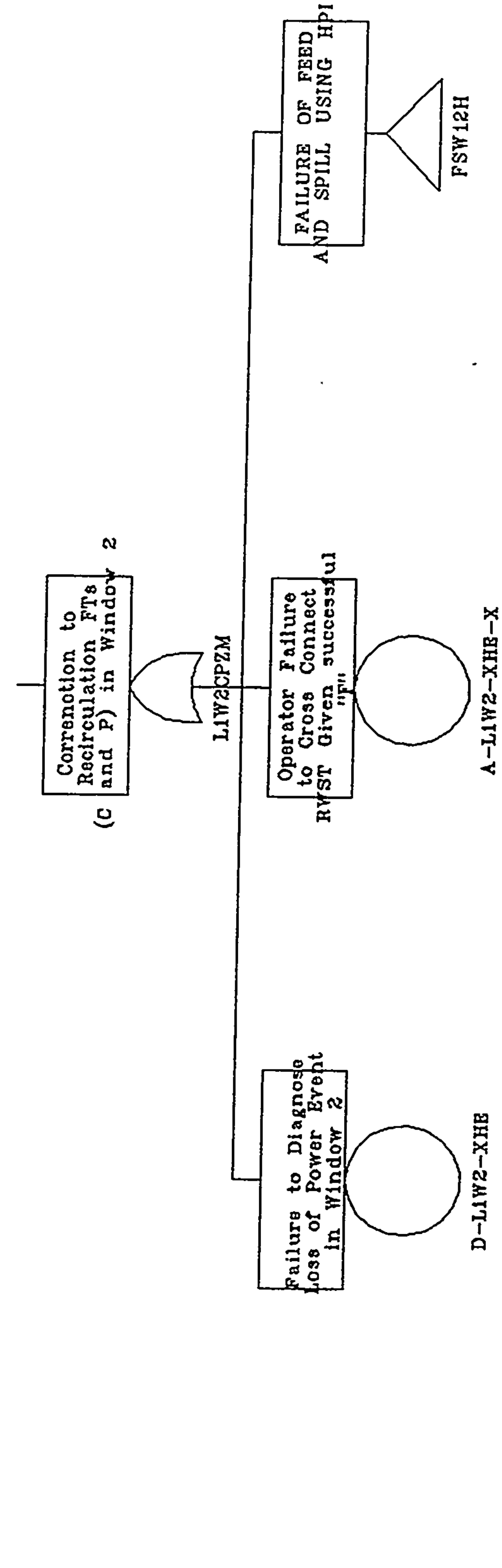


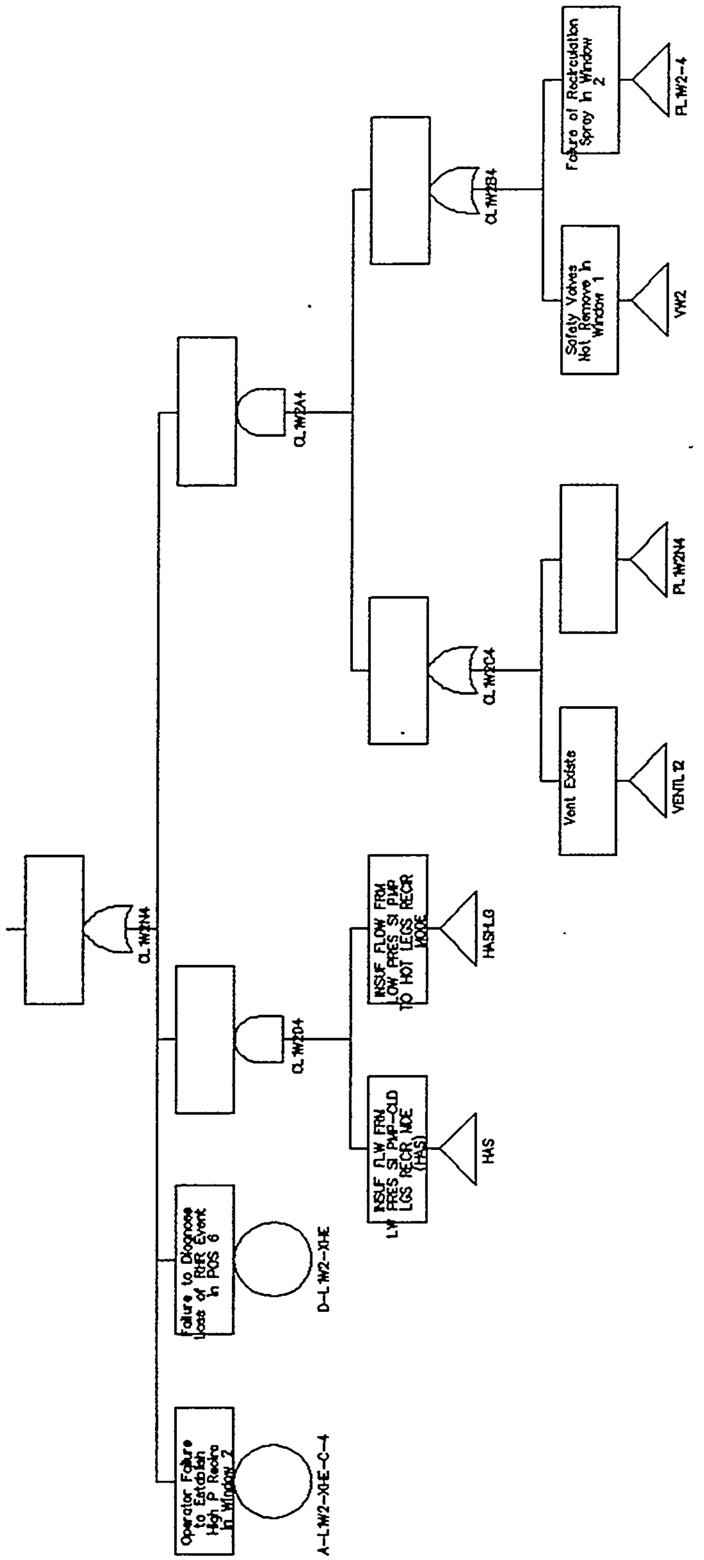
Failure of Recirculation Spray in Window 2-cause HPR failure



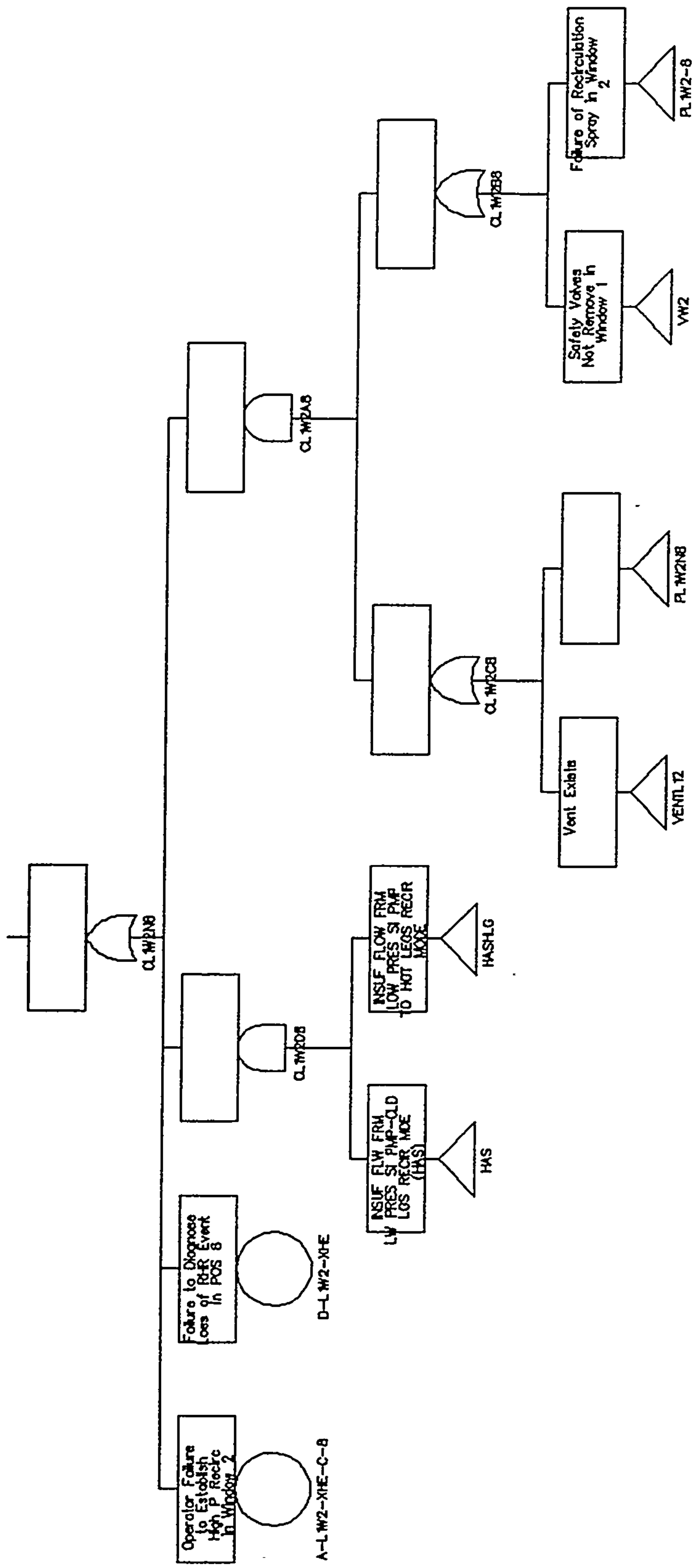
Failure of Recirculation Spray in Window 2-cause HPR failure

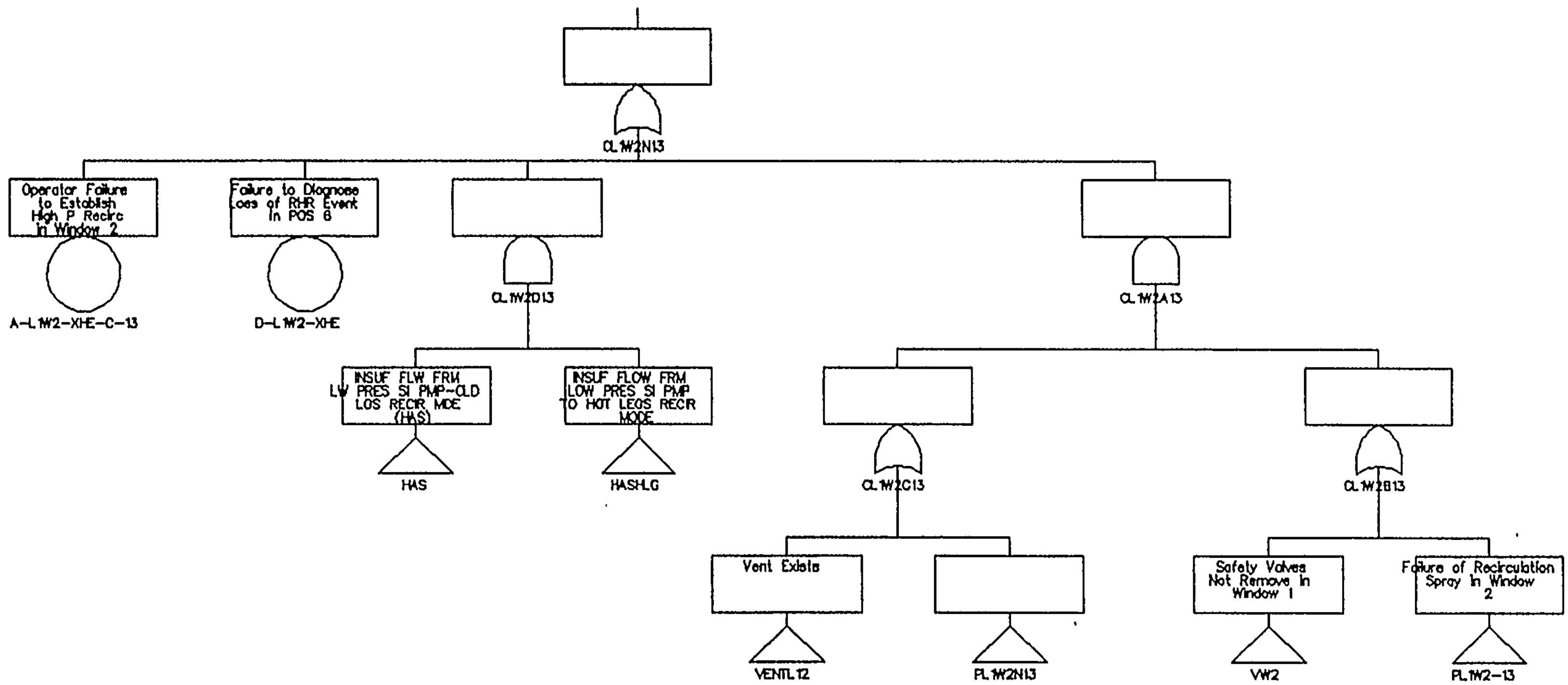


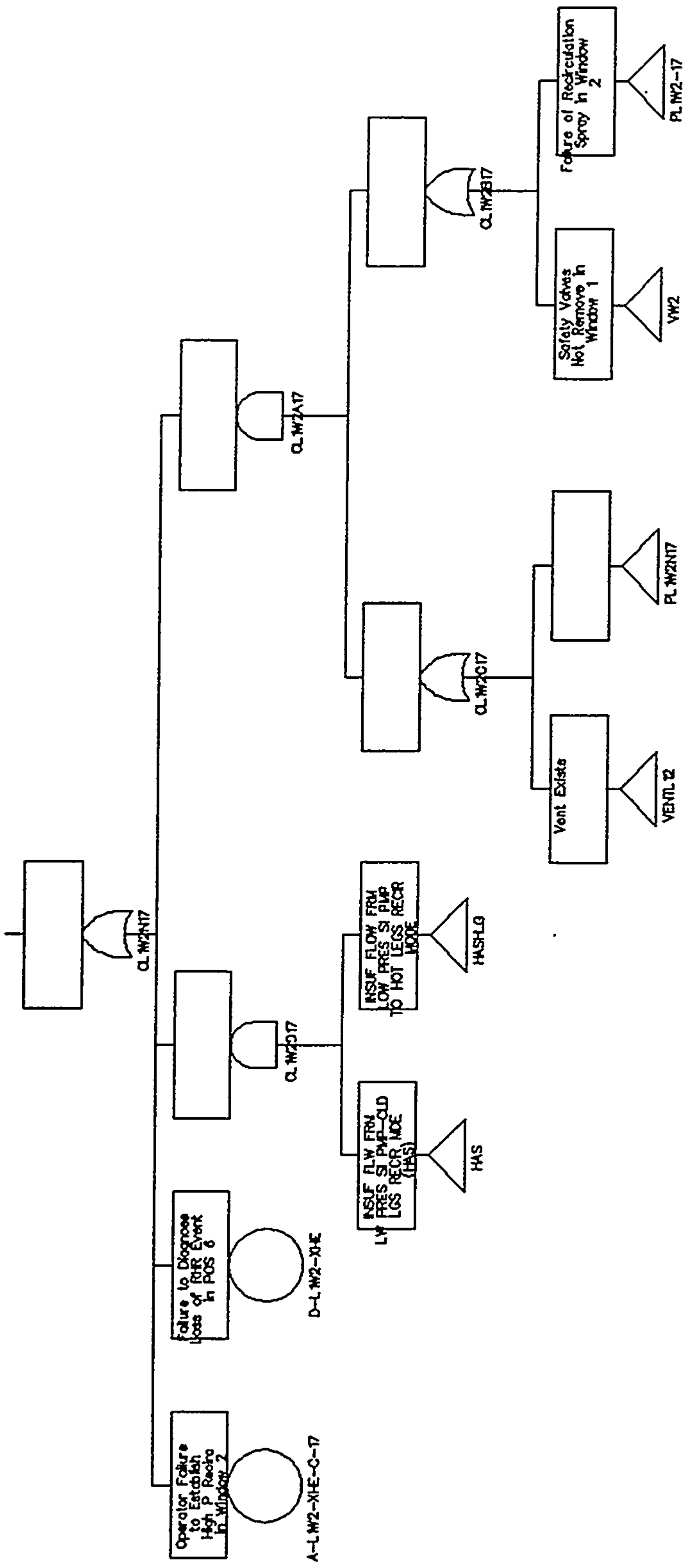

Correnotion to Recirculation FTs (C and P) in Window 2
L1W2CPZM
Failure to Diagnose Loss of Power Event in Window 2
D-L1W2-XHE
Operator Failure to Cross Connect RWST Given successful "F"
A-L1W2-XHE-X
FAILURE OF FEED AND SPILL USING HPI
FSW12H



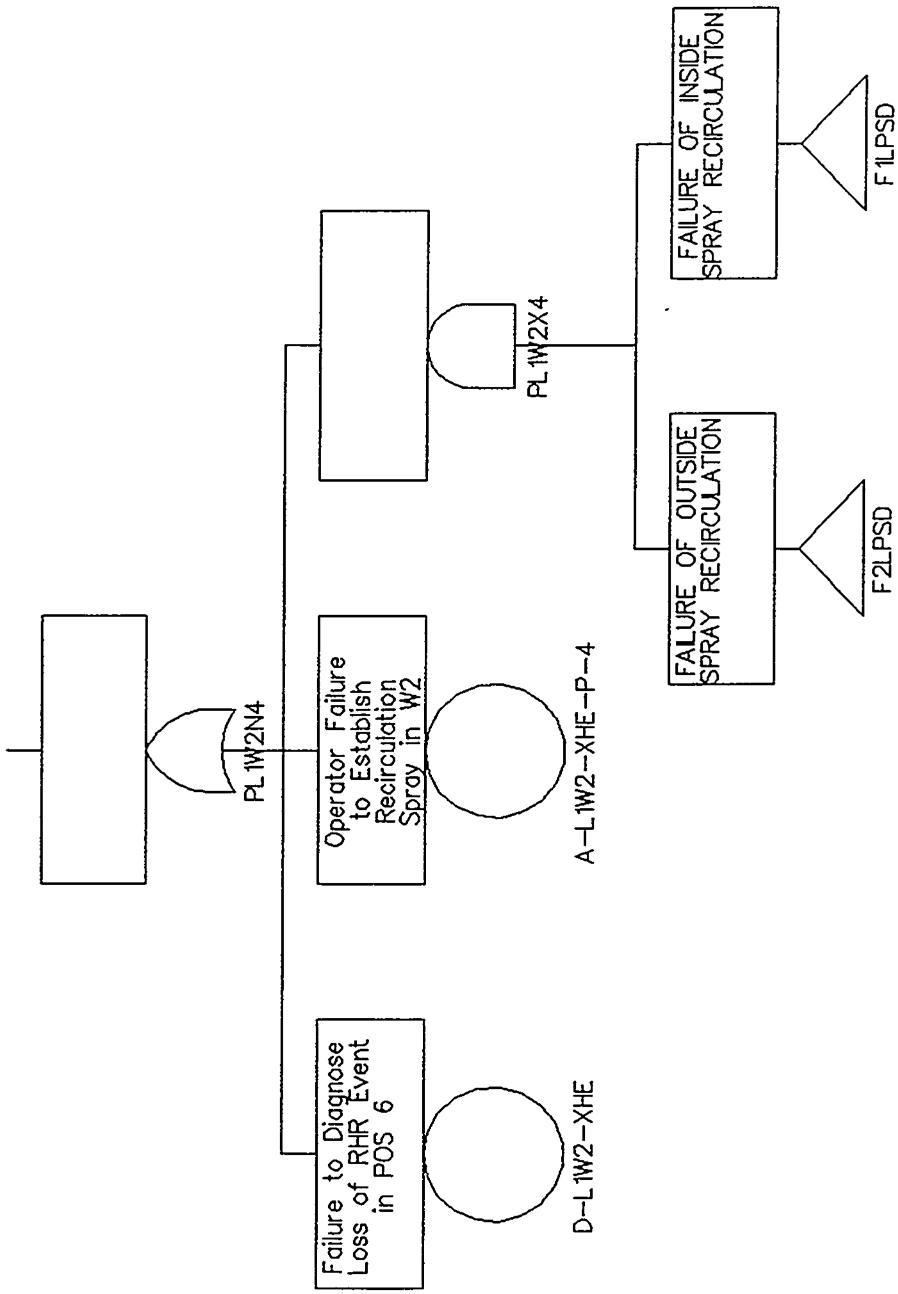
CL1W2N4
CL1W2A4
CL1W2B4
Safety Valves Not Remove In Window 1
VW2
Failure of Recirculation Spray In Window 2
PL1W2-4
CL1W2C4
Vent Exists
VENTL12
PL1W2N4
CL1W2D4
INSUF FLW FRM LW PRES SI PMP-CLD LGS RECIR MDE (HAS)
HAS
INSUF FLOW FRM LOW PRES SI PMP TO HOT LEGS RECIR MODE
HASHLG
Failure to Diagnose Loss of RHR Event in POS 6
D-L1W2-XHE
Operator Failure to Establish High P Recirc In Window 2
A-L1W2-XHE-C-4


CL1W2N8
CL1W2D8
CL1W2A8
CL1W2C8
CL1W2B8
Operator Failure to Establish High P Recirc in Window 2
A-L1W2-XHE-C-8
Failure to Diagnose Loss of RHR Event In POS 8
D-L1W2-XHE
INSUF FLW FRM LW PRES SI PMP-CLD LGS RECIR MDE (HAS)
HAS
INSUF FLOW FRM LOW PRES SI PMP TO HOT LEGS RECIR MODE
HASHLG
Vent Exists
VENTL12
PL1W2N8
Safety Valves Not Remove in Window 1
VW2
Failure of Recirculation Spray in Window 2
PL1W2-8

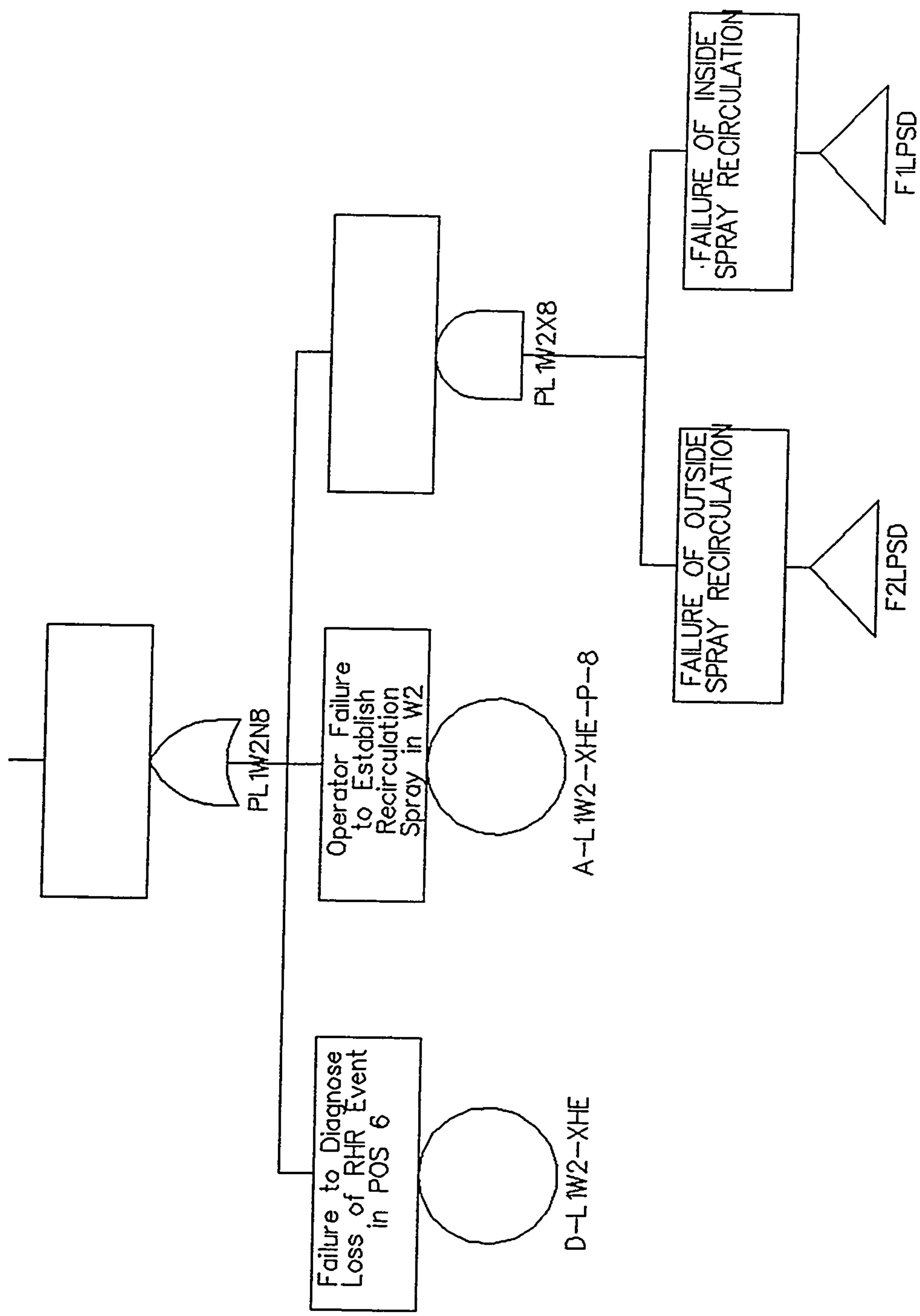

CL1W2N13
Operator Failure to Establish High P Recirc In Window 2
A-L1W2-XHE-C-13
Failure to Diagnose Loss of RHR Event In POS 6
D-L1W2-XHE
CL1W2D13
INSUF FLW FRM LW PRES SI PMP-CLD LOS RECIR MDE (HAS)
HAS
INSUF FLOW FRM LOW PRES SI PMP TO HOT LEGS RECIR MODE
HASHLG
CL1W2A13
CL1W2C13
Vent Exists
VENTL12
PL1W2N13
CL1W2B13
Safety Valves Not Remove In Window 1
VW2
Failure of Recirculation Spray In Window 2
PL1W2-13

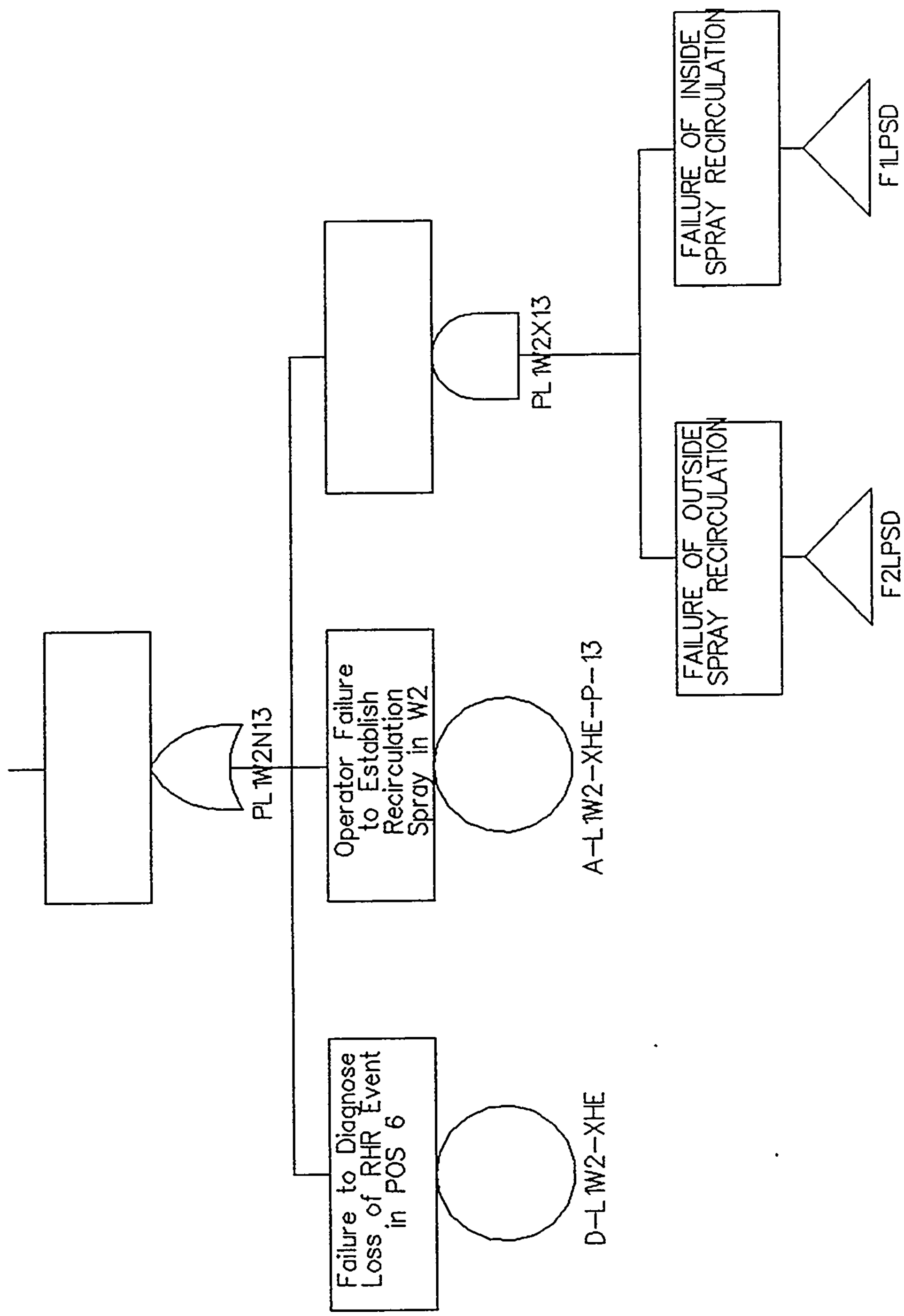


CL1W2N17
CL1W2A17
CL1W2B17
CL1W2C17
CL1W2D17
Failure of Recirculation Spray In Window 2
PL1W2-17
Safety Valves Not Remove In Window 1
VW2
PL1W2N17
Vent Exists
VENTL12
INSUF FLOW FRM LOW PRES SI PMP TO HOT LEGS RECR MODE
HASHLG
INSUF FLW FRM LW PRES SI PMP-CLD LGS RECR MDE (HAS)
HAS
Failure to Diagnose Loss of RHR Event In POS 8
D-L1W2-XHE
Operator Failure to Establish High P Recirc In Window 2
A-L1W2-XHE-C-17

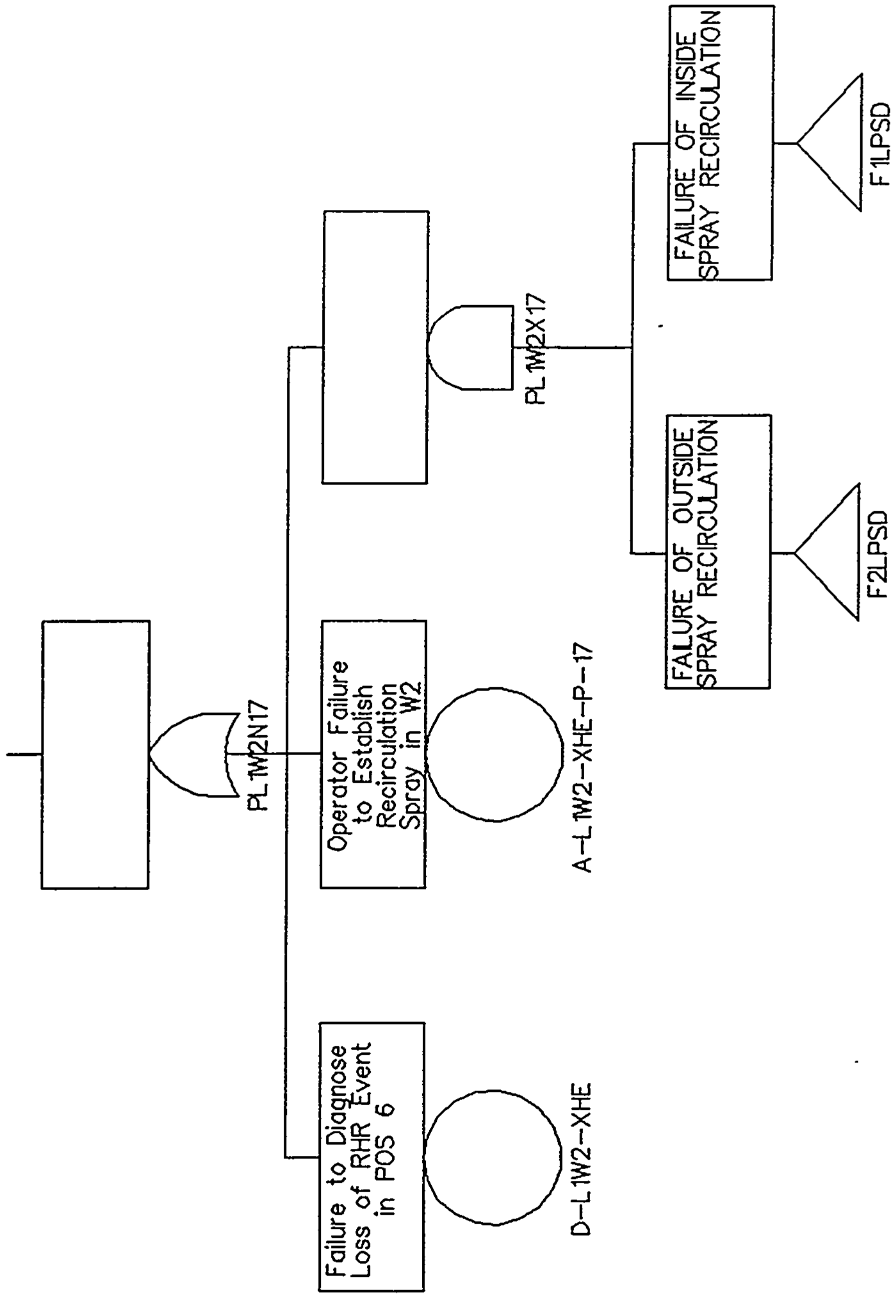


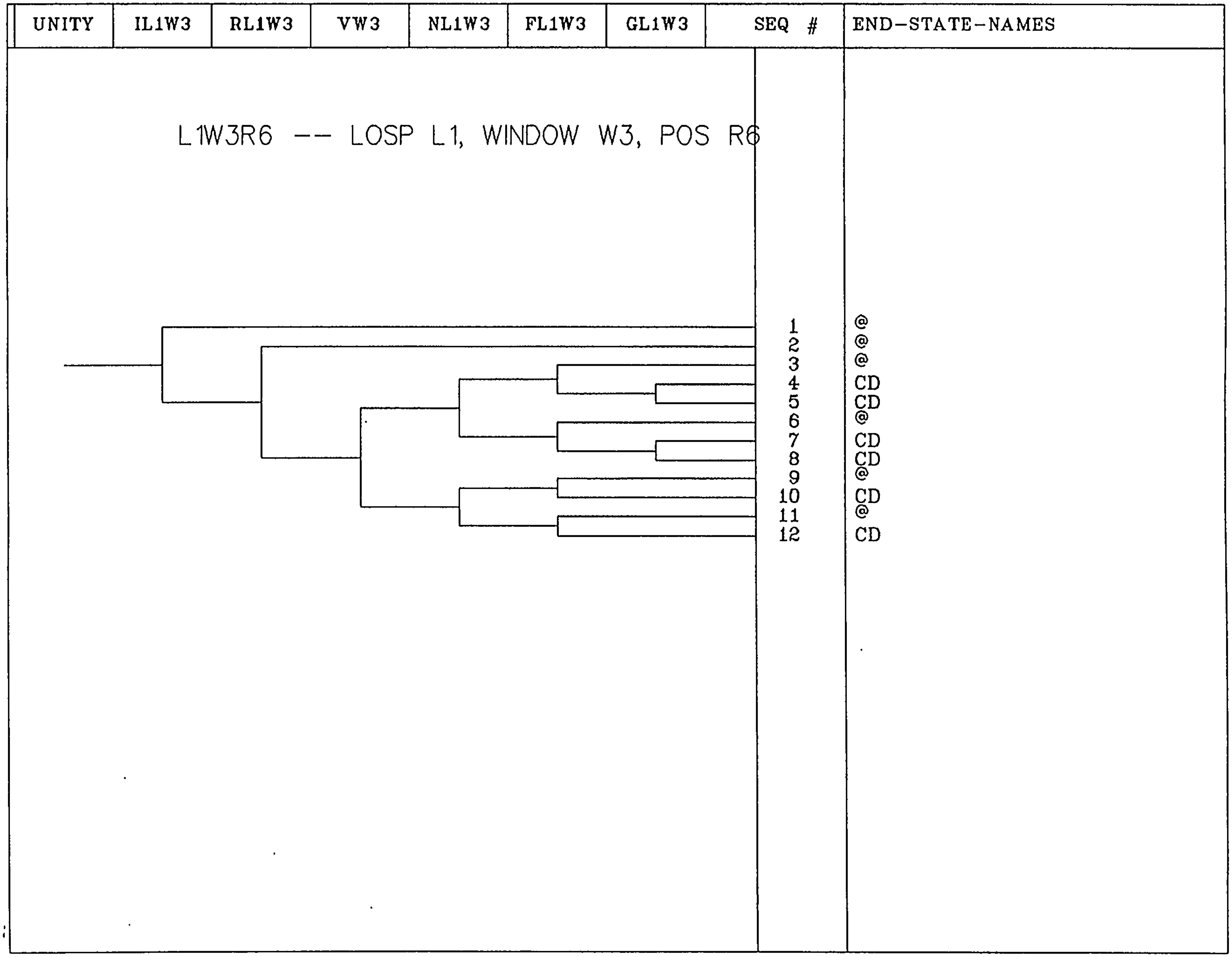
PL1W2N4
Failure to Diagnose Loss of RHR Event in POS 6
D-L1W2-XHE
Operator Failure to Establish Recirculation Spray in W2
A-L1W2-XHE-P-4
PL1W2X4
FAILURE OF OUTSIDE SPRAY RECIRCULATION
F2LPSD
FAILURE OF INSIDE SPRAY RECIRCULATION
F1LPSD

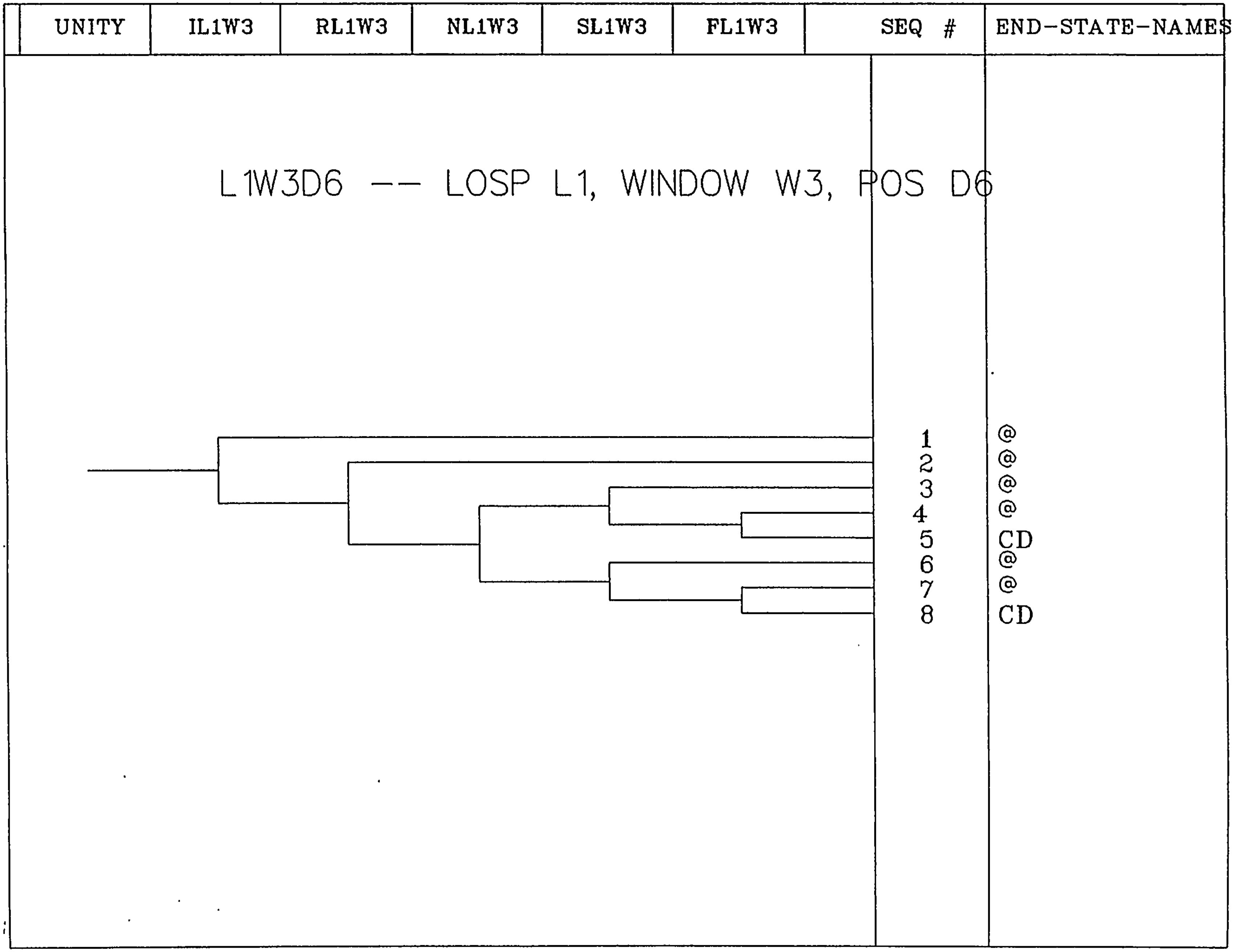

PL1W2N8
Failure to Diagnose Loss of RHR Event in POS 6
D-L1W2-XHE
Operator Failure to Establish Recirculation Spray in W2
A-L1W2-XHE-P-8
PL1W2X8
FAILURE OF OUTSIDE SPRAY RECIRCULATION
F2LPSD
FAILURE OF INSIDE SPRAY RECIRCULATION
F1LPSD

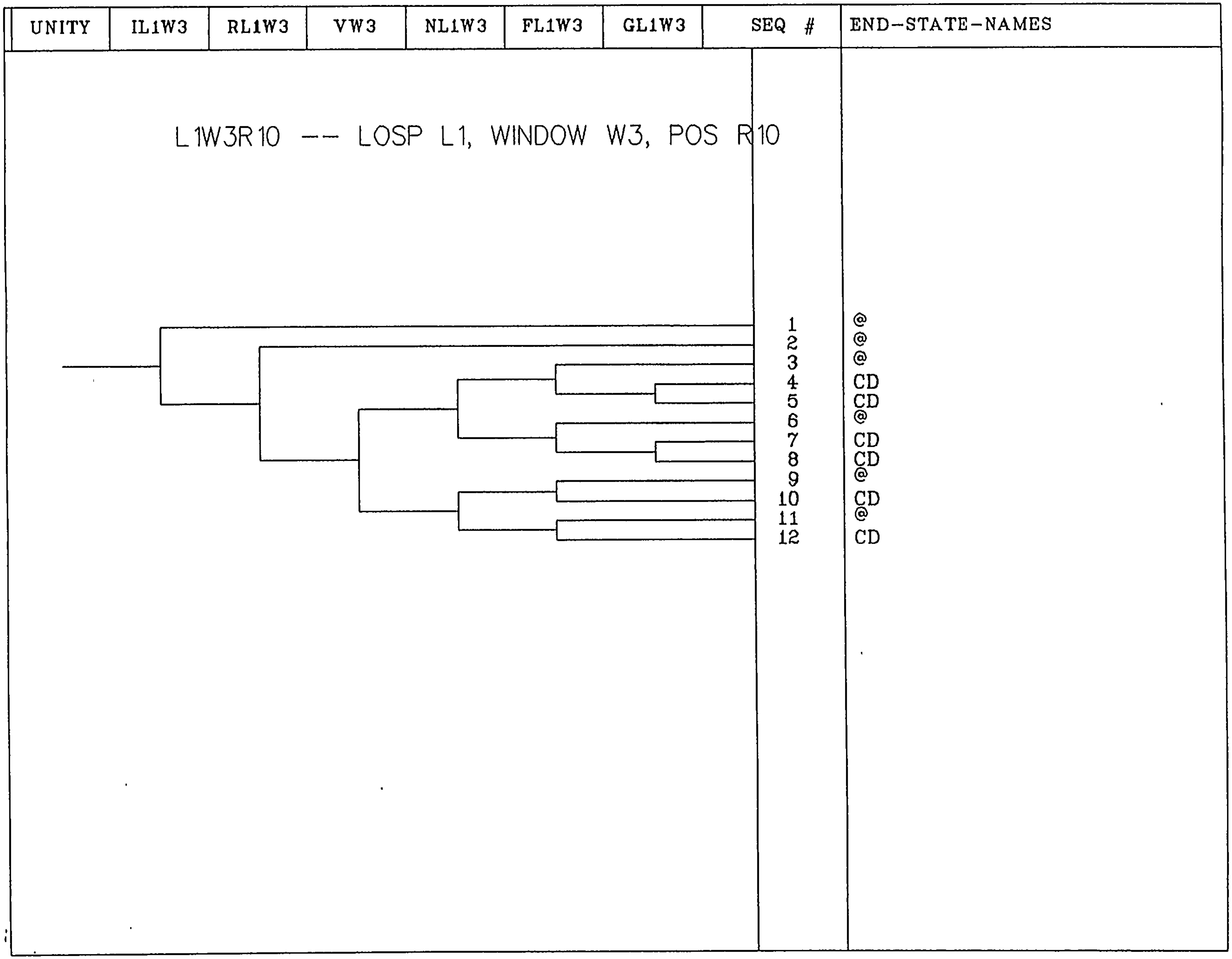


PL1W2N13
Failure to Diagnose Loss of RHR Event in POS 6
D-L1W2-XHE
Operator Failure to Establish Recirculation Spray in W2
A-L1W2-XHE--P--13
PL1W2X13
FAILURE OF OUTSIDE SPRAY RECIRCULATION
F2LPSD
FAILURE OF INSIDE SPRAY RECIRCULATION
F1LPSD


PL1W2N17
Operator Failure to Establish Recirculation Spray in W2
A-L1W2-XHE-P-17
Failure to Diagnose Loss of RHR Event in POS 6
D-L1W2-XHE
PL1W2X17
FAILURE OF INSIDE SPRAY RECIRCULATION
F1LPSD
FAILURE OF OUTSIDE SPRAY RECIRCULATION
F2LPSD

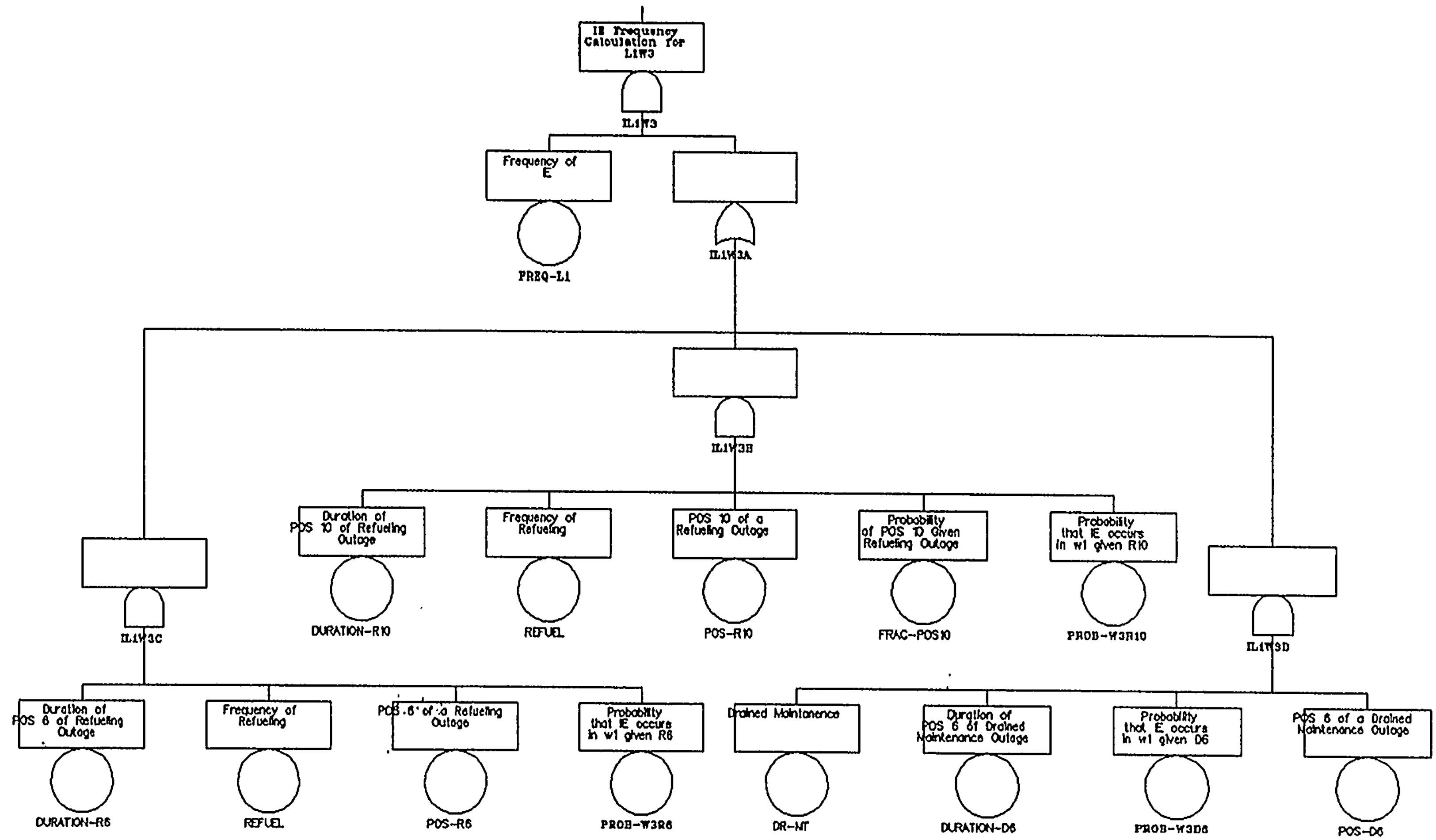

UNITY
IL1W3
RL1W3
VW3
NL1W3
FL1W3
GL1W3
SEQ #
END-STATE-NAMES
L1W3R6 -- LOSP L1, WINDOW W3, POS R6
1 @
2 @
3 @
4 CD
5 CD
6 @
7 CD
8 CD
9 @
10 CD
11 @
12 CD


UNITY
IL1W3
RL1W3
NL1W3
SL1W3
FL1W3
SEQ #
END-STATE-NAMES
L1W3D6 -- LOSP L1, WINDOW W3, POS D6
1 @
2 @
3 @
4 @
5 CD
6 @
7 @
8 CD

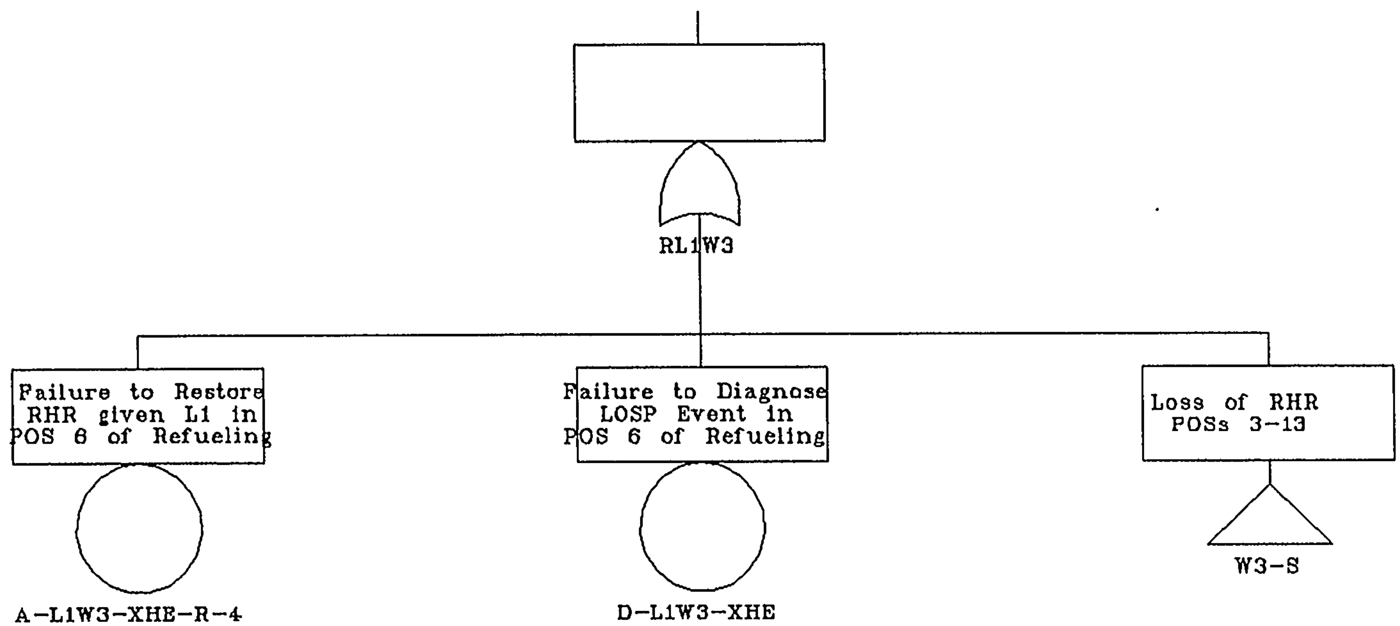


UNITY
IL1W3
RL1W3
VW3
NL1W3
FL1W3
GL1W3
SEQ #
END-STATE-NAMES
L1W3R10 -- LOSP L1, WINDOW W3, POS R10
1 @
2 @
3 @
4 CD
5 CD
6 @
7 CD
8 CD
9 @
10 CD
11 @
12 CD

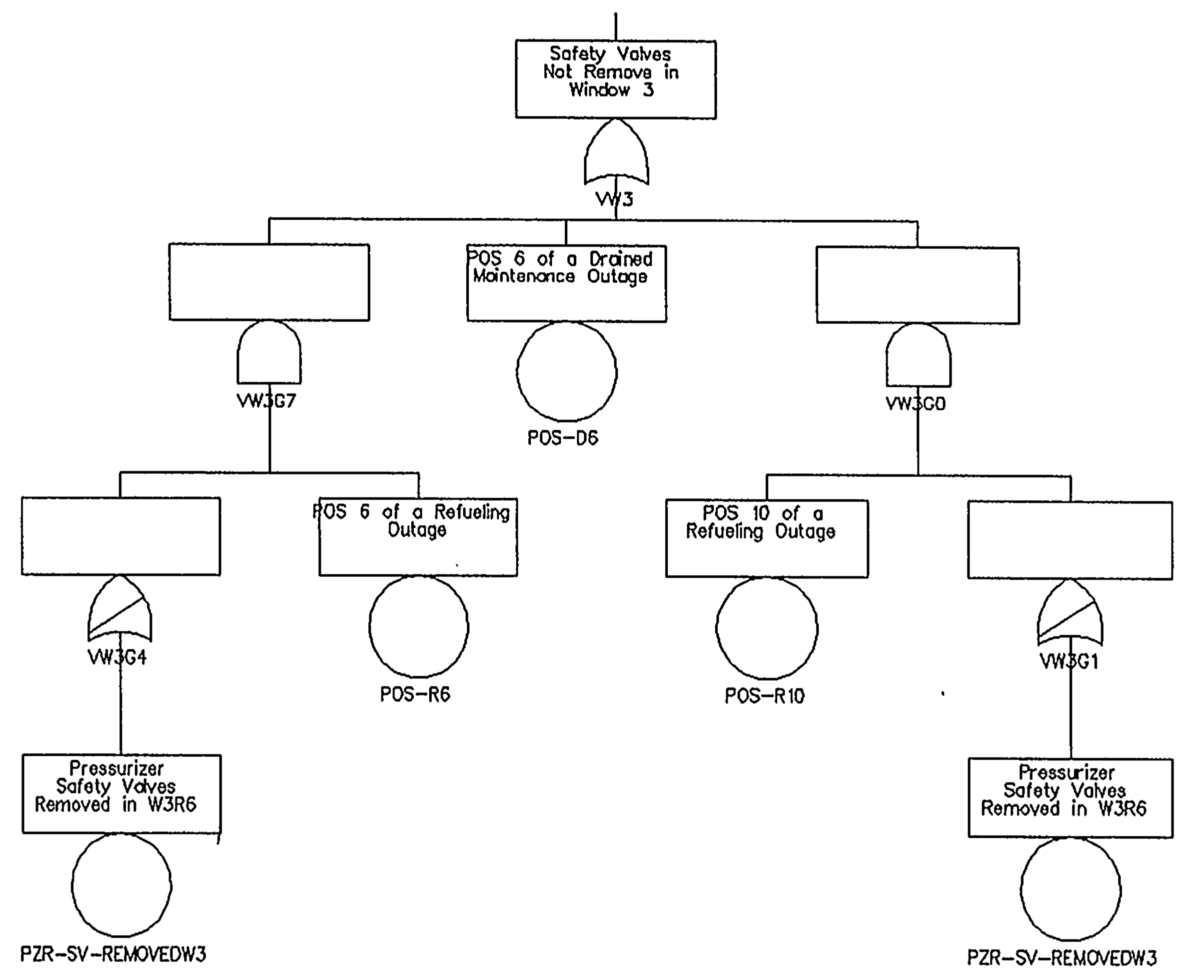
I top event for L1 In window 3



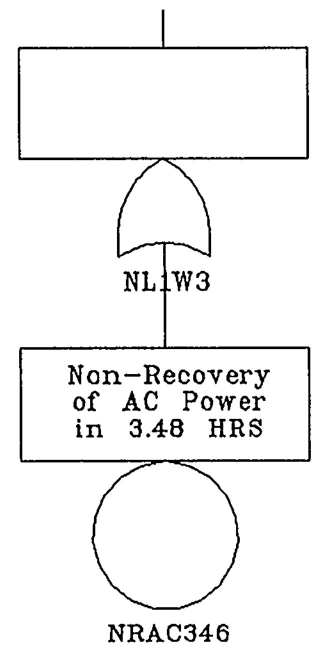
Restore RHR given L1



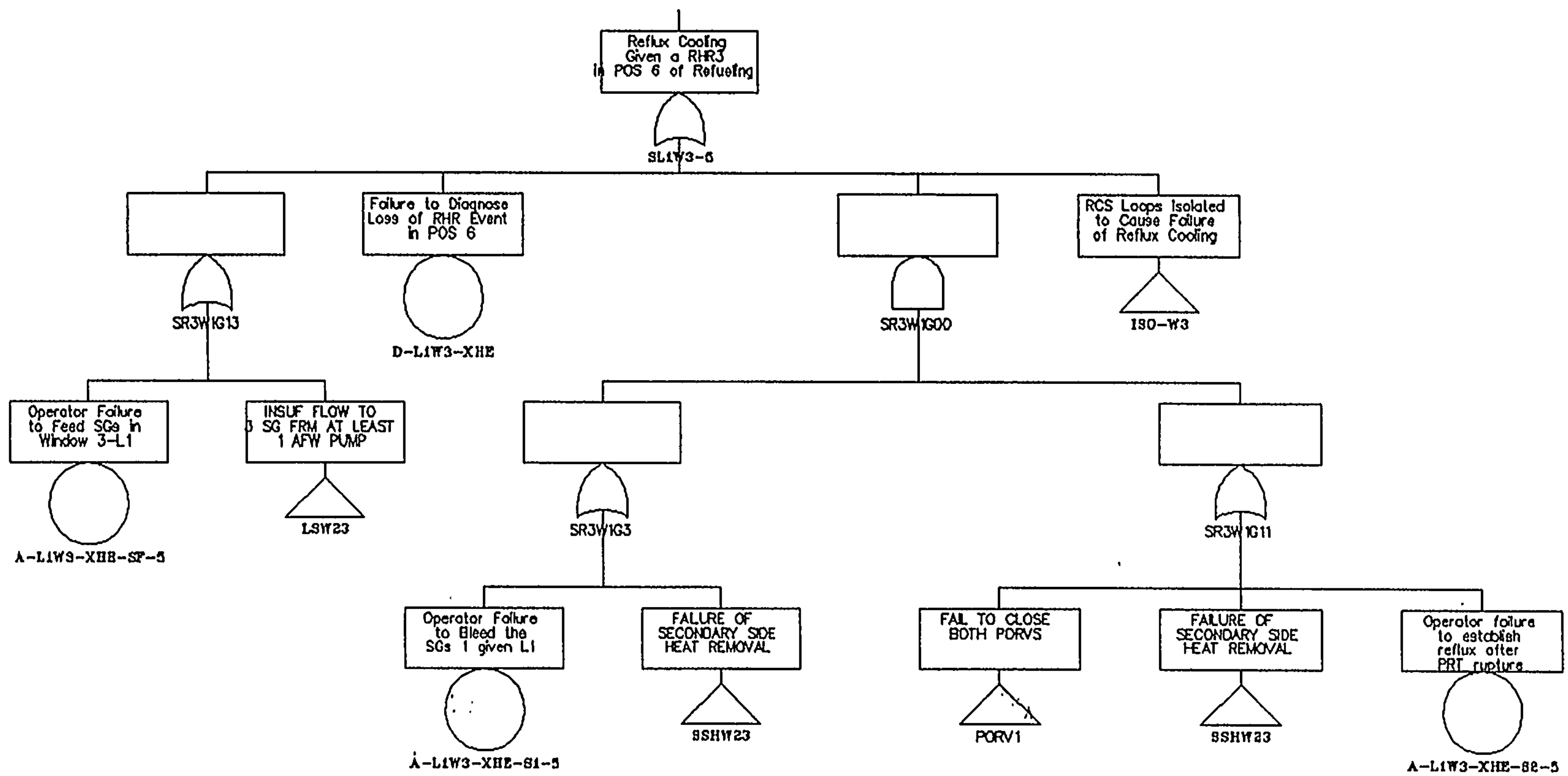
Safety valves Not Removed in Window 3



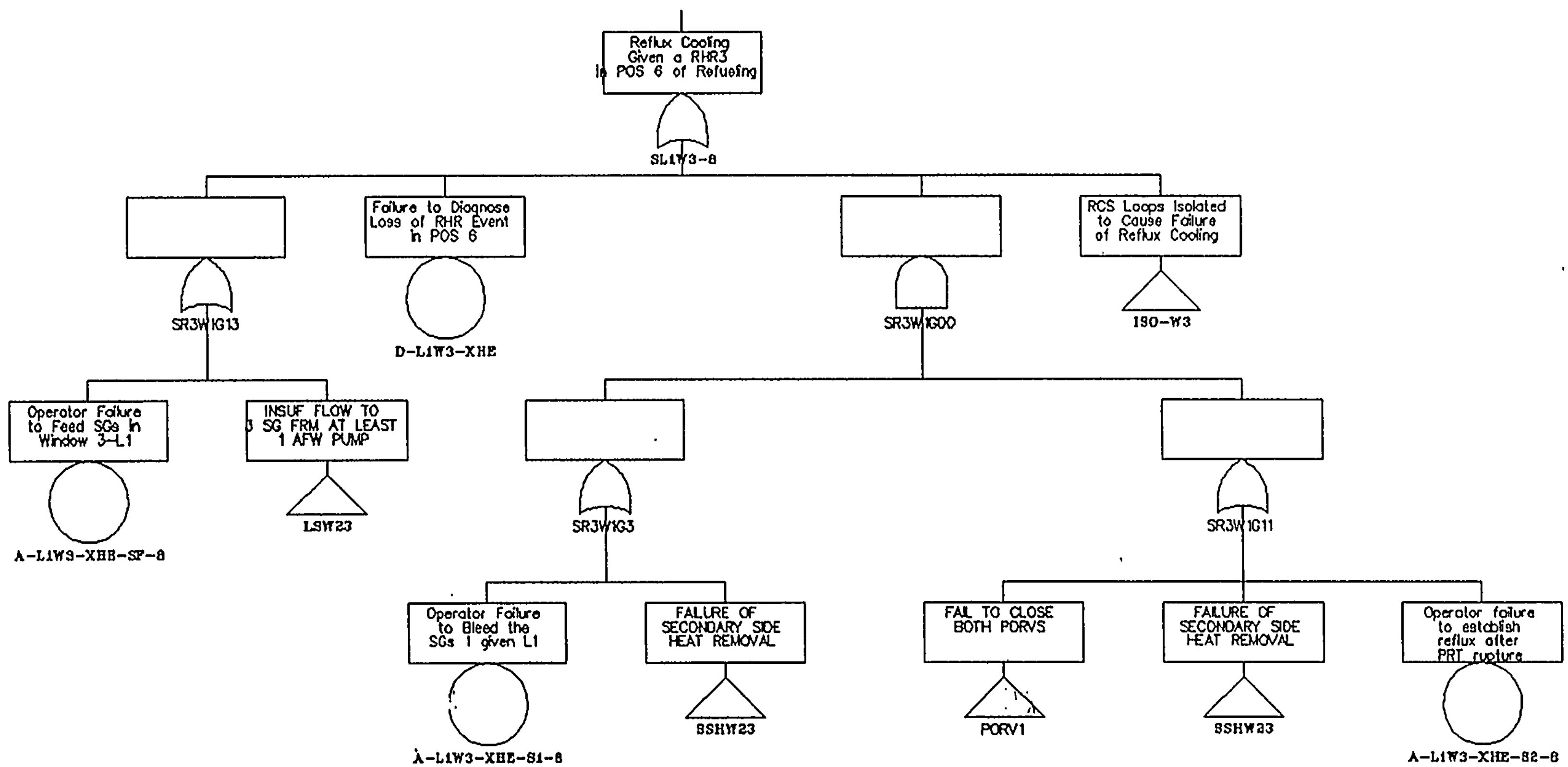
Non-Recovery of AC Power



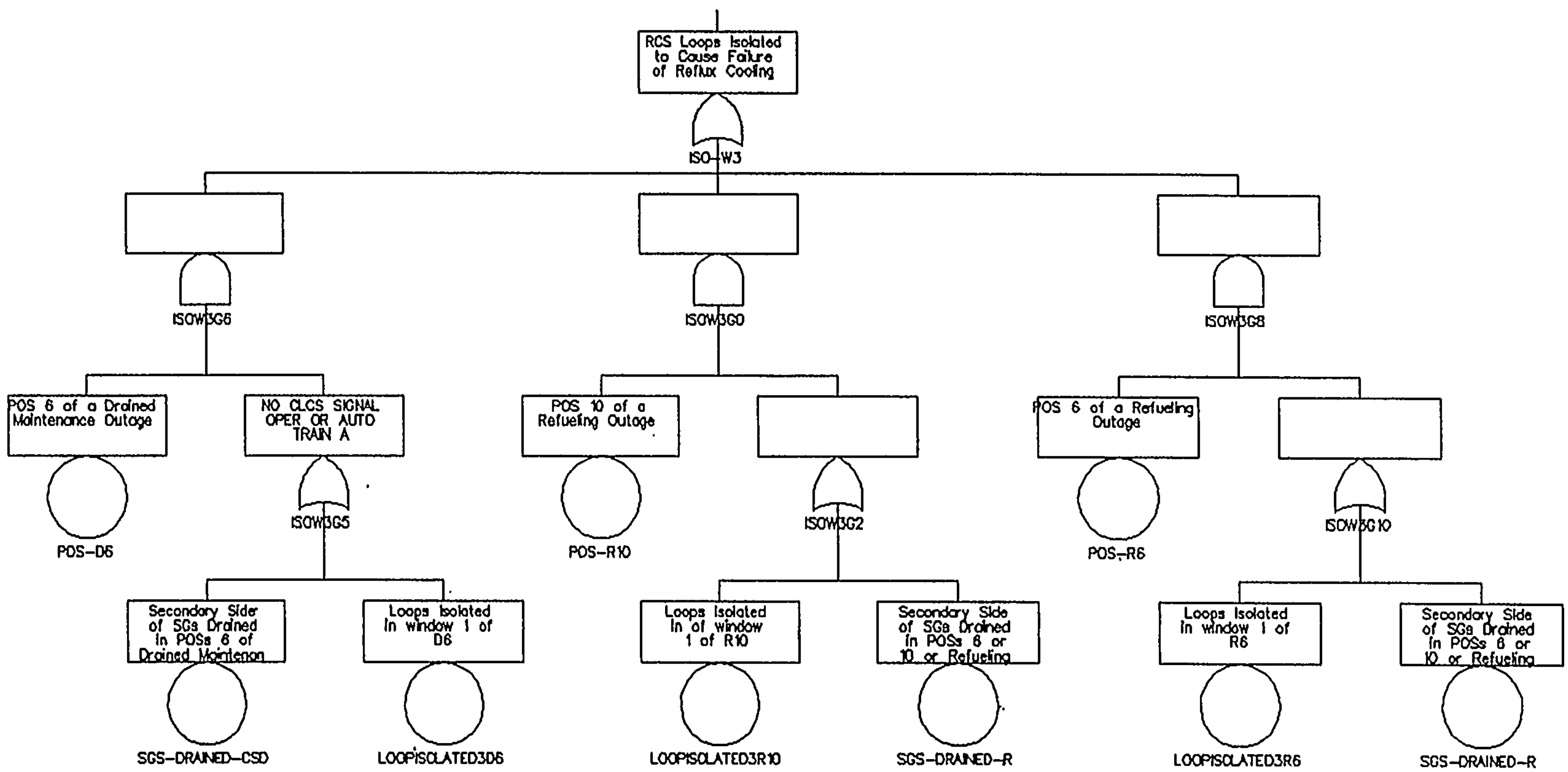
Reflux Cooling in window 3



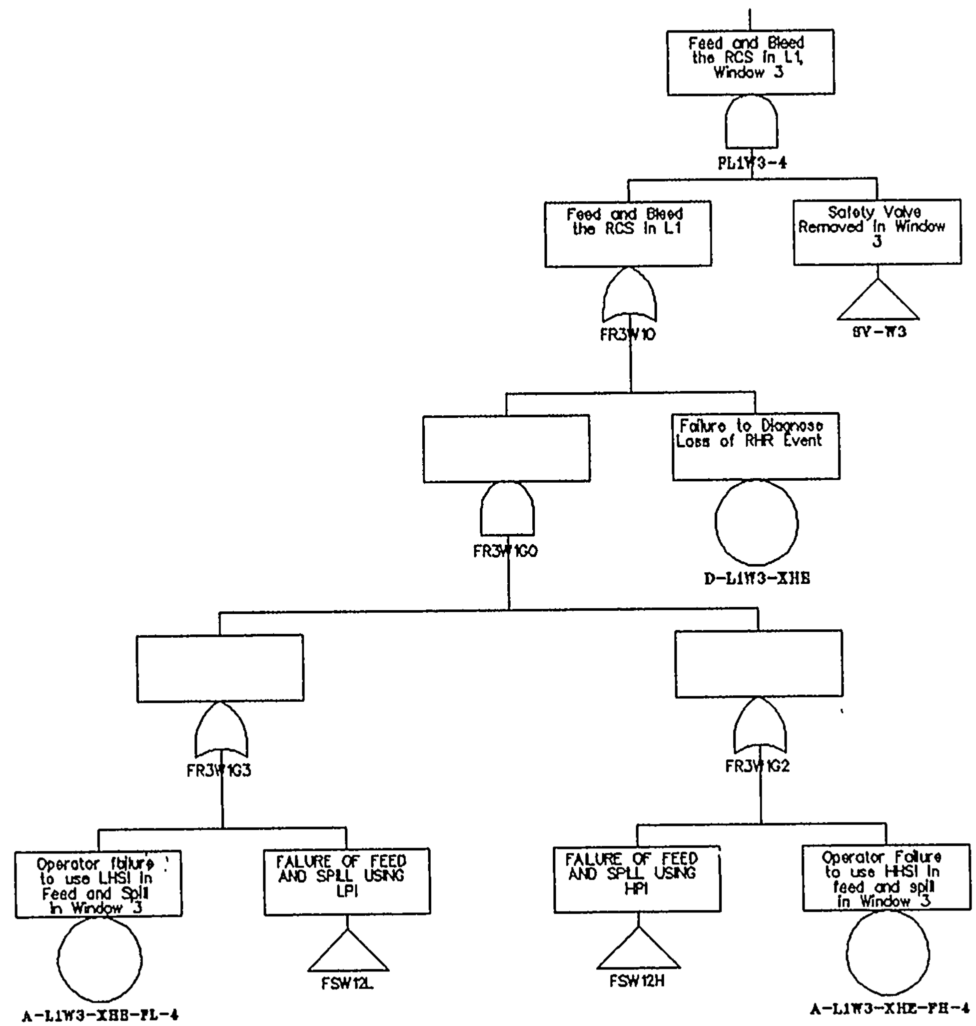
Reflux Cooling in window 3



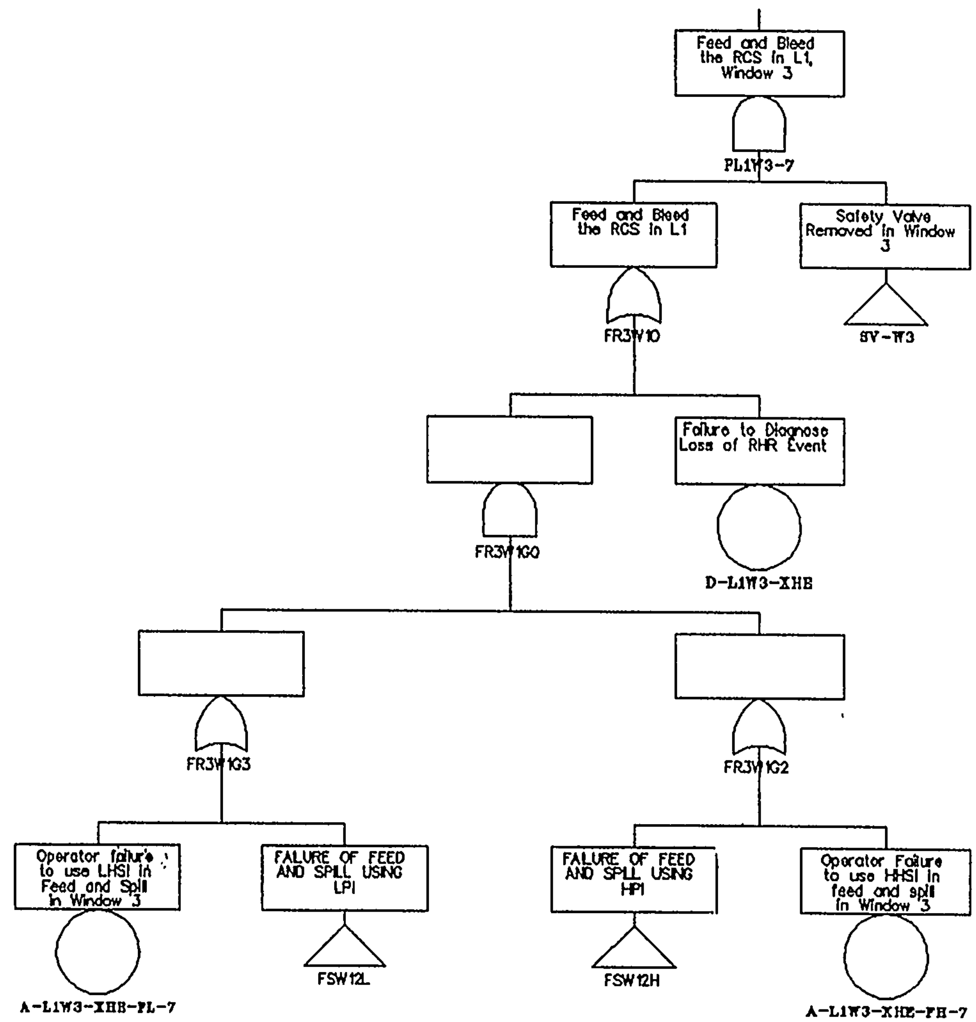
RCS Loops isolated to cause failure of reflux in window 3

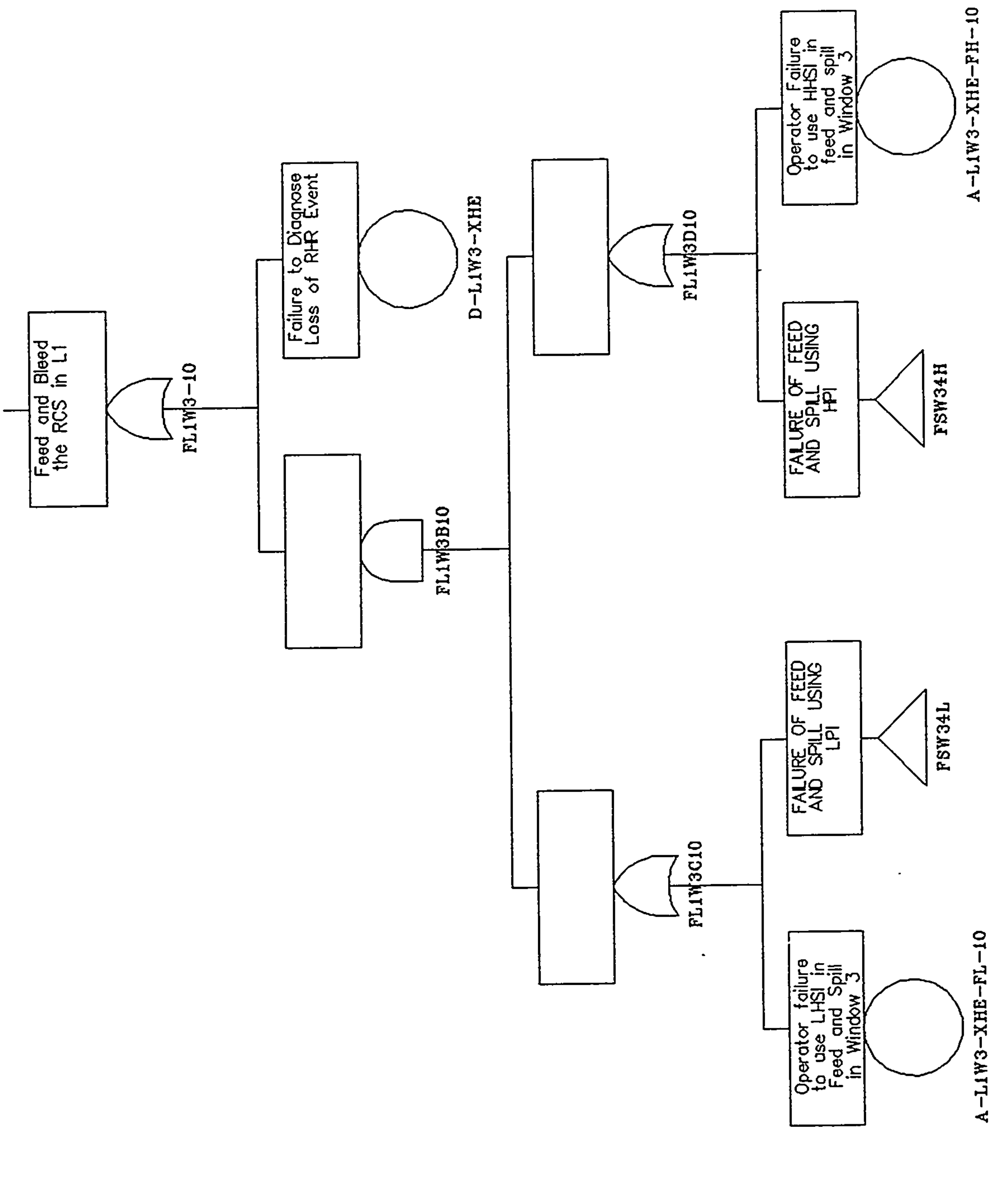


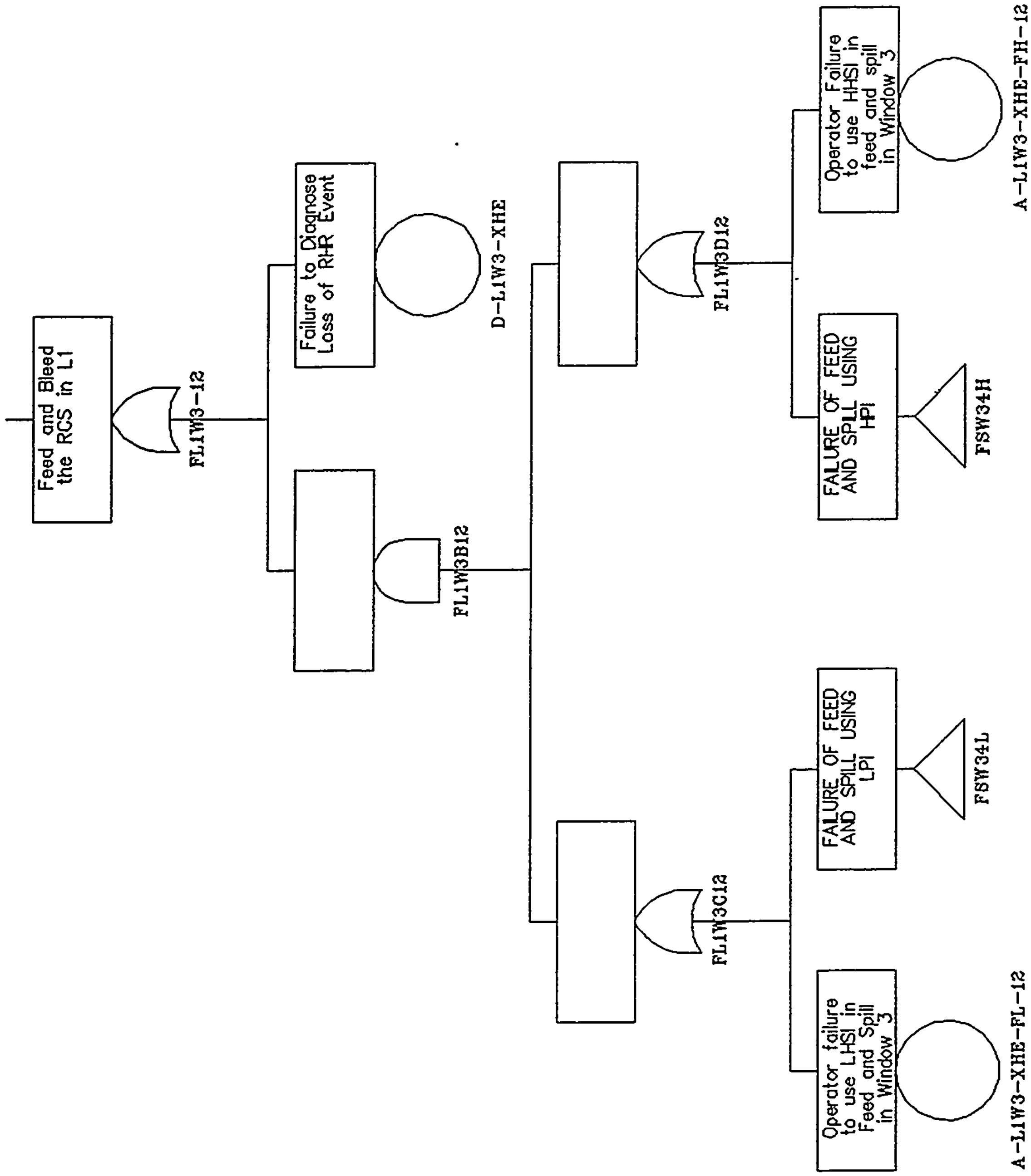
Feed and Bleed the RCS in L1, Window 3



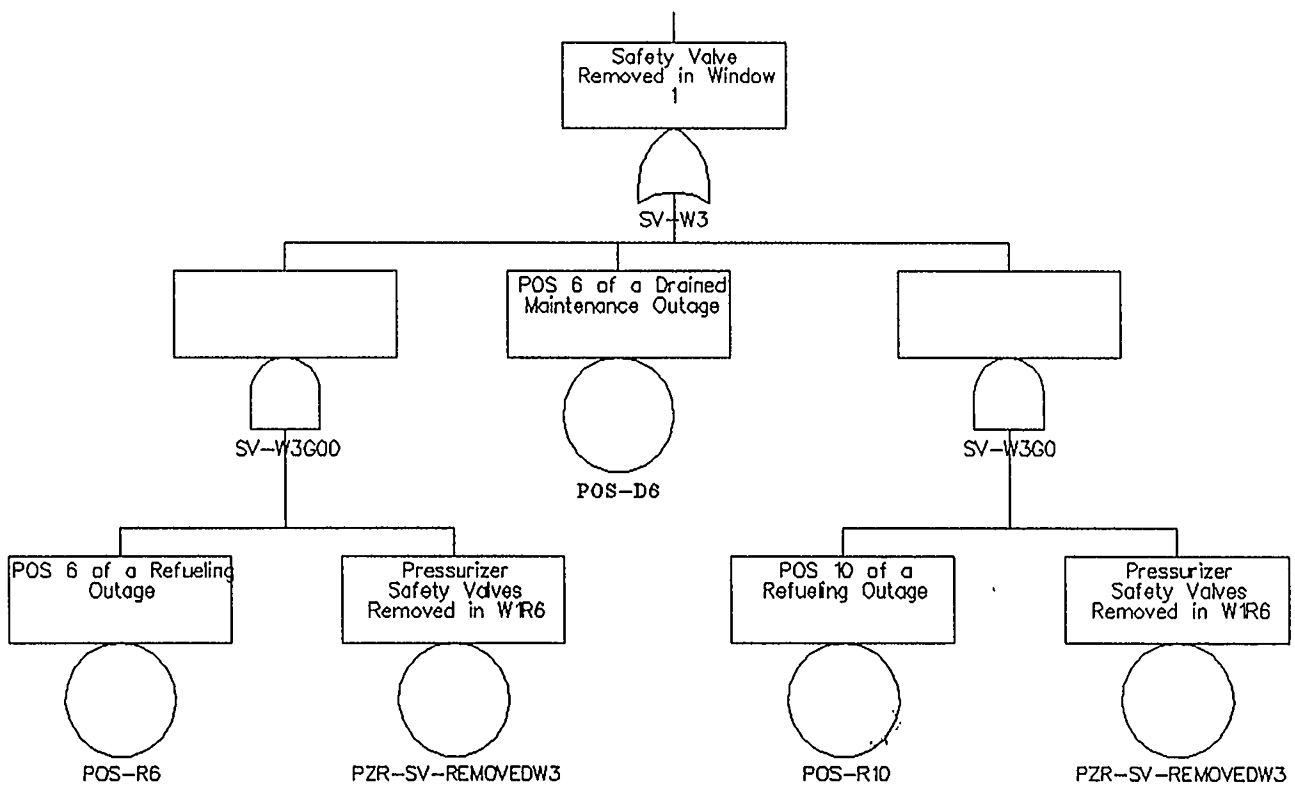
Feed and Bleed the RCS in L1, Window 3



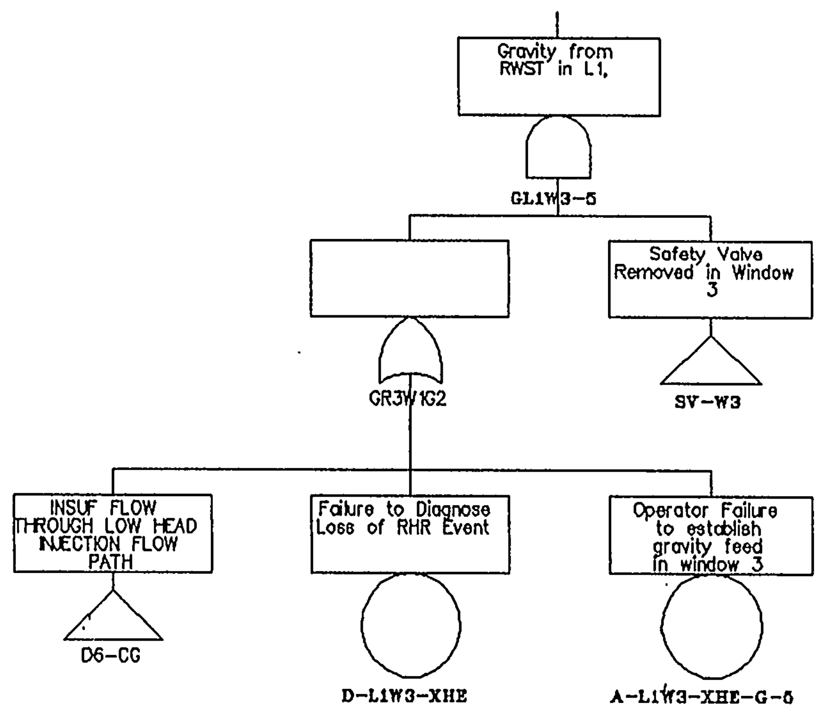

Feed and Bleed the RCS in L1
FL1W3-10
Failure to Diagnose Loss of RHR Event
D-L1W3-XHE
FL1W3B10
FL1W3D10
FAILURE OF FEED AND SPILL USING HPI
FSW34H
Operator Failure to use HHSI in feed and spill in Window 3
A-L1W3-XHE-FH-10
FL1W3C10
FAILURE OF FEED AND SPILL USING LPI
FSW34L
Operator failure to use LHSI in Feed and Spill in Window 3
A-L1W3-XHE-FL-10


Feed and Bleed the RCS in L1
FL1W3-12
Failure to Diagnose Loss of RHR Event
D-L1W3-XHE
FL1W3B12
FL1W3D12
FALURE OF FEED AND SPLL USING HPI
FSW34H
Operator Failure to use HHSI in feed and spill in Window 3
A-L1W3-XHE-FH-12
FL1W3C12
FALURE OF FEED AND SPILL USING LPI
FSW34L
Operator failure to use LHSI in Feed and Spill in Window 3
A-L1W3-XHE-FL-12

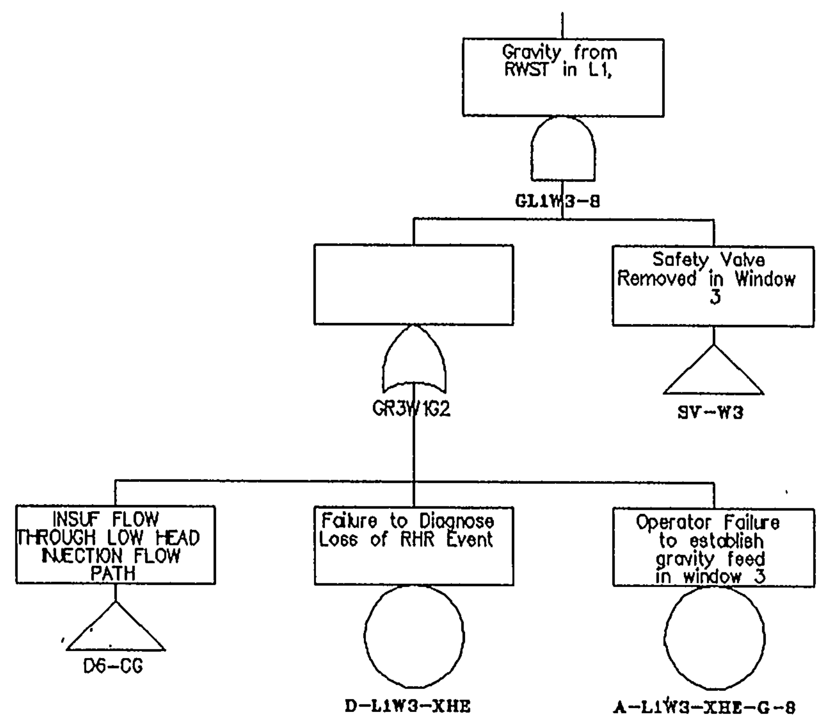
Safety Valves Removed in Window 3

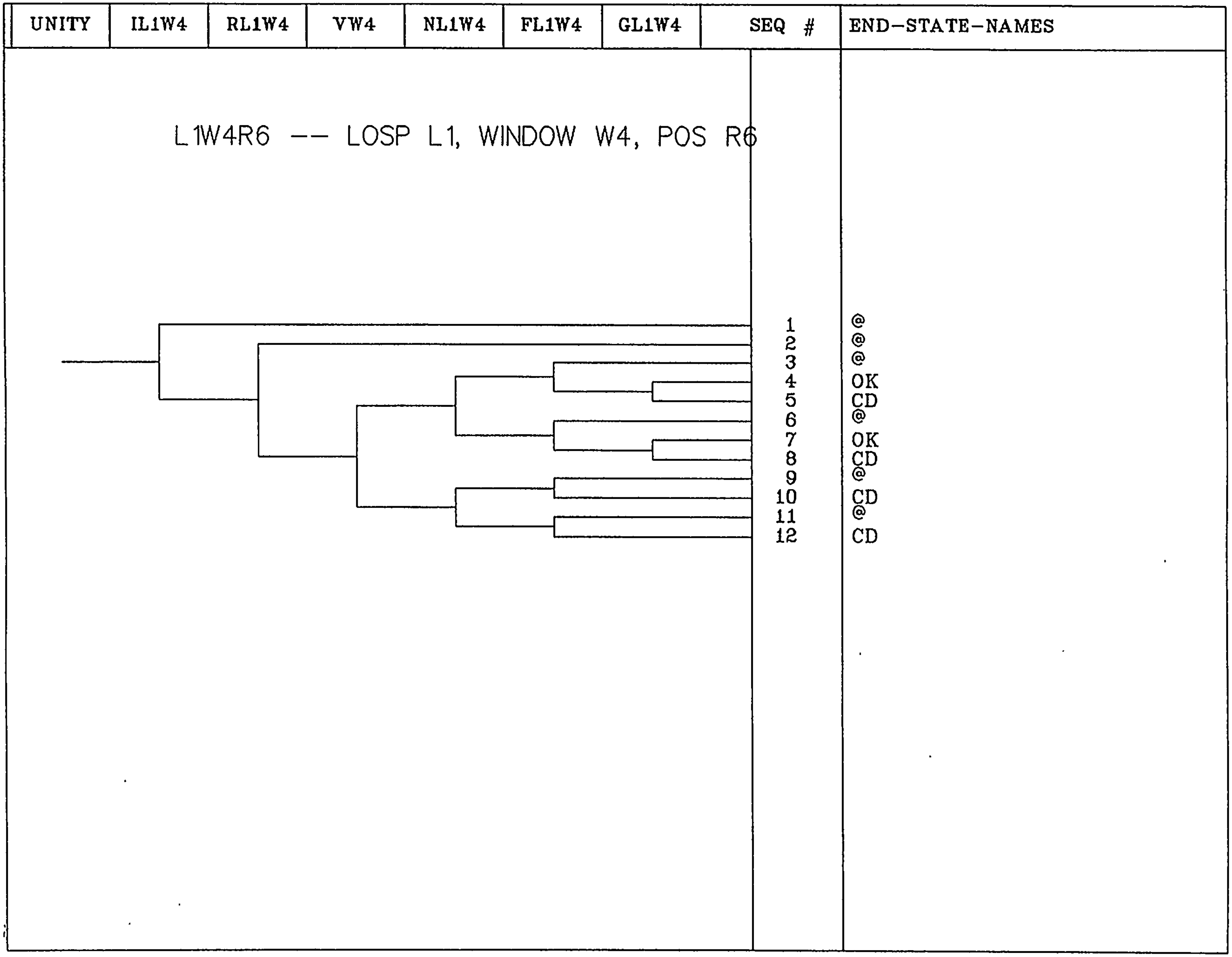


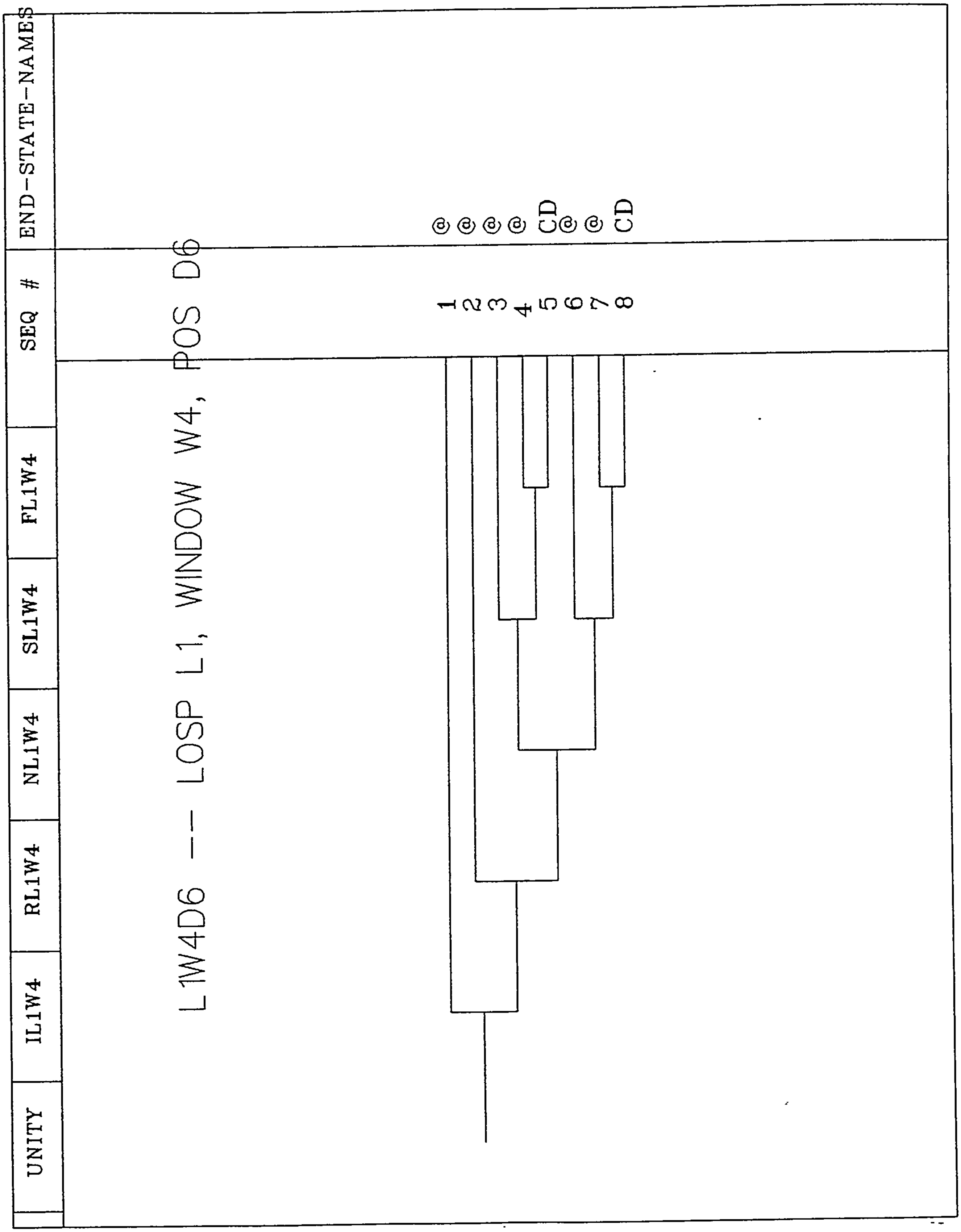
Gravity from RWST in L1, Window 3

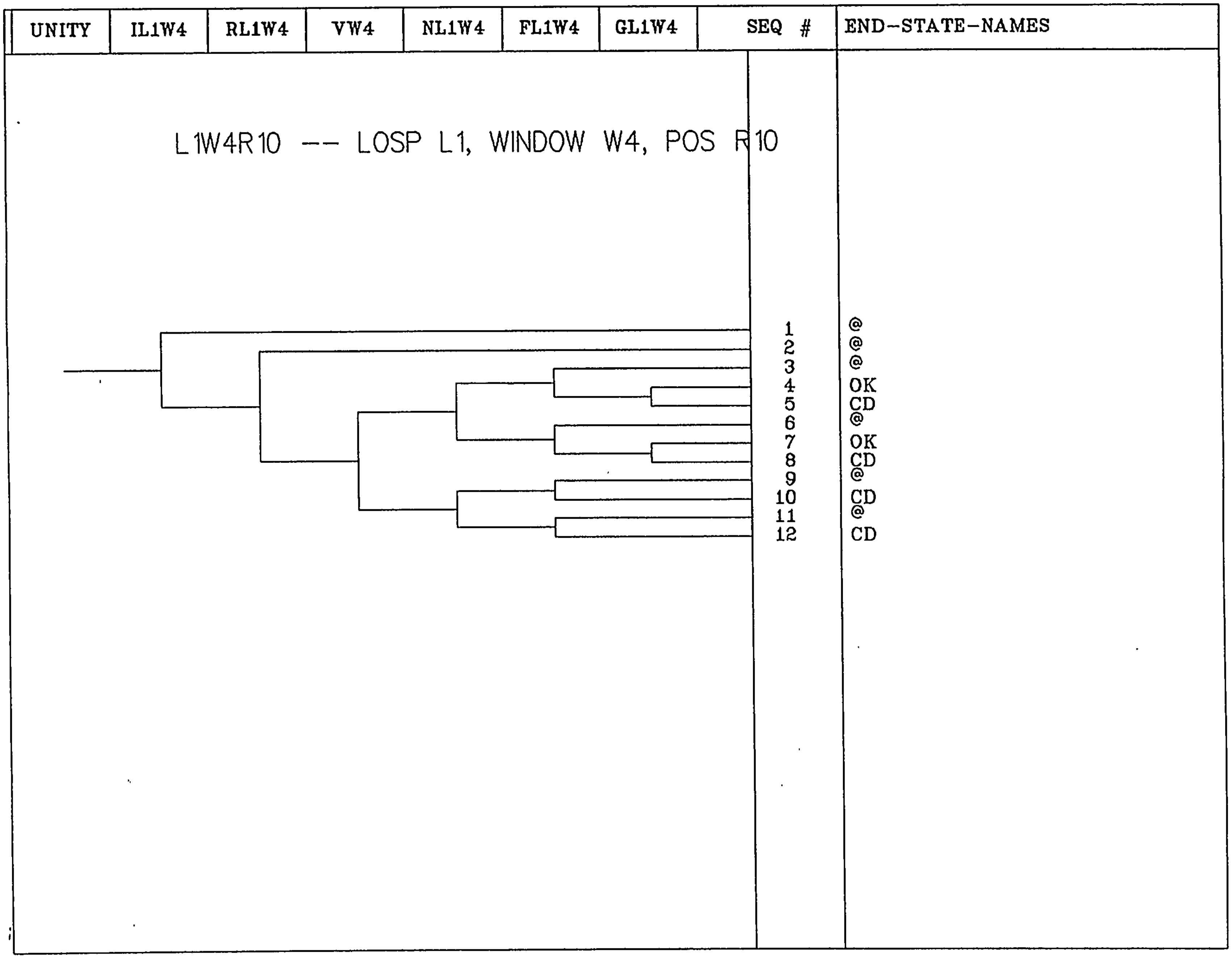


Gravity from RWST in L1, Window 3

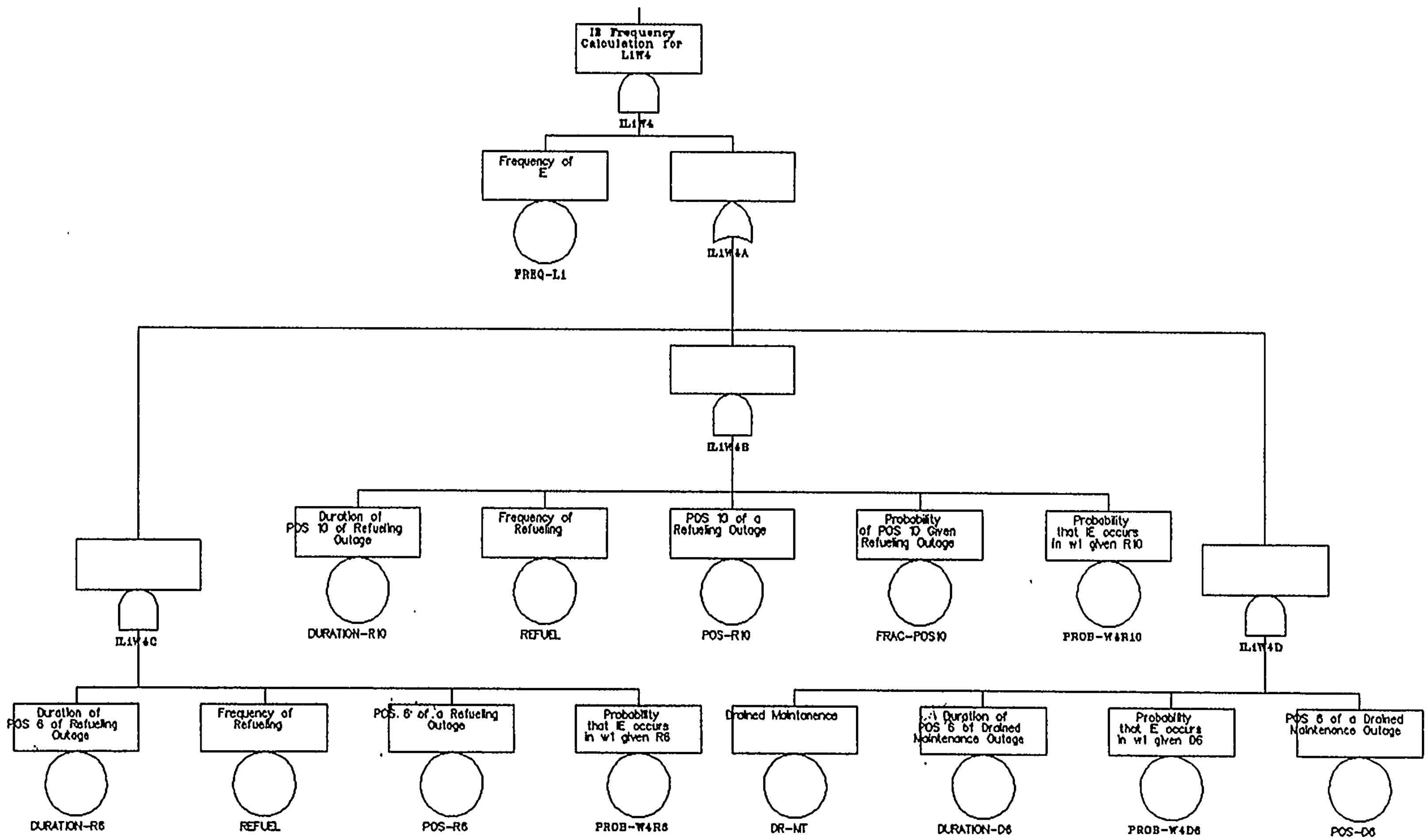



UNITY
IL1W4
RL1W4
VW4
NL1W4
FL1W4
GL1W4
SEQ #
END-STATE-NAMES
L1W4R6 -- LOSP L1, WINDOW W4, POS R6
1 @
2 @
3 @
4 OK
5 CD
6 @
7 OK
8 CD
9 @
10 CD
11 @
12 CD

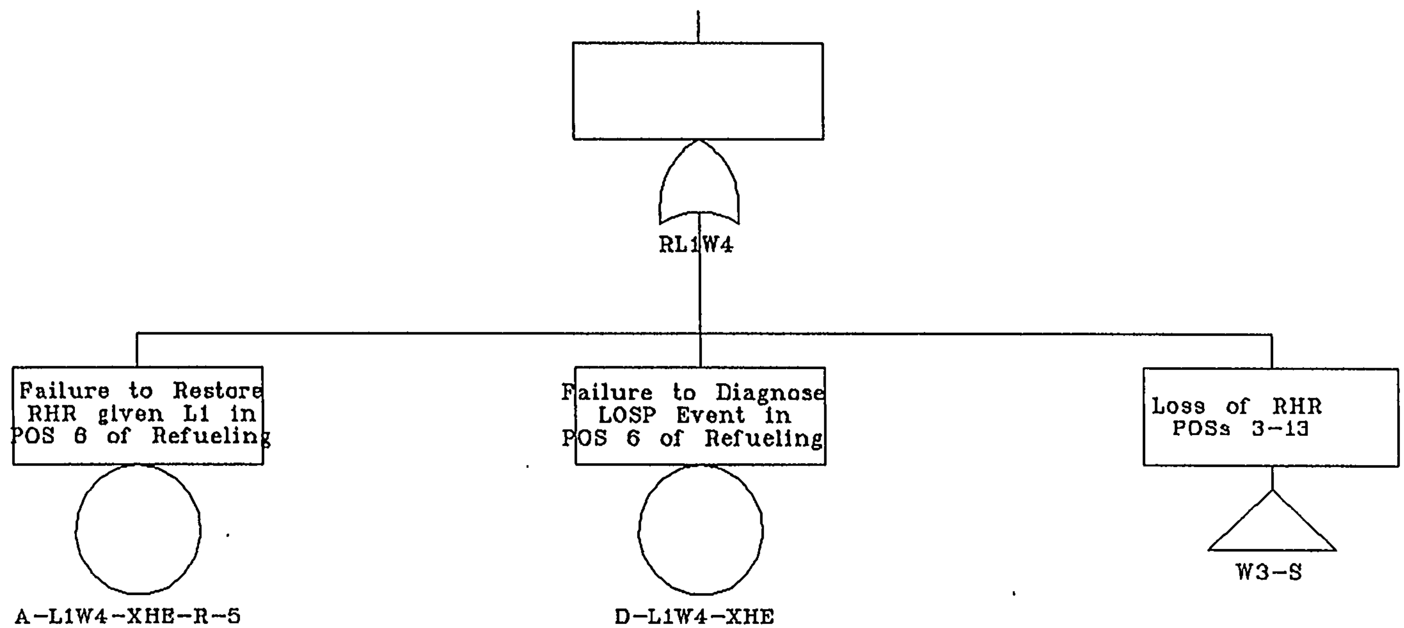

L1W4D6 -- LOSP L1, WINDOW W4, POS D6
UNITY
IL1W4
RL1W4
NL1W4
SL1W4
FL1W4
SEQ #
END-STATE-NAMES
1 @
2 @
3 @
4 @
5 CD
6 @
7 @
8 CD


UNITY
IL1W4
RL1W4
VW4
NL1W4
FL1W4
GL1W4
SEQ #
END-STATE-NAMES
L1W4R10 -- LOSP L1, WINDOW W4, POS R10
1 @
2 @
3 @
4 OK
5 CD
6 @
7 OK
8 CD
9 @
10 CD
11 @
12 CD

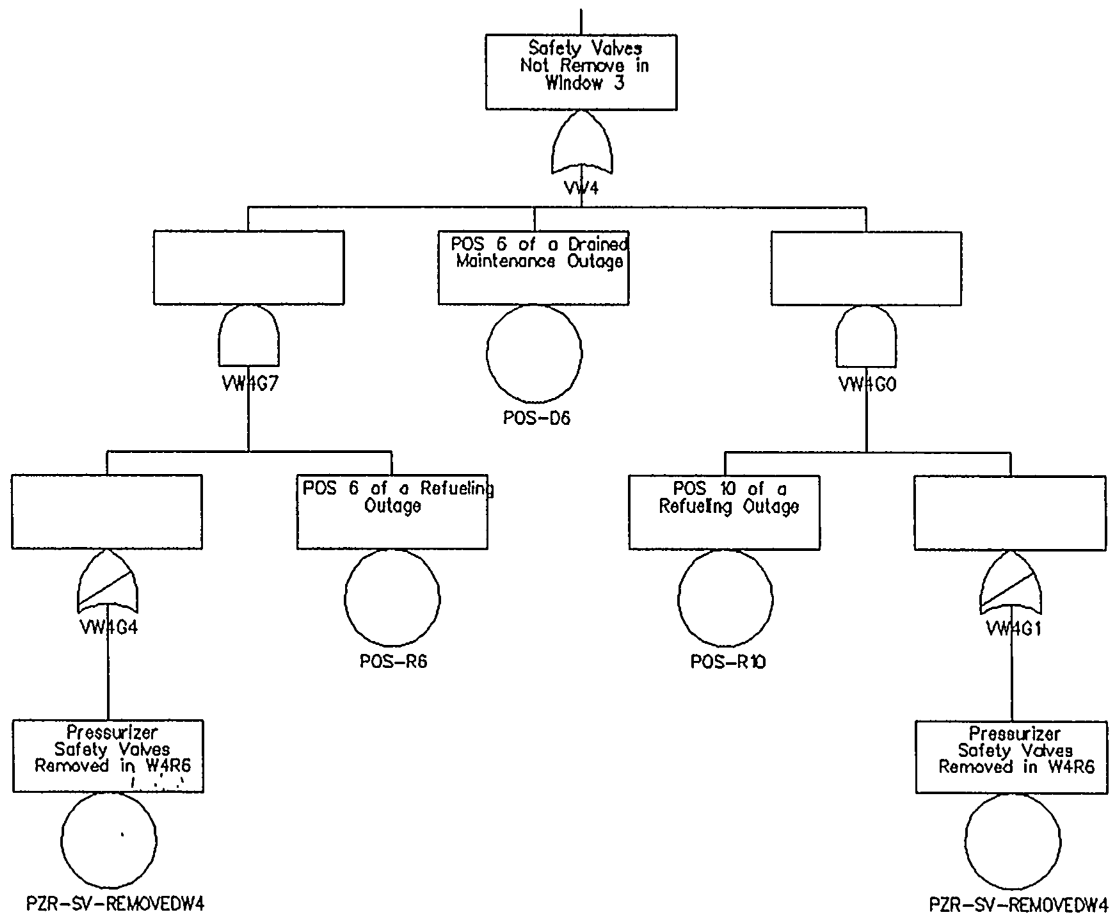
I top event for L1 In window 4



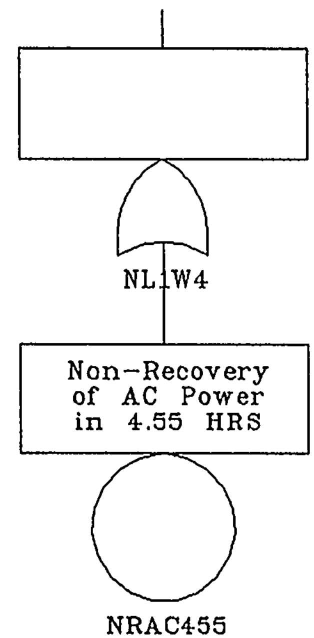
Restore RHR given L1



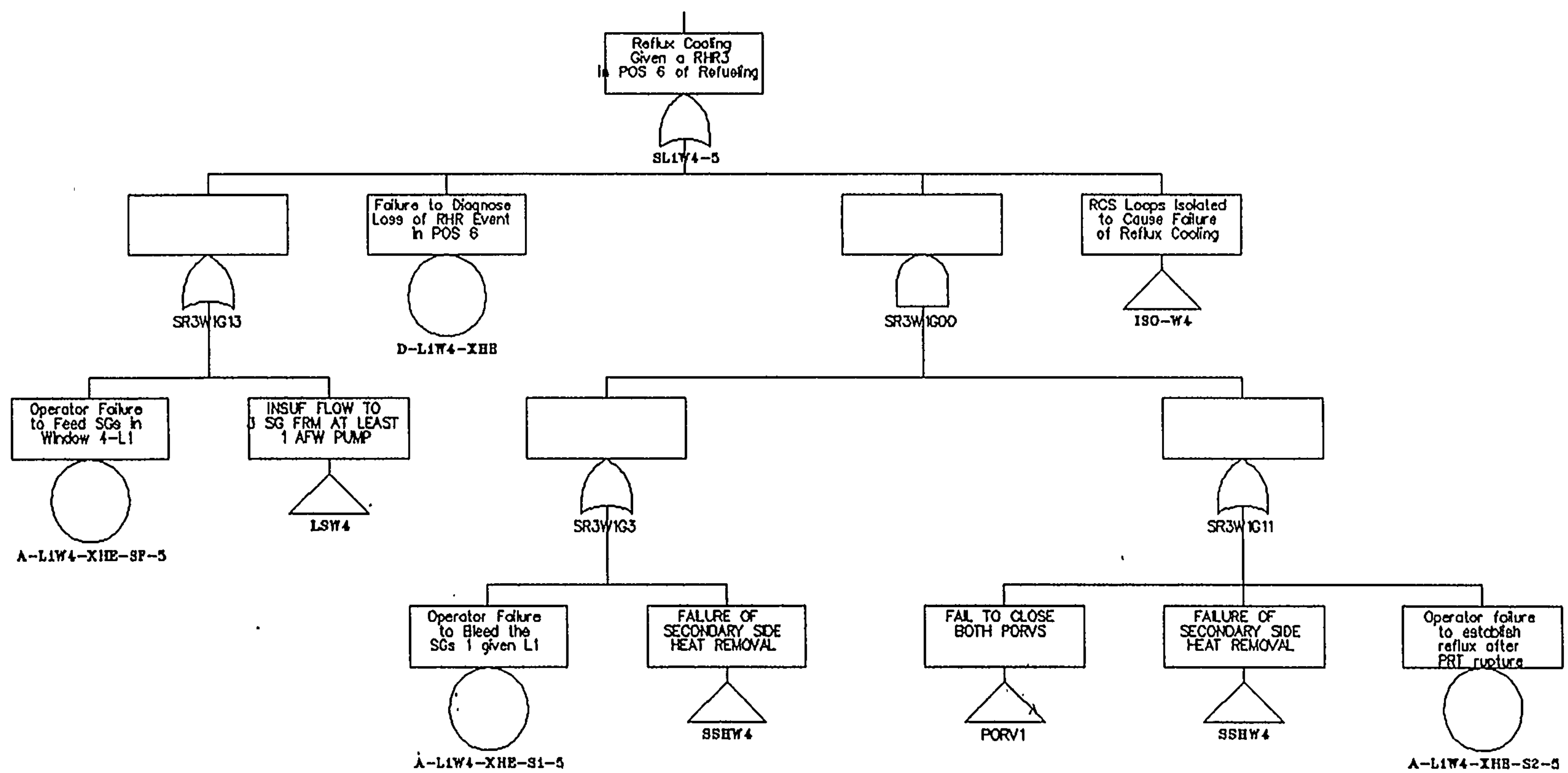
Safety valves Not Removed in Window 4



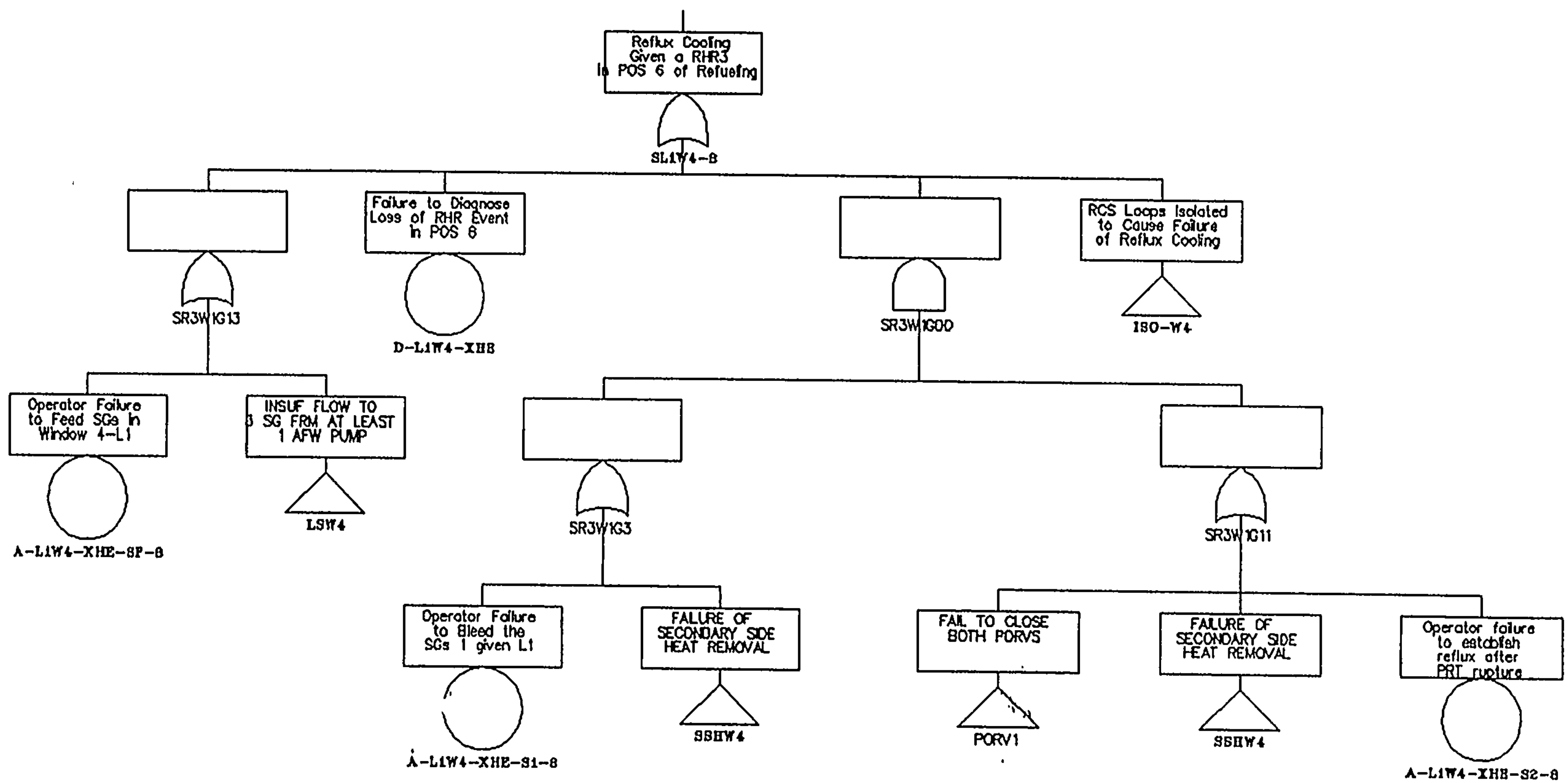
Non-Recovery of AC Power



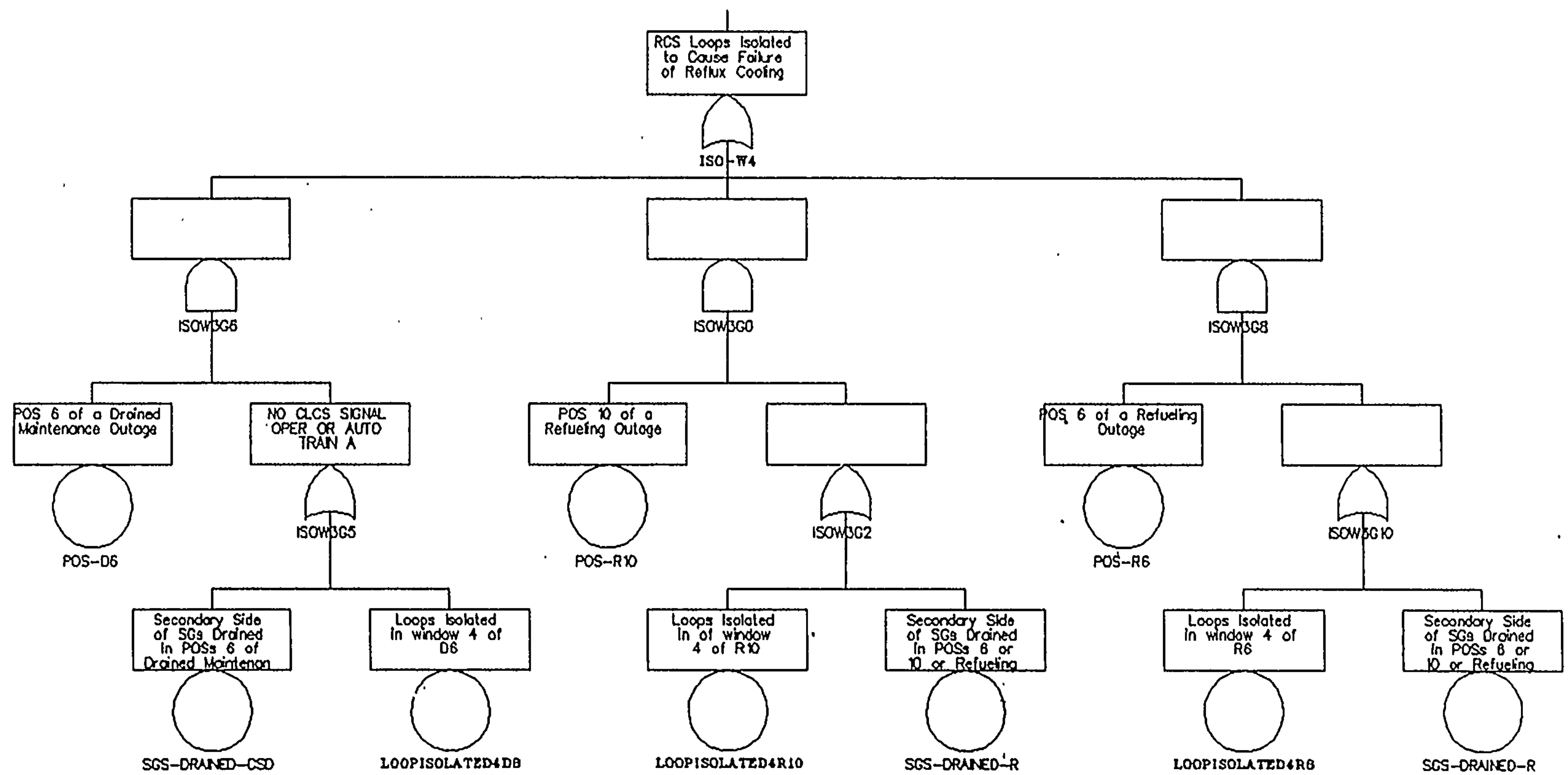
Reflux Cooling in window 4



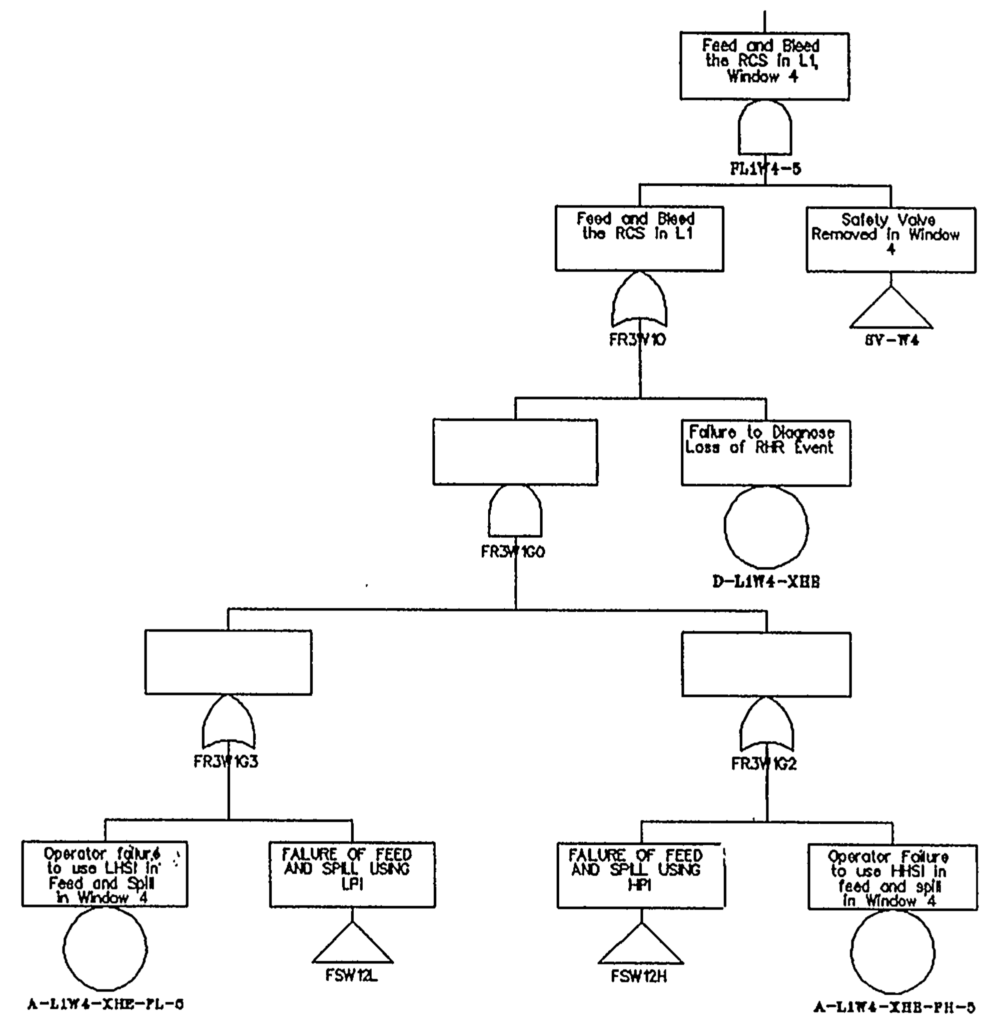
Reflux Cooling in window 4



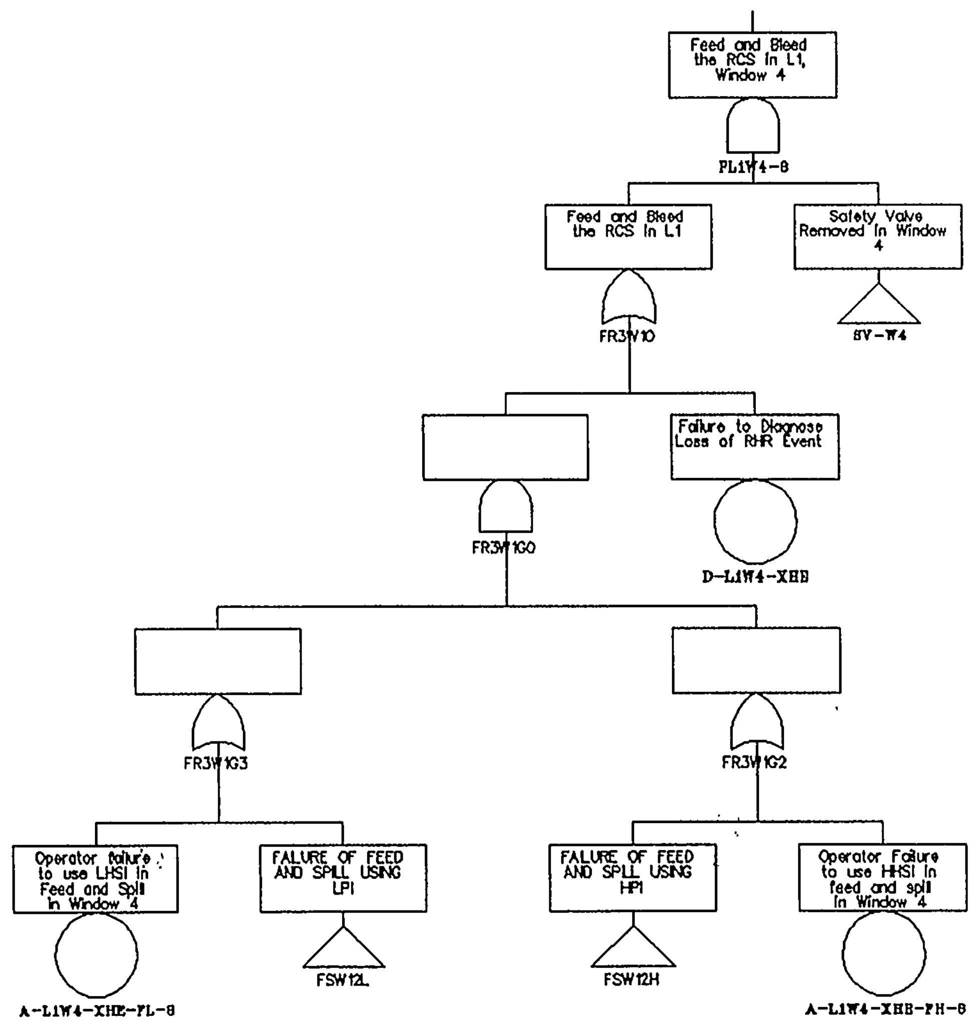
RCS Loops isolated to cause failure of reflux in window 4

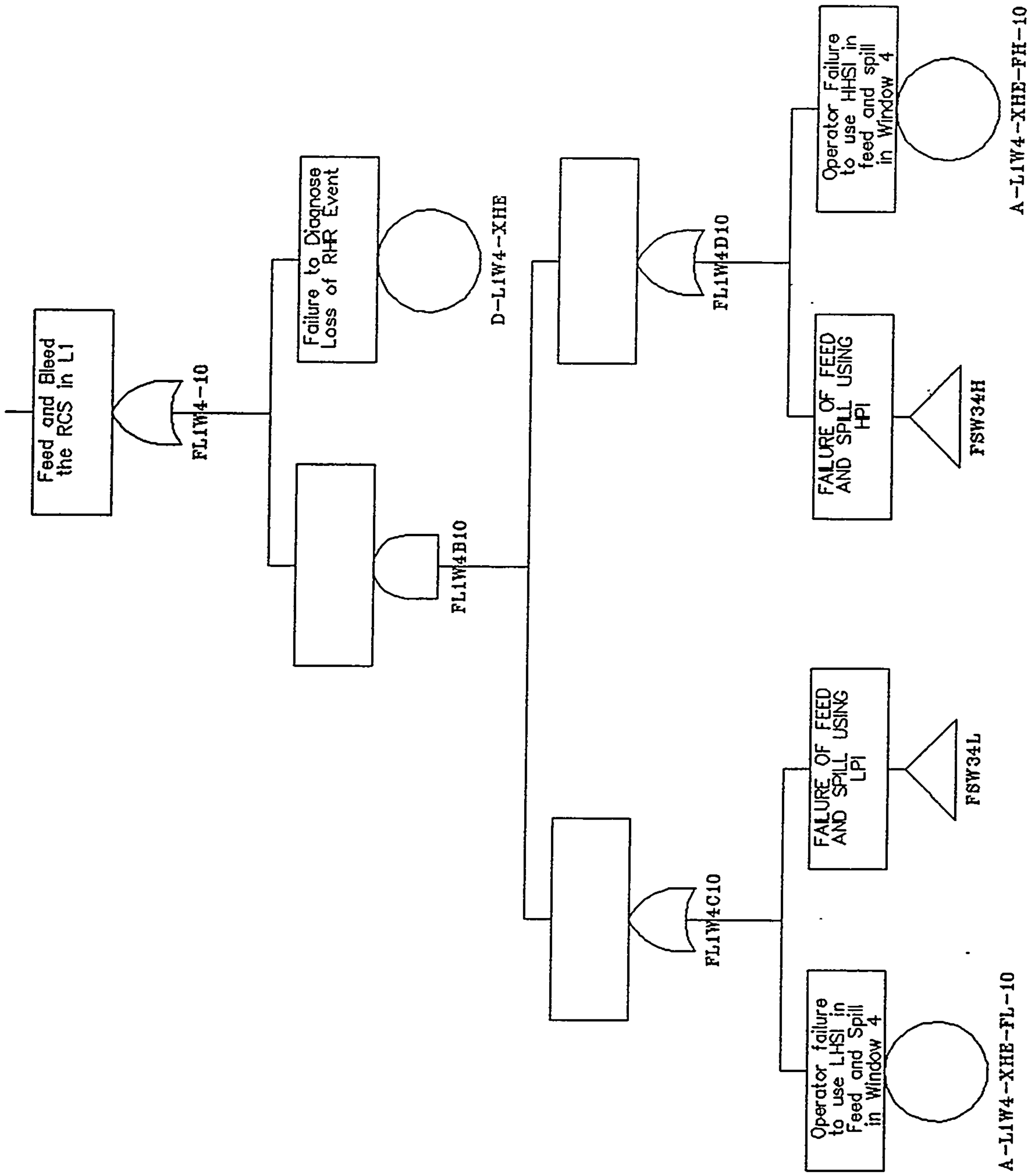


Feed and Bleed the RCS in L1, Window 4

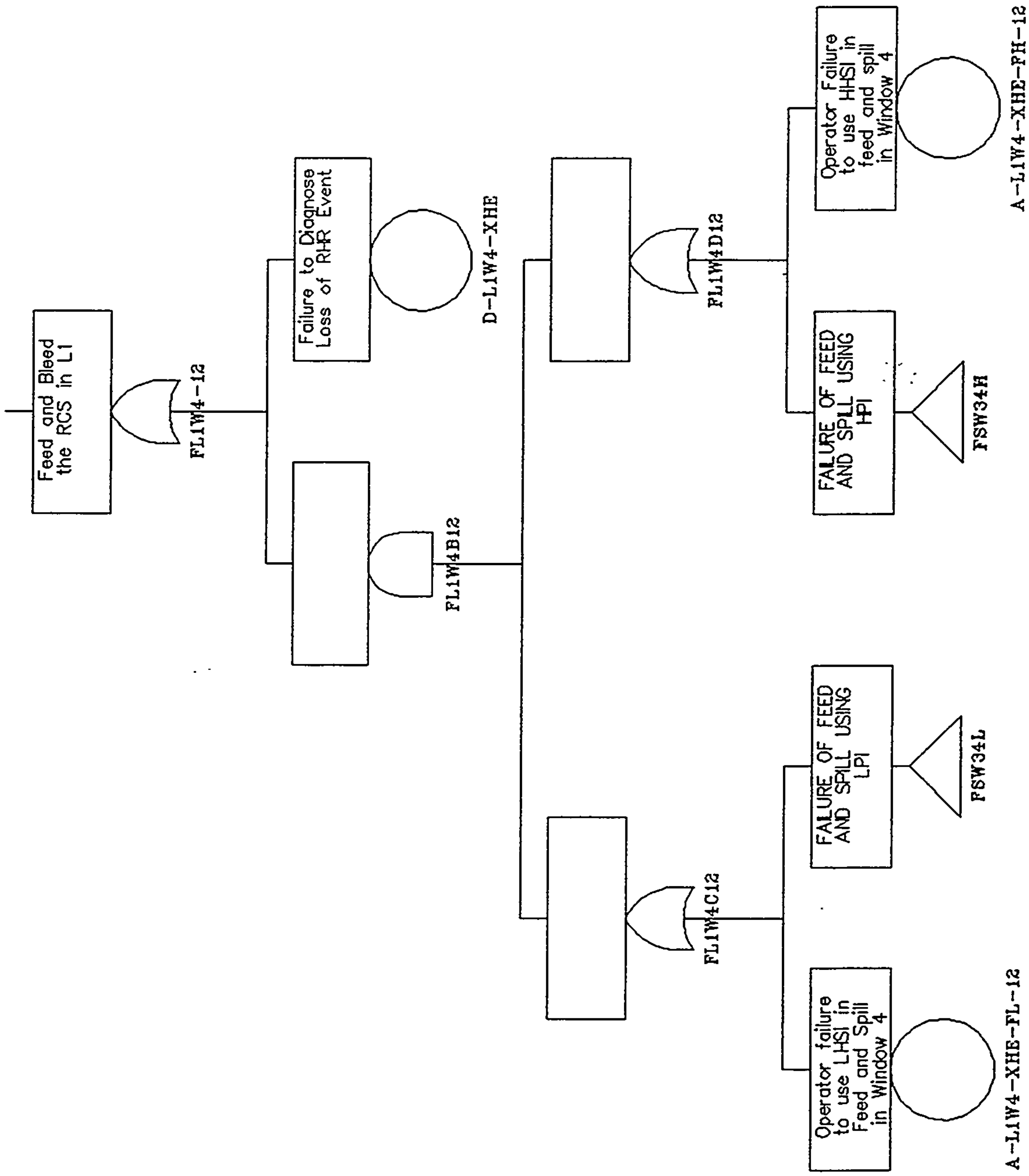


Feed and Bleed the RCS in L1, Window 4



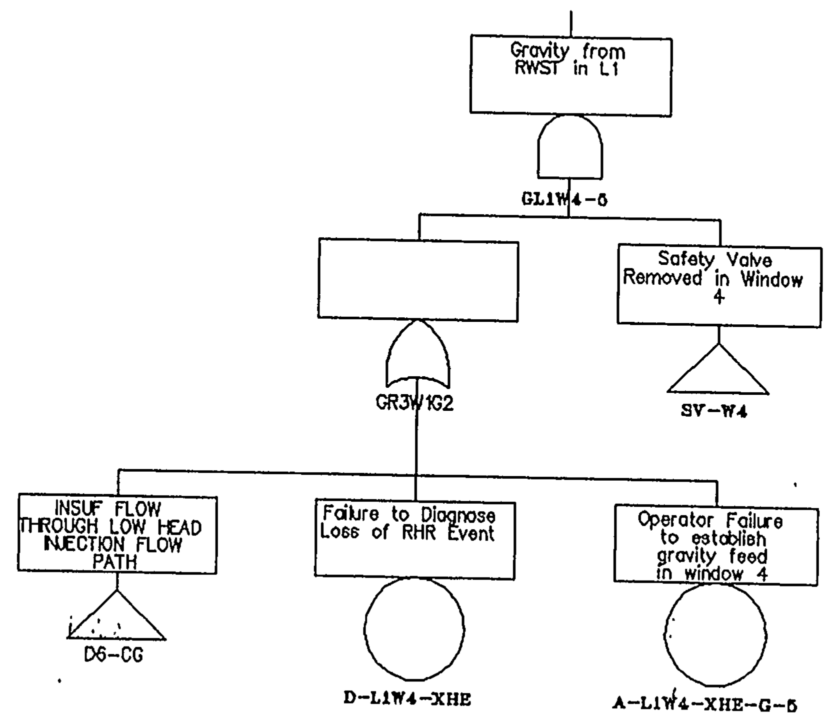


Feed and Bleed the RCS in L1
FL1W4-10
Failure to Diagnose Loss of RHR Event
D-L1W4-XHE
FL1W4B10
FL1W4D10
FAILURE OF FEED AND SPILL USING HPI
FSW34H
Operator Failure to use HHSI in feed and spill in Window 4
A-L1W4-XHE-FH-10
FL1W4C10
FAILURE OF FEED AND SPILL USING LPI
FSW34L
Operator failure to use LHSI in Feed and Spill in Window 4
A-L1W4-XHE-FL-10

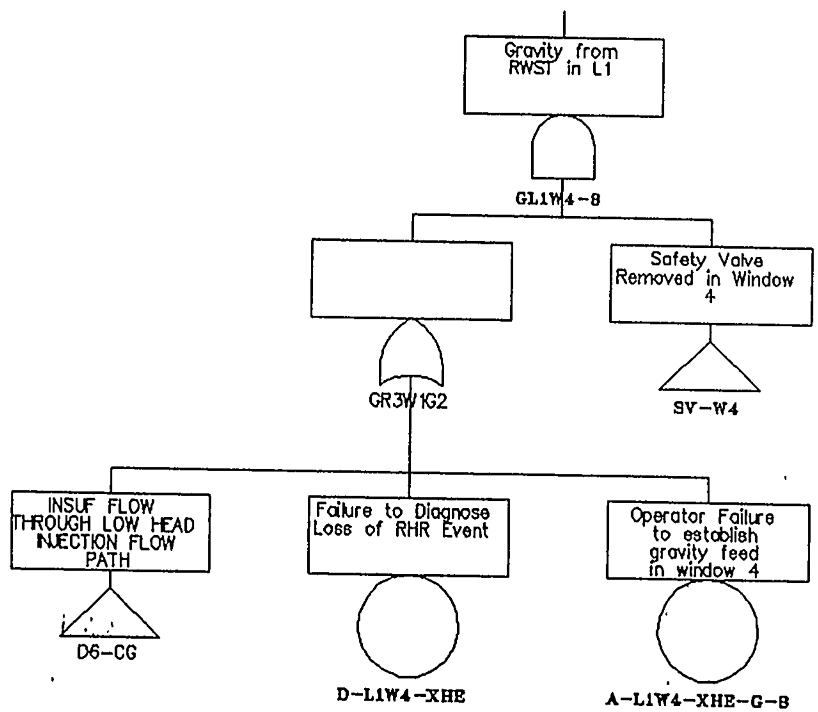


Feed and Bleed the RCS in L1
FL1W4-12
Failure to Diagnose Loss of RHR Event
D-L1W4-XHE
FL1W4B12
FL1W4D12
FL1W4C12
FAILURE OF FEED AND SPILL USING HPI
FSW34H
Operator Failure to use HHSI in feed and spill in Window 4
A-L1W4-XHE-FH-12
FAILURE OF FEED AND SPILL USING LPI
FSW34L
Operator failure to use LHSI in Feed and Spill in Window 4
A-L1W4-XHE-FL-12

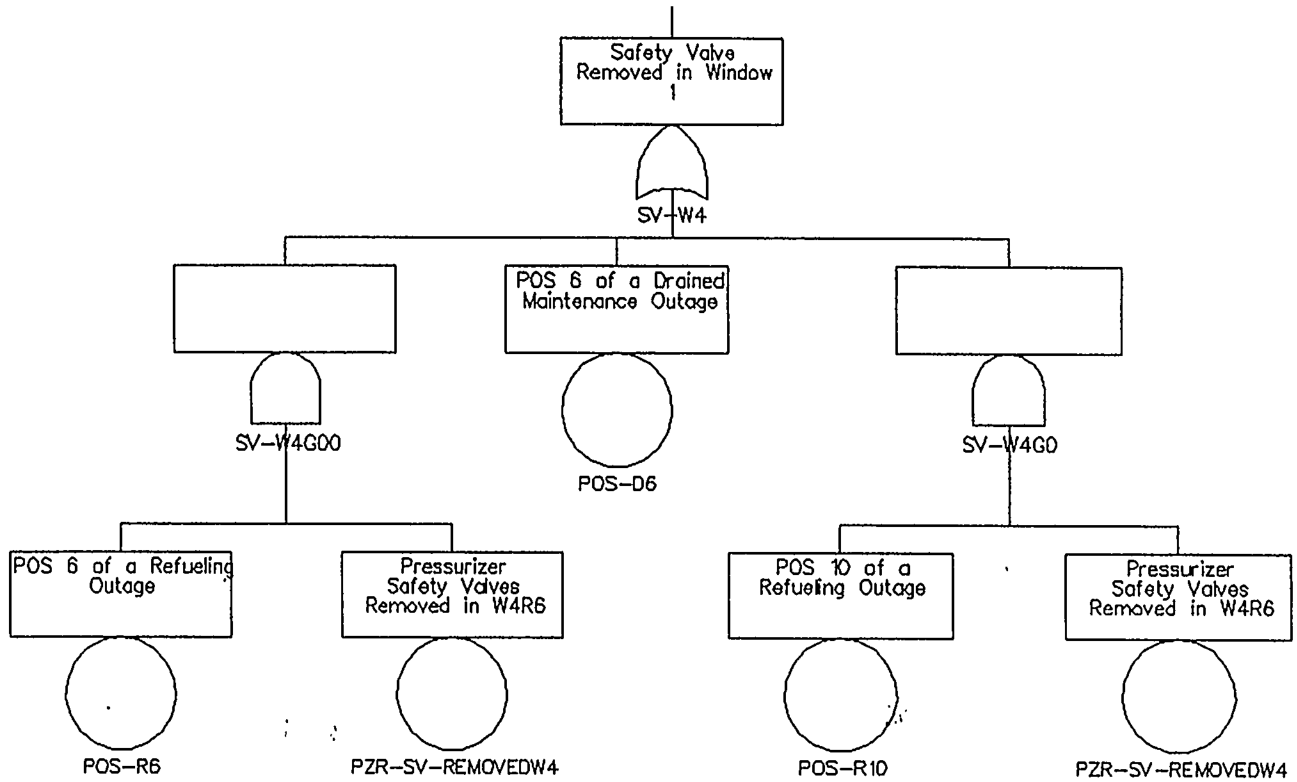
Gravity from RWST in L1, Window 4



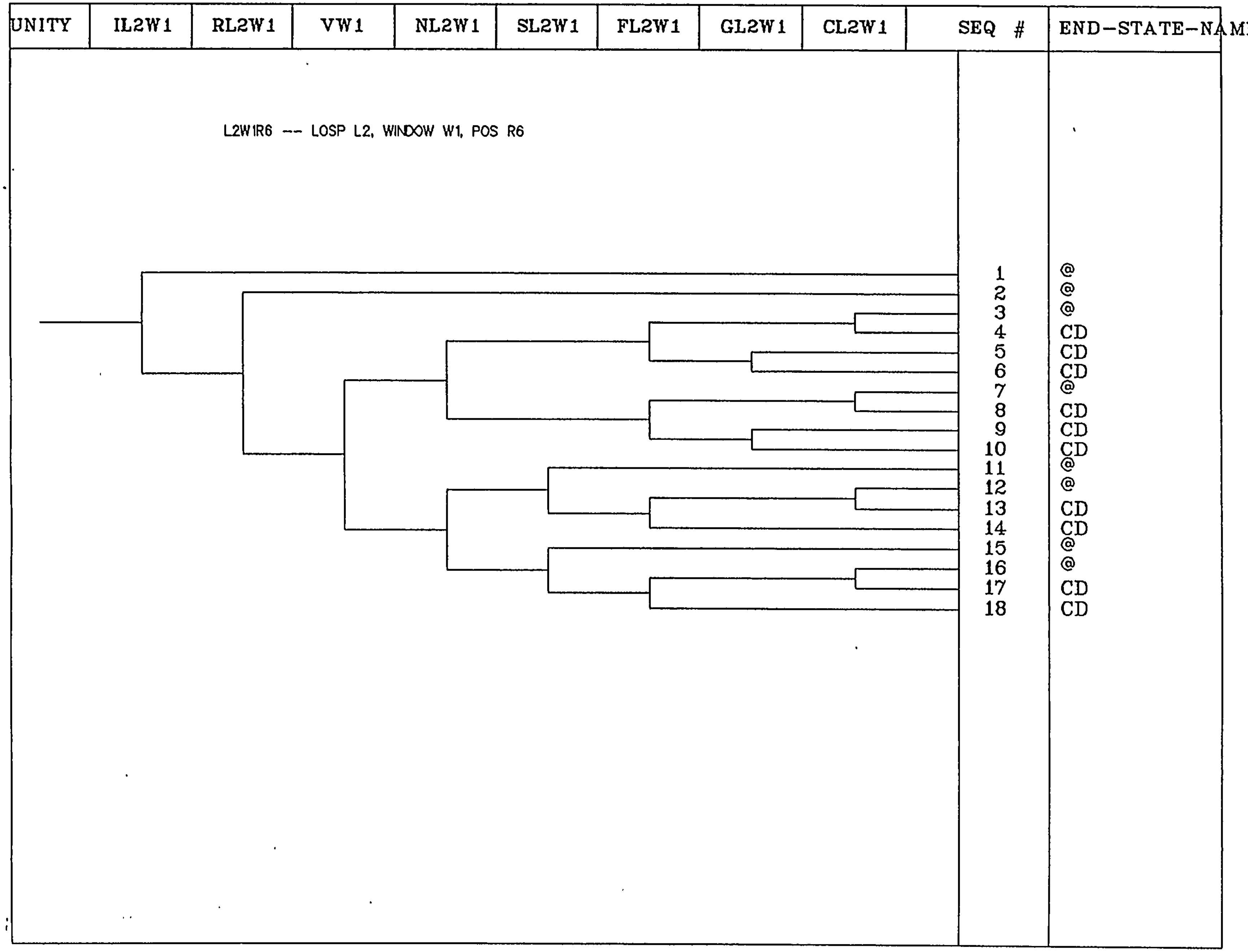
Gravity from RWST in L1, Window 4

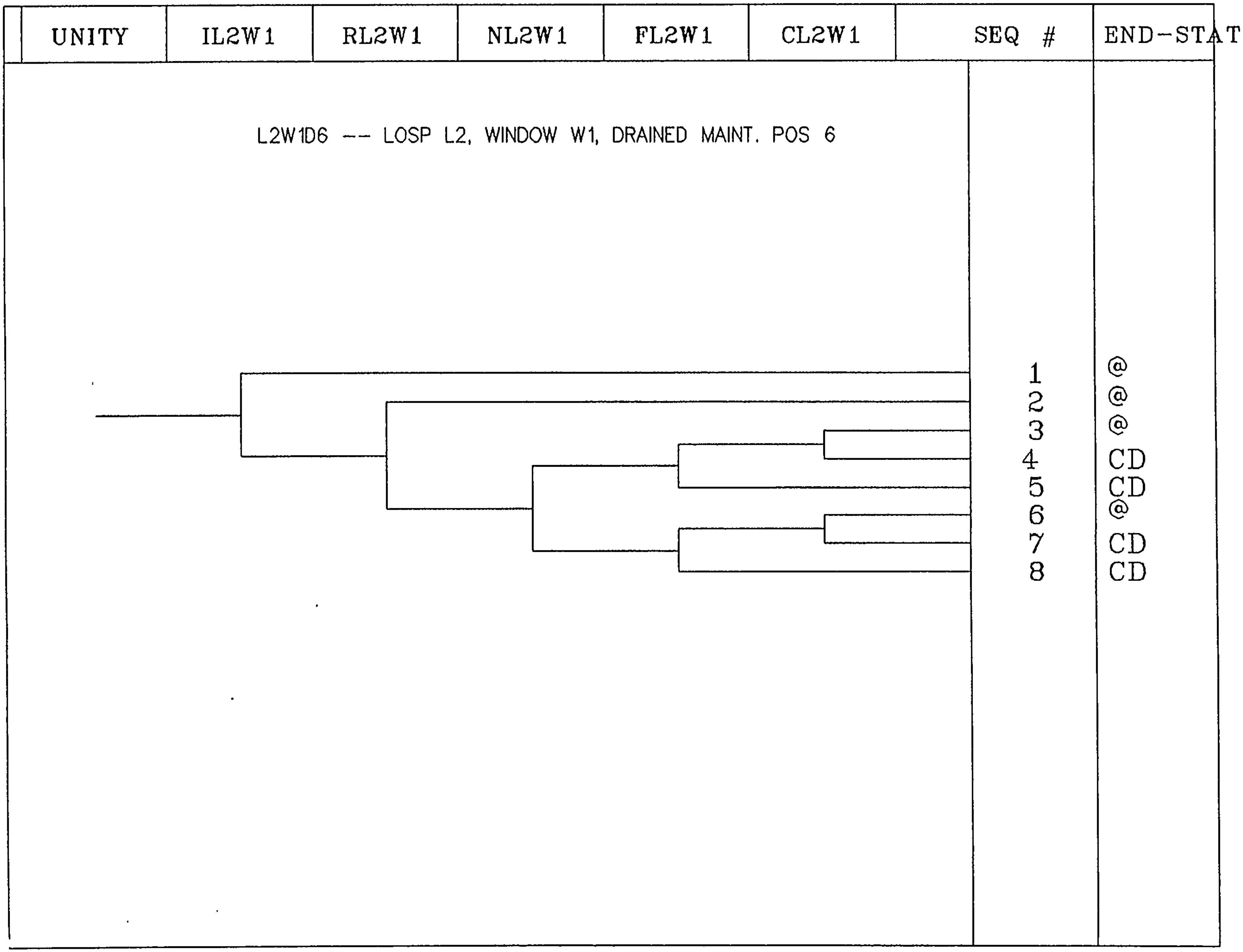


Safety Valves Removed in Window 4

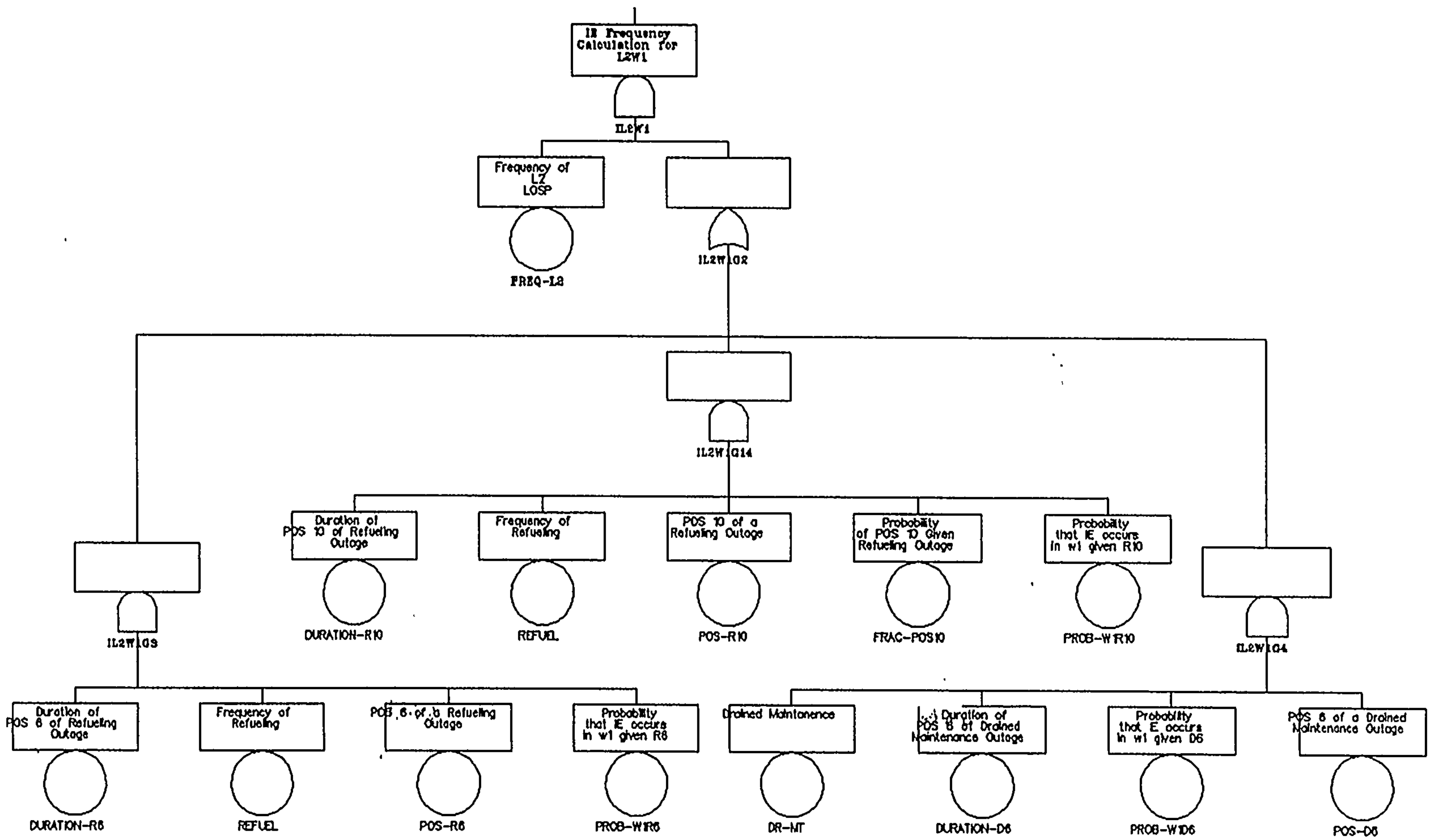


Appendix E.7 Event Trees and High Level Fault Trees for Loss of Offsite Power(L2)

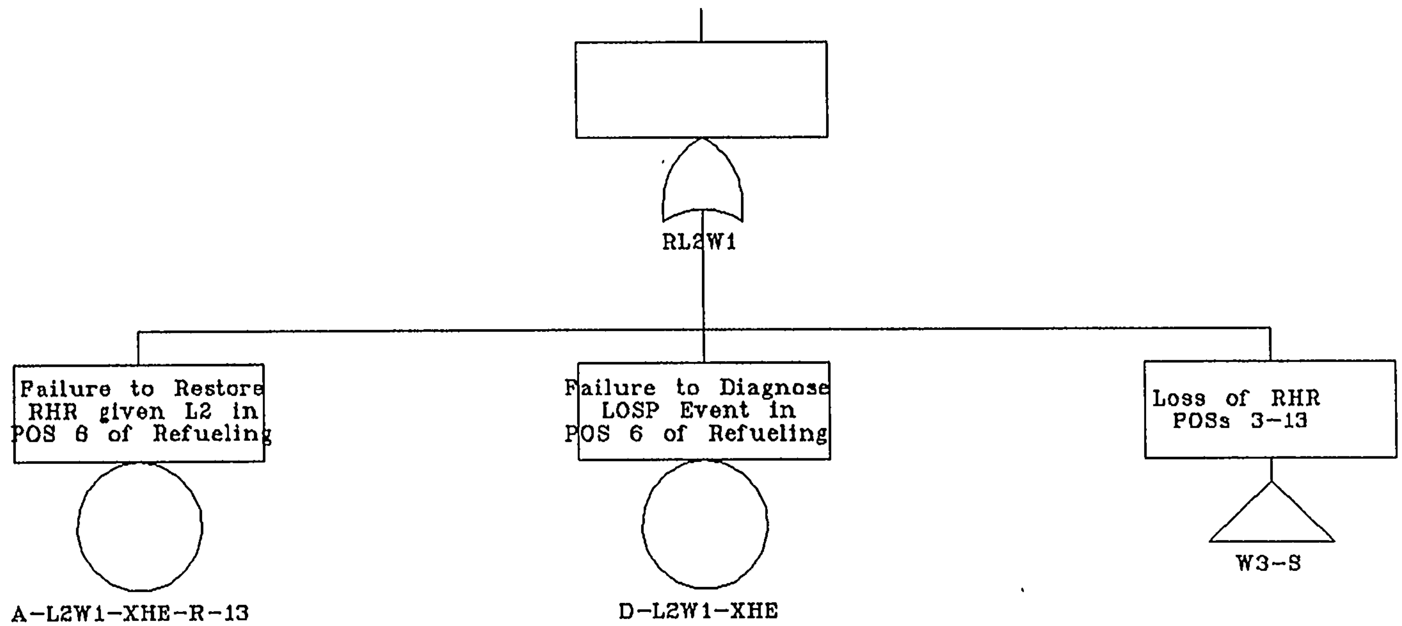

UNITY
IL2W1
RL2W1
VW1
NL2W1
SL2W1
FL2W1
GL2W1
CL2W1
SEQ #
END-STATE-NAME
L2W1R6 -- LOSP L2, WINDOW W1, POS R6
1 @
2 @
3 @
4 CD
5 CD
6 CD
7 @
8 CD
9 CD
10 CD
11 @
12 @
13 CD
14 CD
15 @
16 @
17 CD
18 CD


UNITY
IL2W1
RL2W1
NL2W1
FL2W1
CL2W1
SEQ #
END-STATE
L2W1D6 -- LOSP L2, WINDOW W1, DRAINED MAINT. POS 6
1 @
2 @
3 @
4 CD
5 CD
6 @
7 CD
8 CD

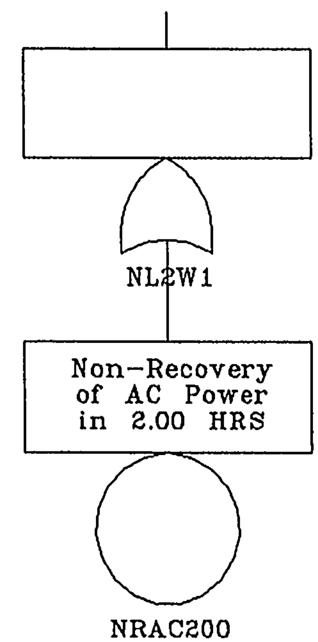
I top event for L2 LOSP — L2 in window 1



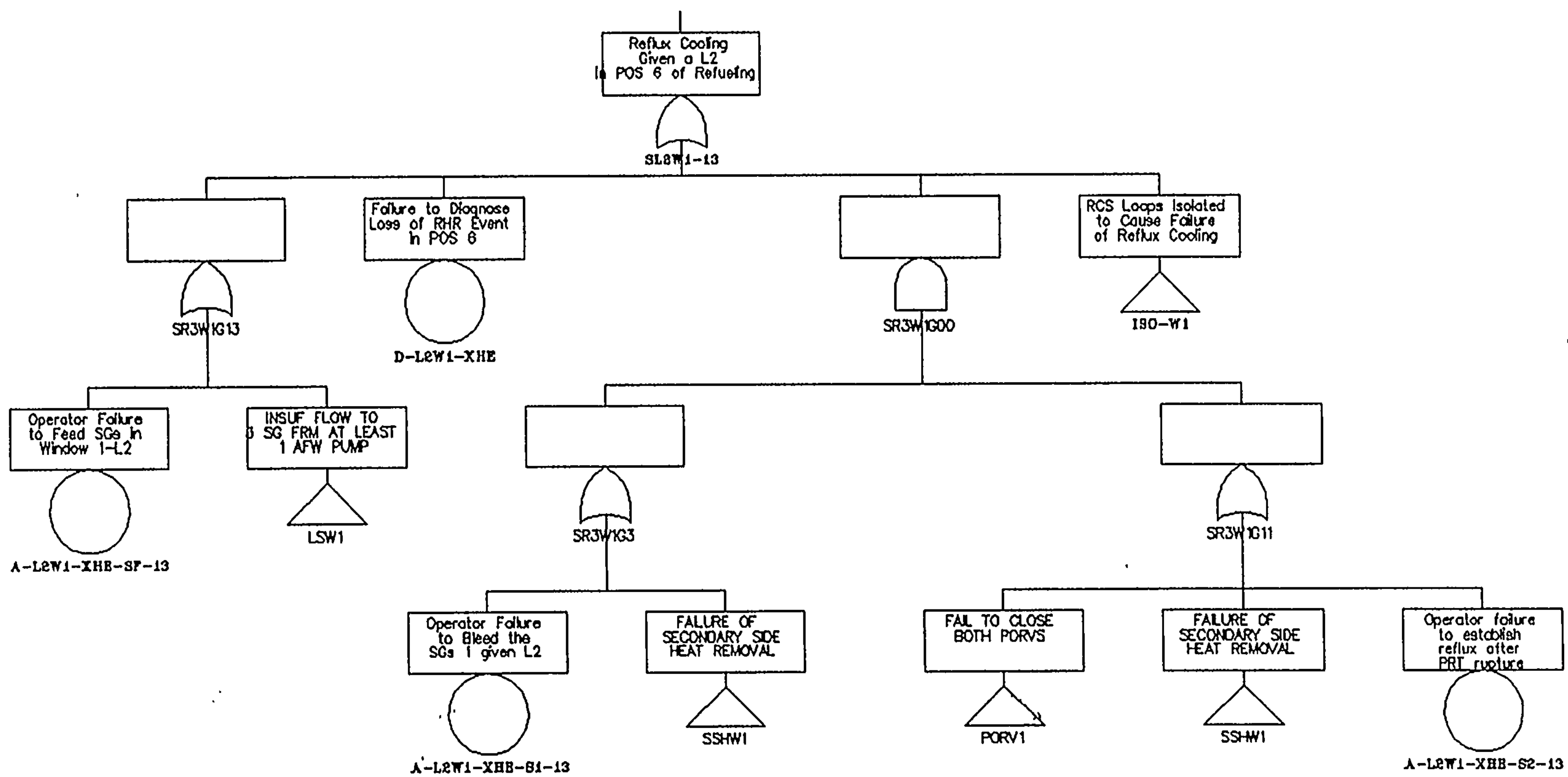
Restore RHR given L2 in POS 6 - Refueling



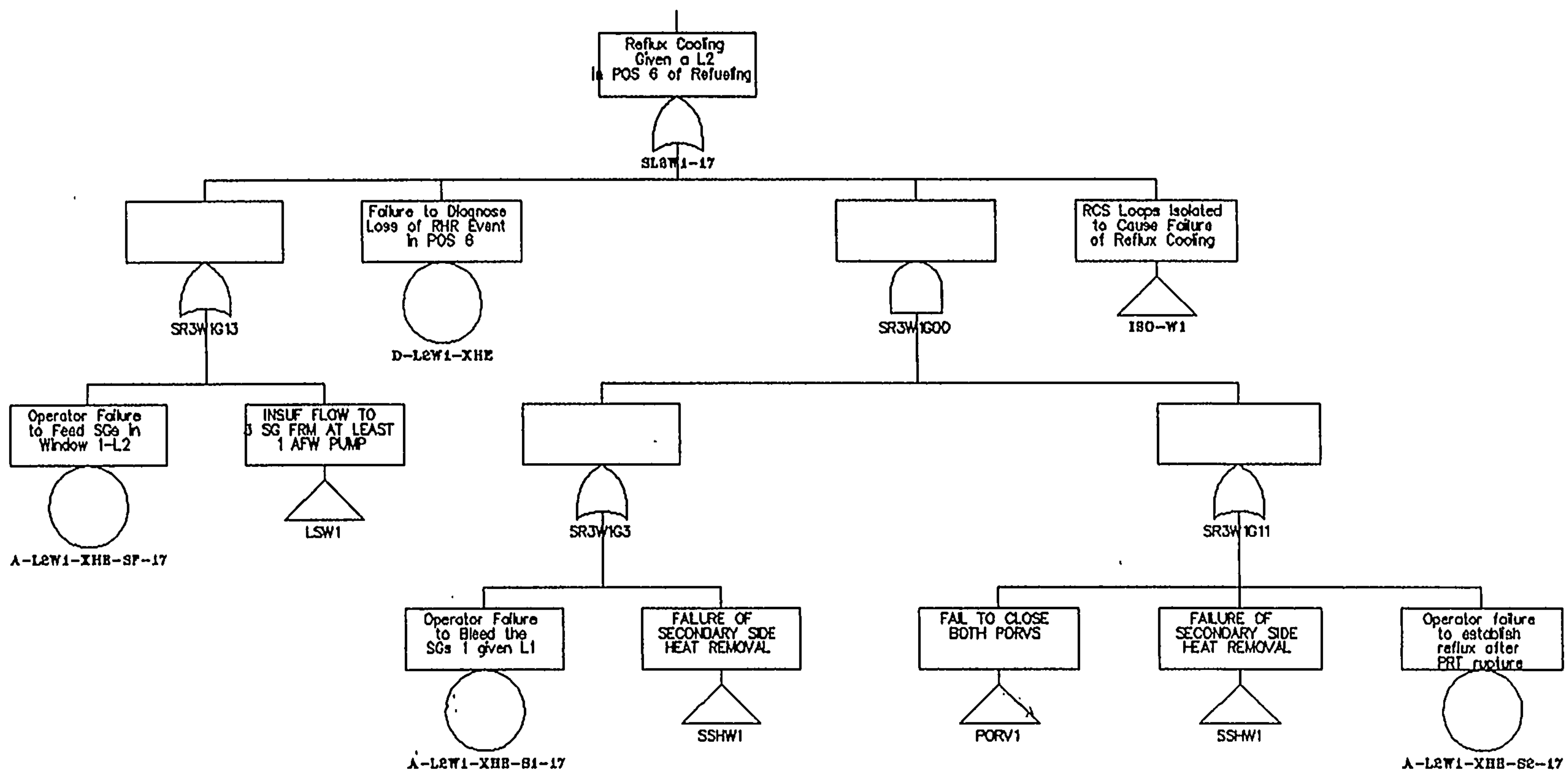
Non-Recovery of AC Power in 144 min. of LOOP



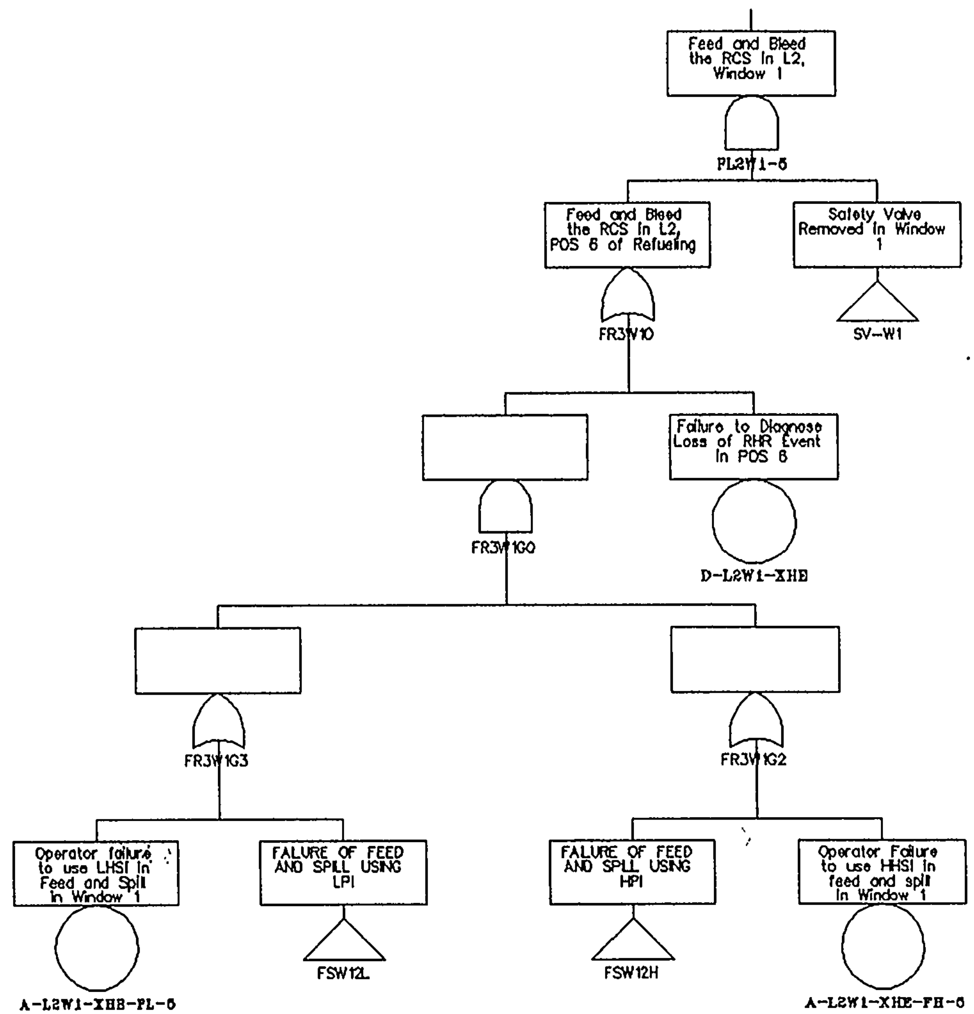
Reflux Cooling in window 1



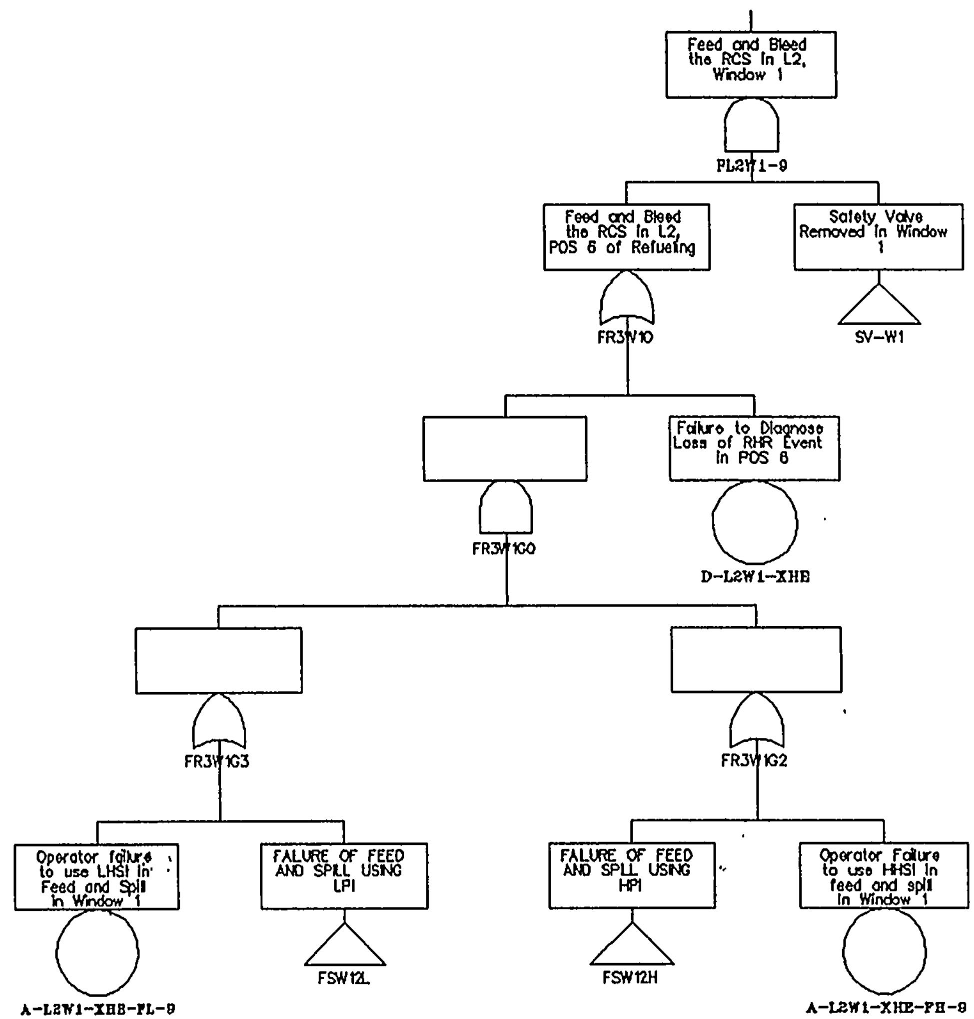
Reflux Cooling in window 1

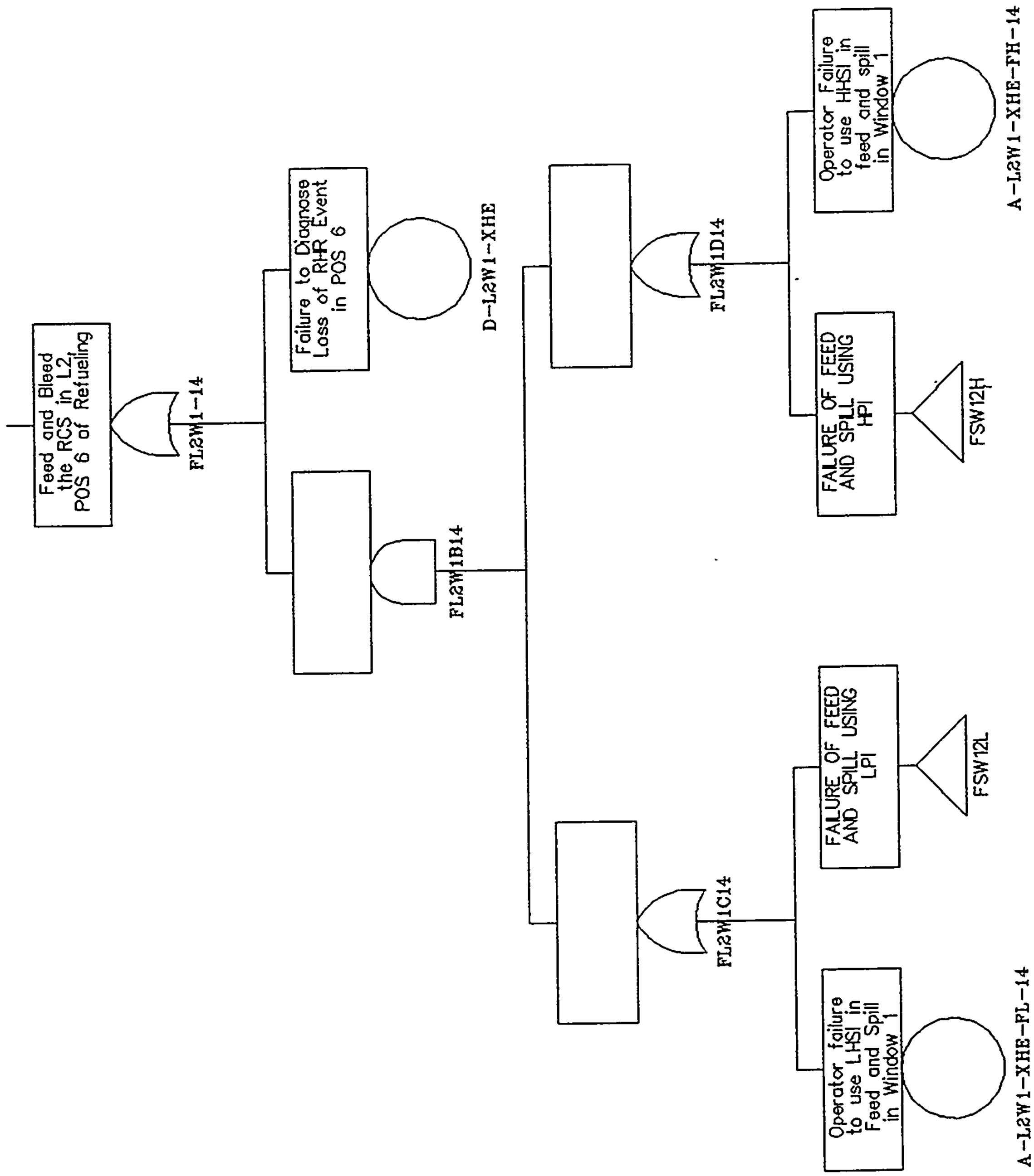


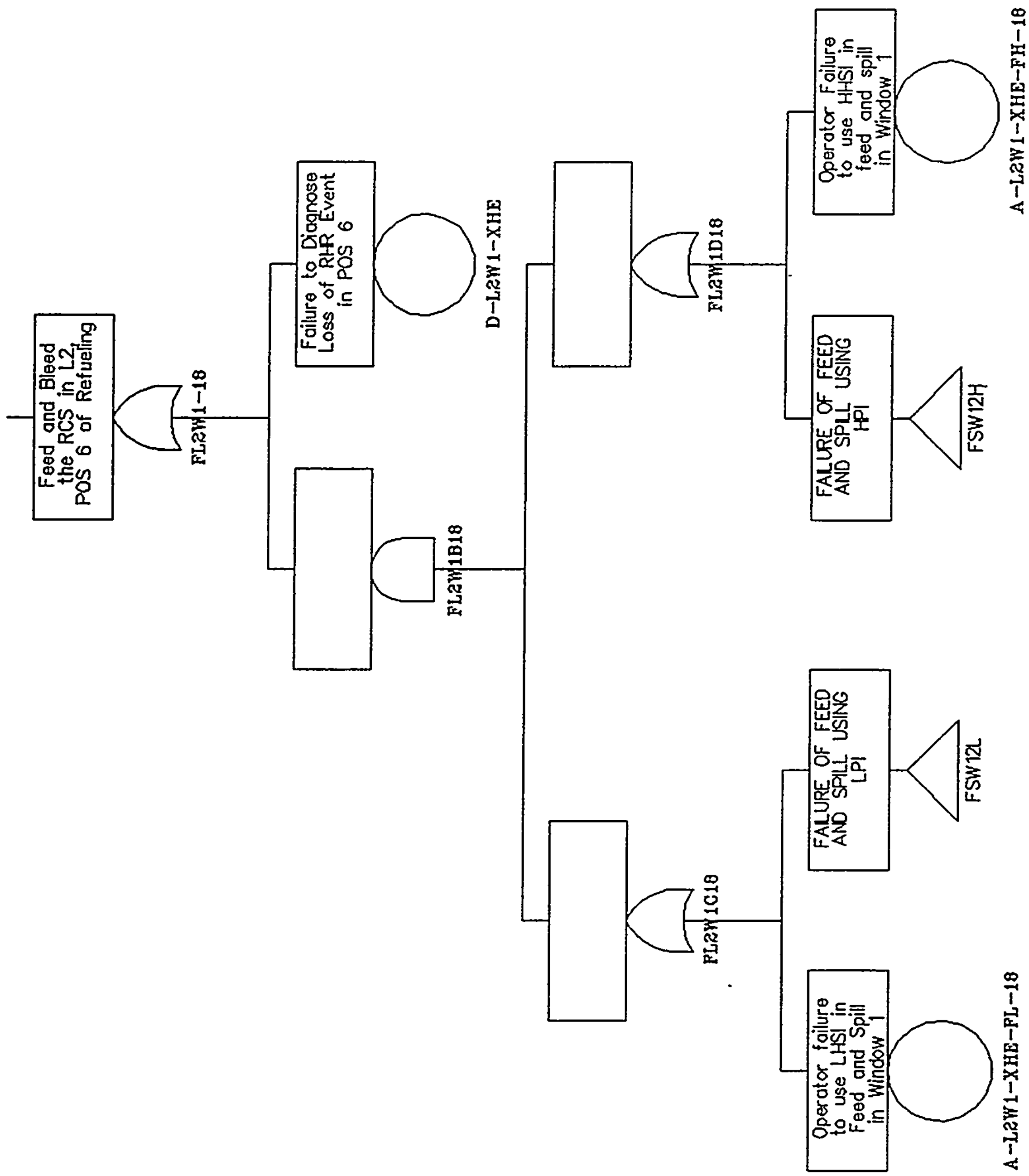
Feed and Bleed the RCS in L2, Window 1



Feed and Bleed the RCS in L2, Window 1

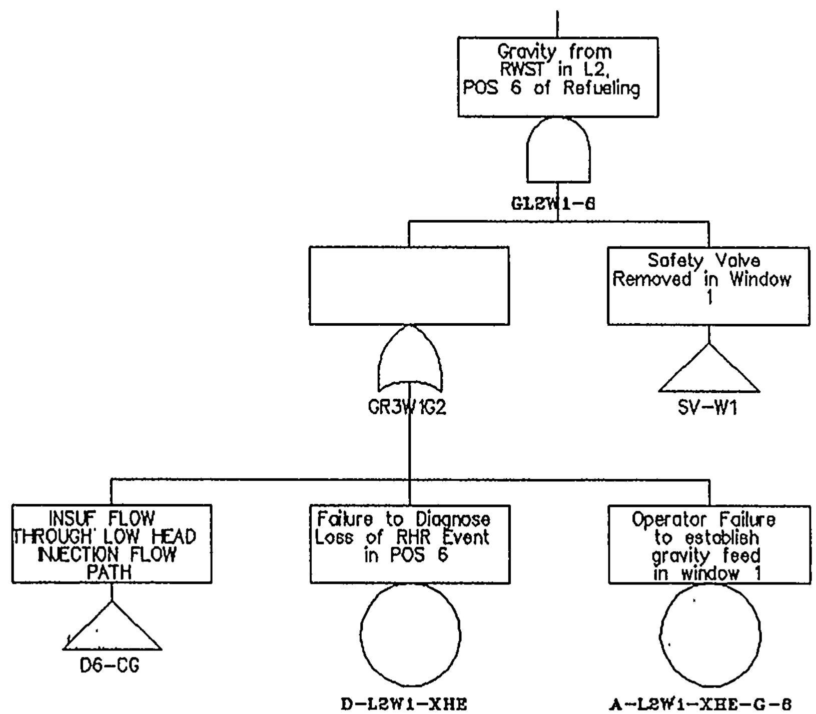



Feed and Bleed the RCS in L2, POS 6 of Refueling
FL2W1-14
Failure to Diagnose Loss of RHR Event in POS 6
D-L2W1-XHE
FL2W1B14
FL2W1D14
FL2W1C14
Operator Failure to use HHSI in feed and spill in Window 1
A-L2W1-XHE-FH-14
FAILURE OF FEED AND SPILL USING HPI
FSW12H
FAILURE OF FEED AND SPILL USING LPI
FSW12L
Operator failure to use LHSI in Feed and Spill in Window 1
A-L2W1-XHE-FL-14

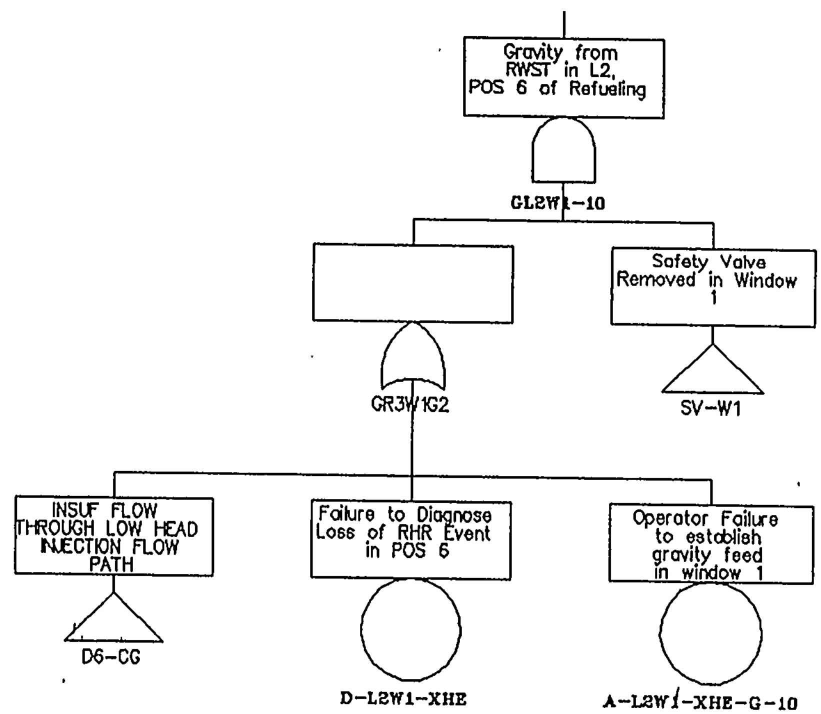


Feed and Bleed the RCS in L2, POS 6 of Refueling
FL2W1-18
Failure to Diagnose Loss of RHR Event in POS 6
D-L2W1-XHE
FL2W1B18
FL2W1D18
FL2W1C18
Operator Failure to use HHSI in feed and spill in Window 1
A-L2W1-XHE-FH-18
FAILURE OF FEED AND SPILL USING HPI
FSW12H
FAILURE OF FEED AND SPILL USING LPI
FSW12L
Operator failure to use LHSI in Feed and Spill in Window 1
A-L2W1-XHE-FL-18

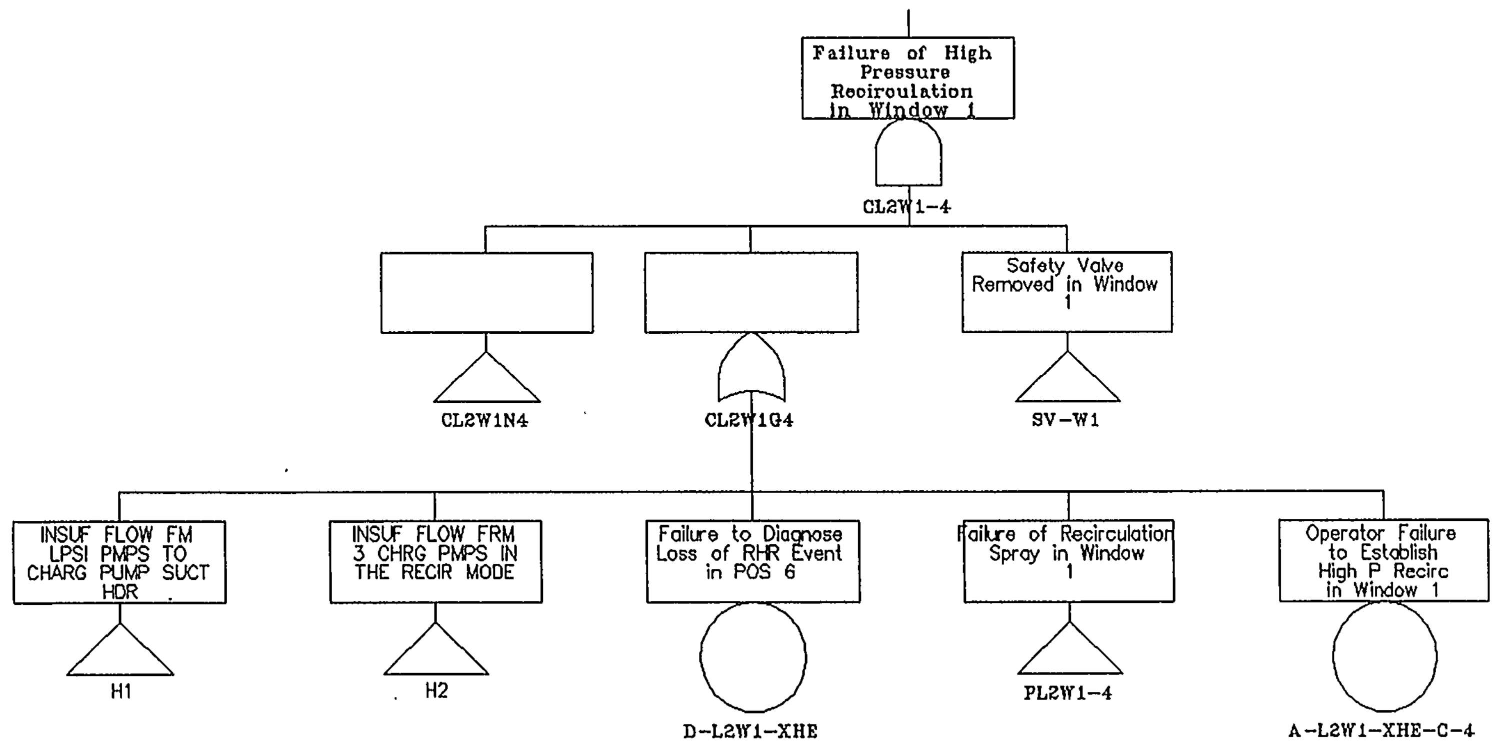
Gravity from RWST in L2, Window 1



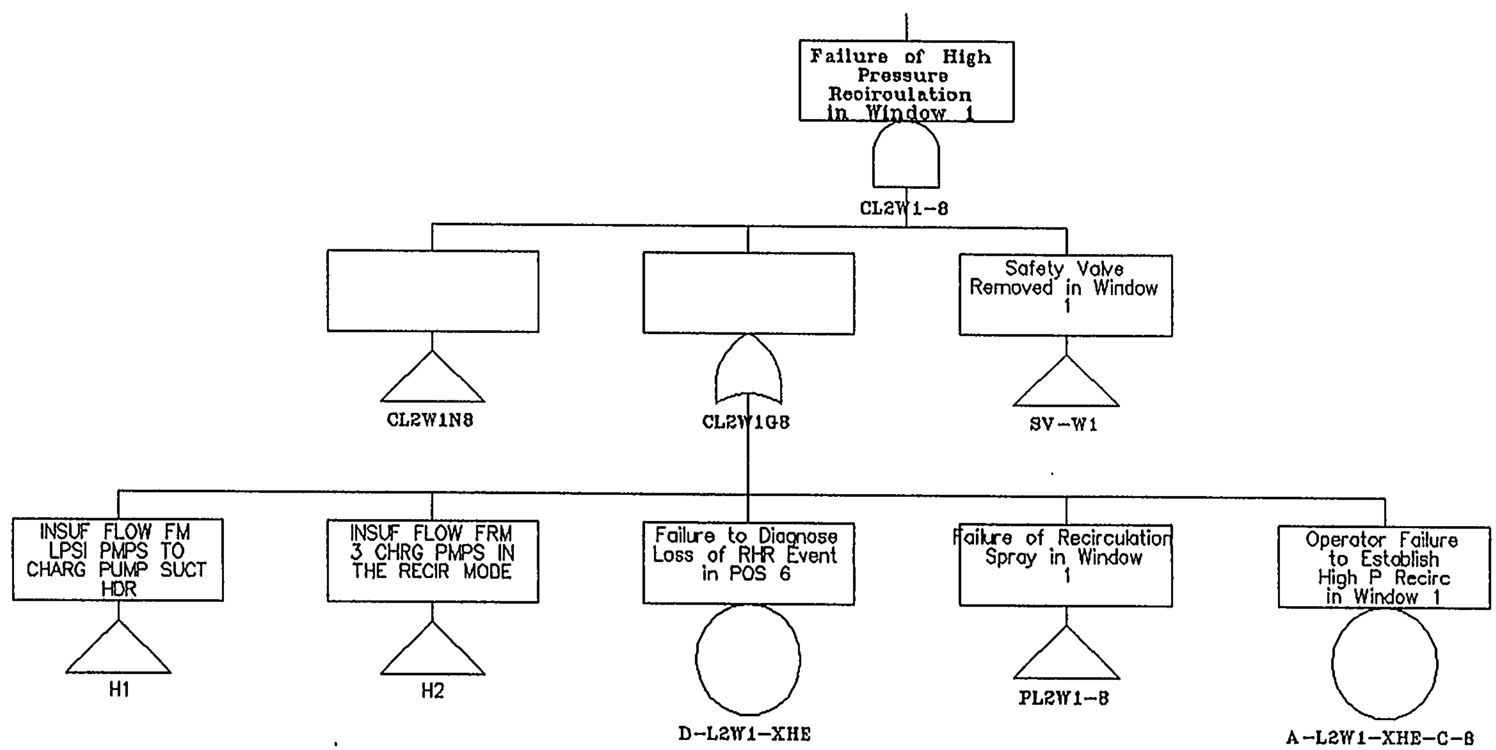
Gravity from RWST in L2, Window 1



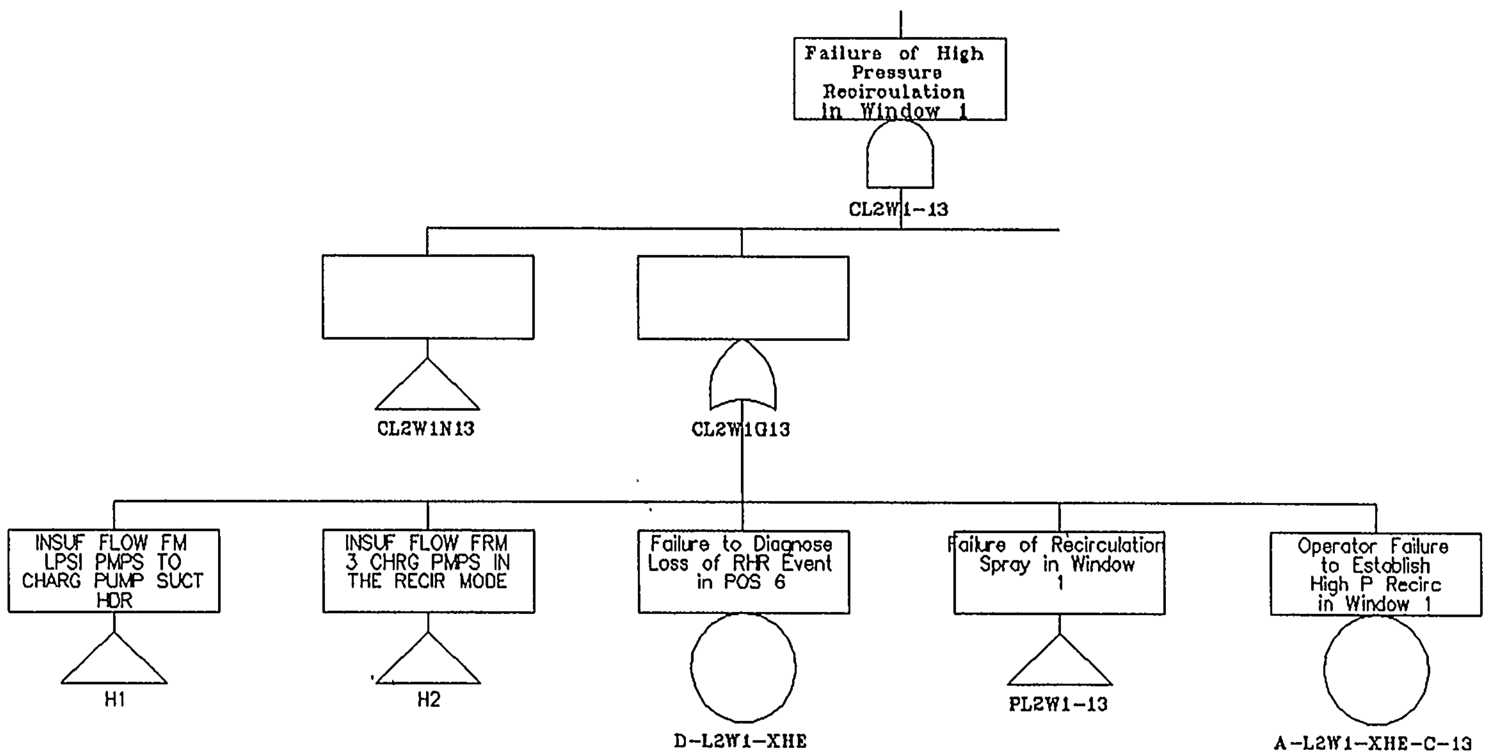
Failure of High Pressure Recirculation in Window 1



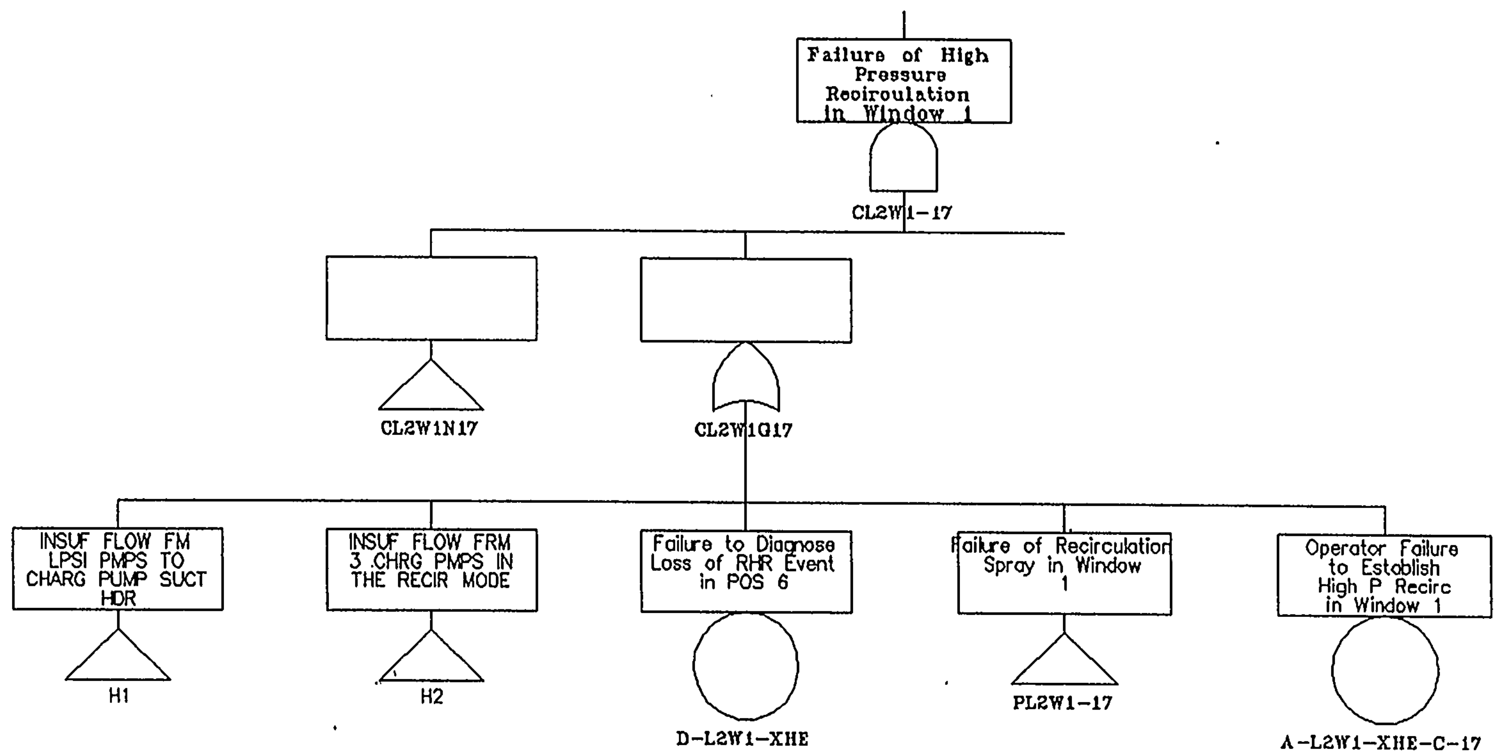
Failure of High Pressure Recirculation in Window 1

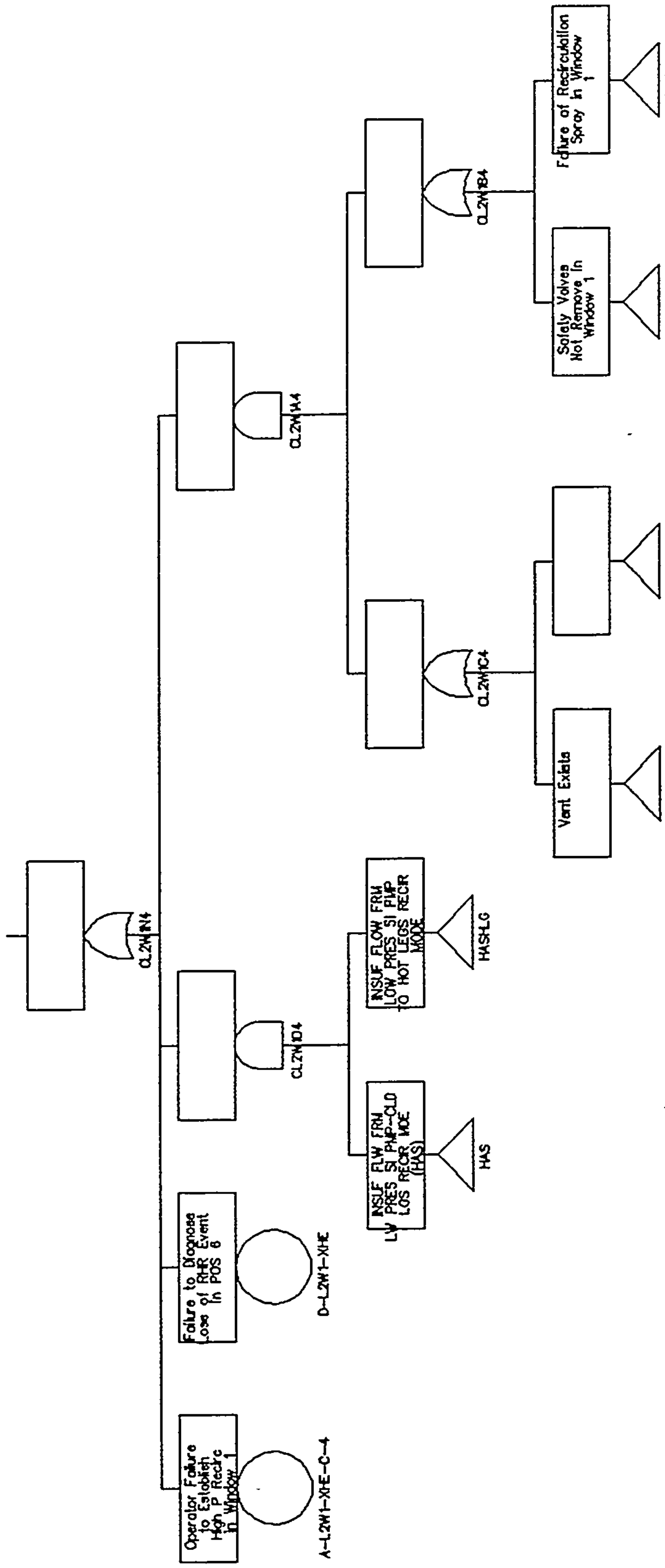


Failure of High Pressure Recirculation in Window 1

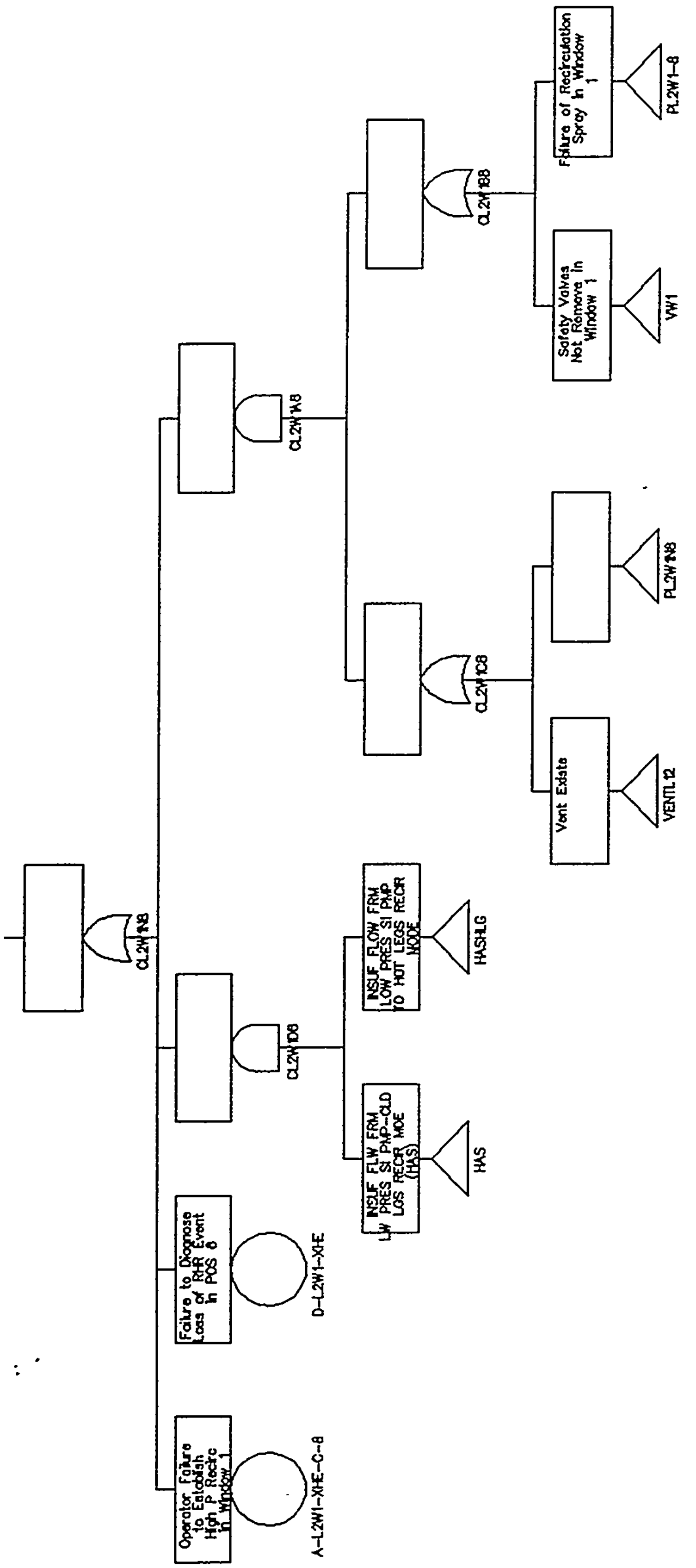


Failure of High Pressure Recirculation in Window 1

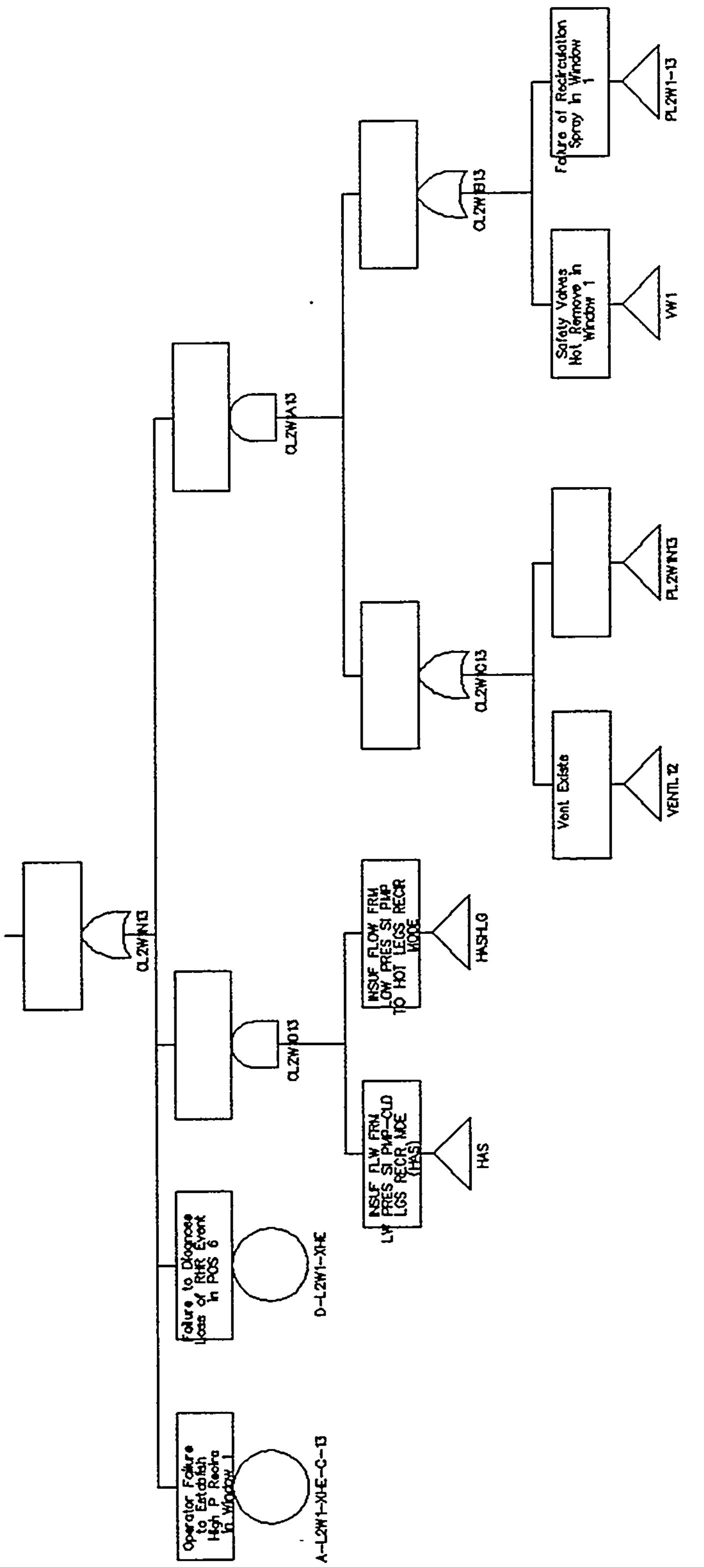


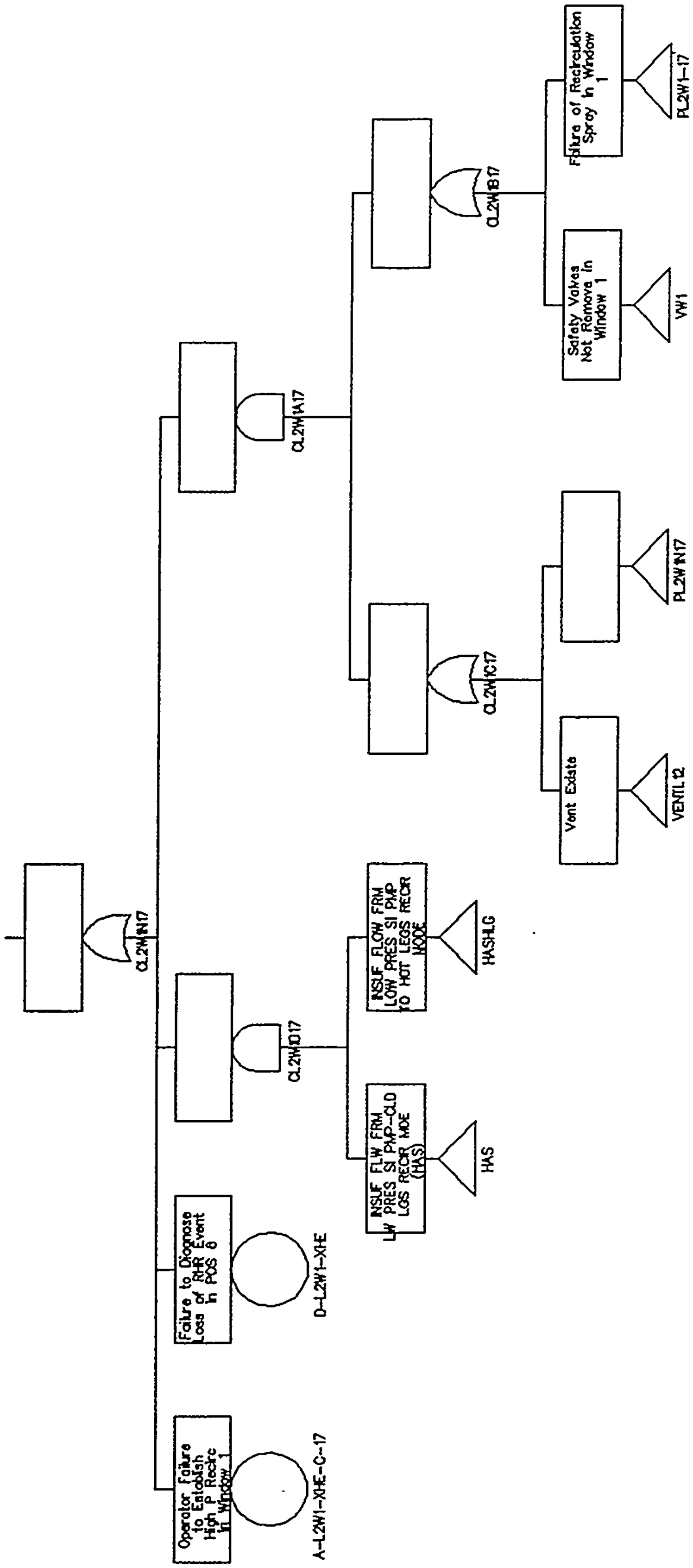


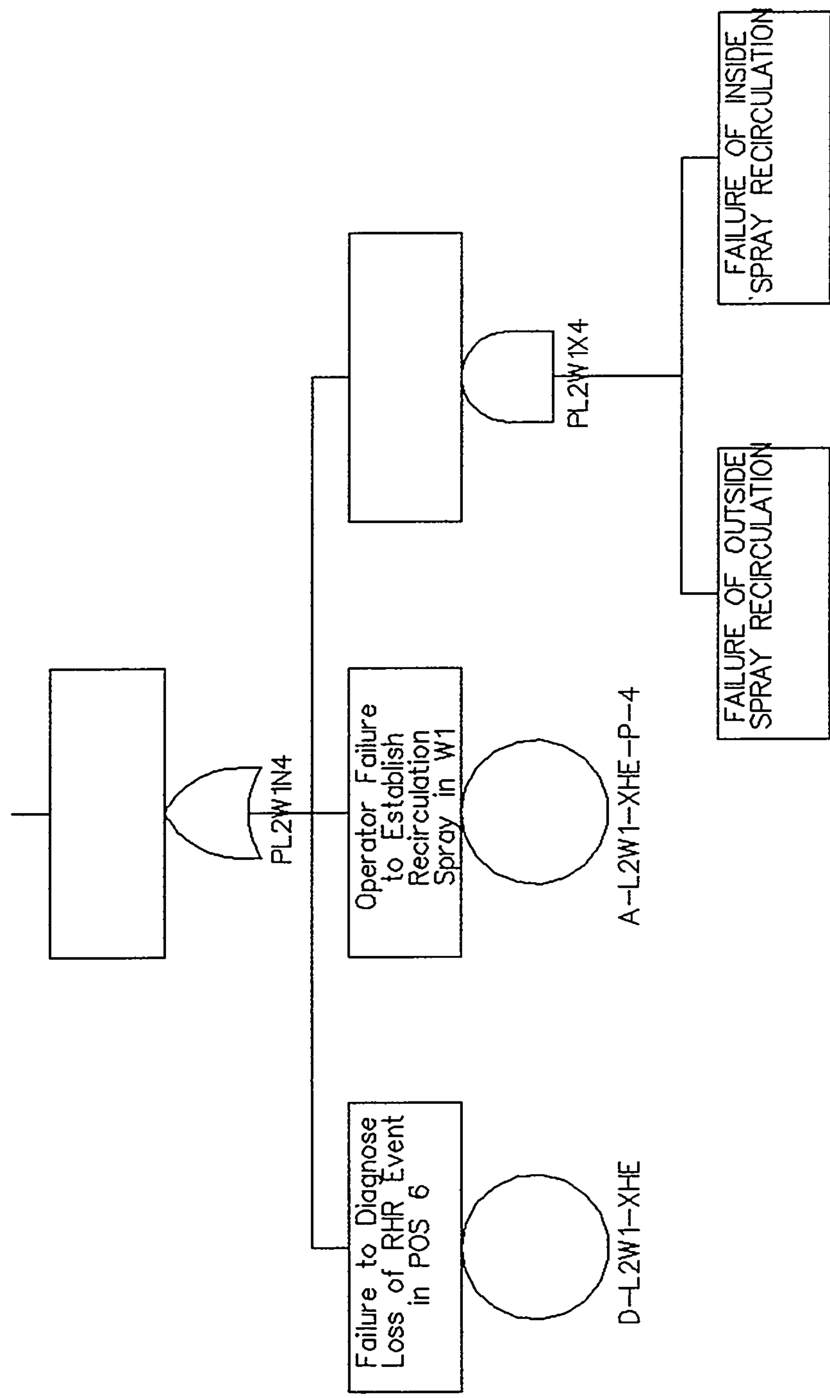
Failure of Recirculation Spray In Window 1
PL2W1-4
CL2W1B4
Safety Valves Not Remove In Window 1
VW1
CL2W1A4
PL2W1N4
CL2W1C4
Vent Exists
VENTL12
CL2W1N4
INSUF FLOW FRM LOW PRES SI PMP TO HOT LEGS RECIR MODE
HASHLG
CL2W1D4
INSUF FLW FRM LW PRES SI PMP-CLD LOS RECIR MOE (HAS)
HAS
Failure to Diagnose Loss of RHR Event In POS 6
D-L2W1-XHE
Operator Failure to Establish High P Recirc In Window 1
A-L2W1-XHE-C-4

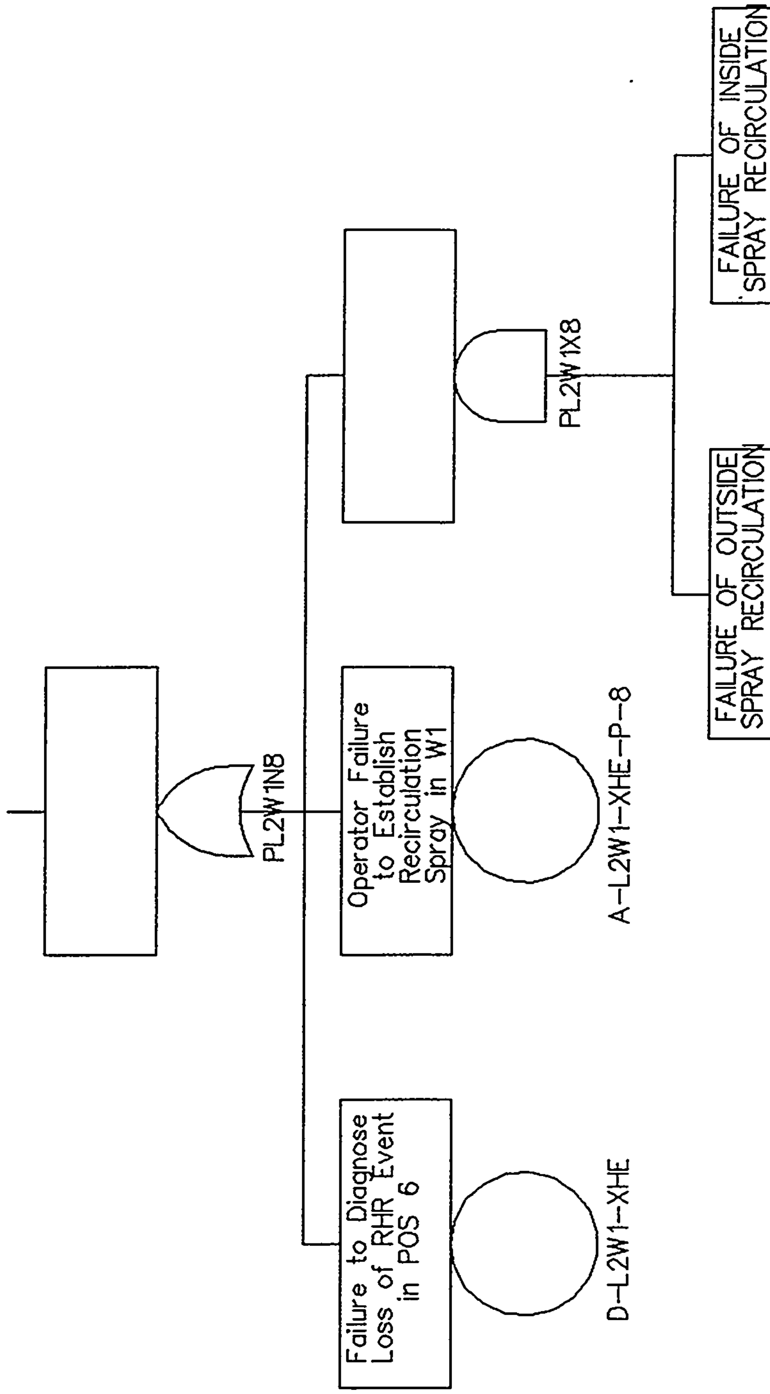


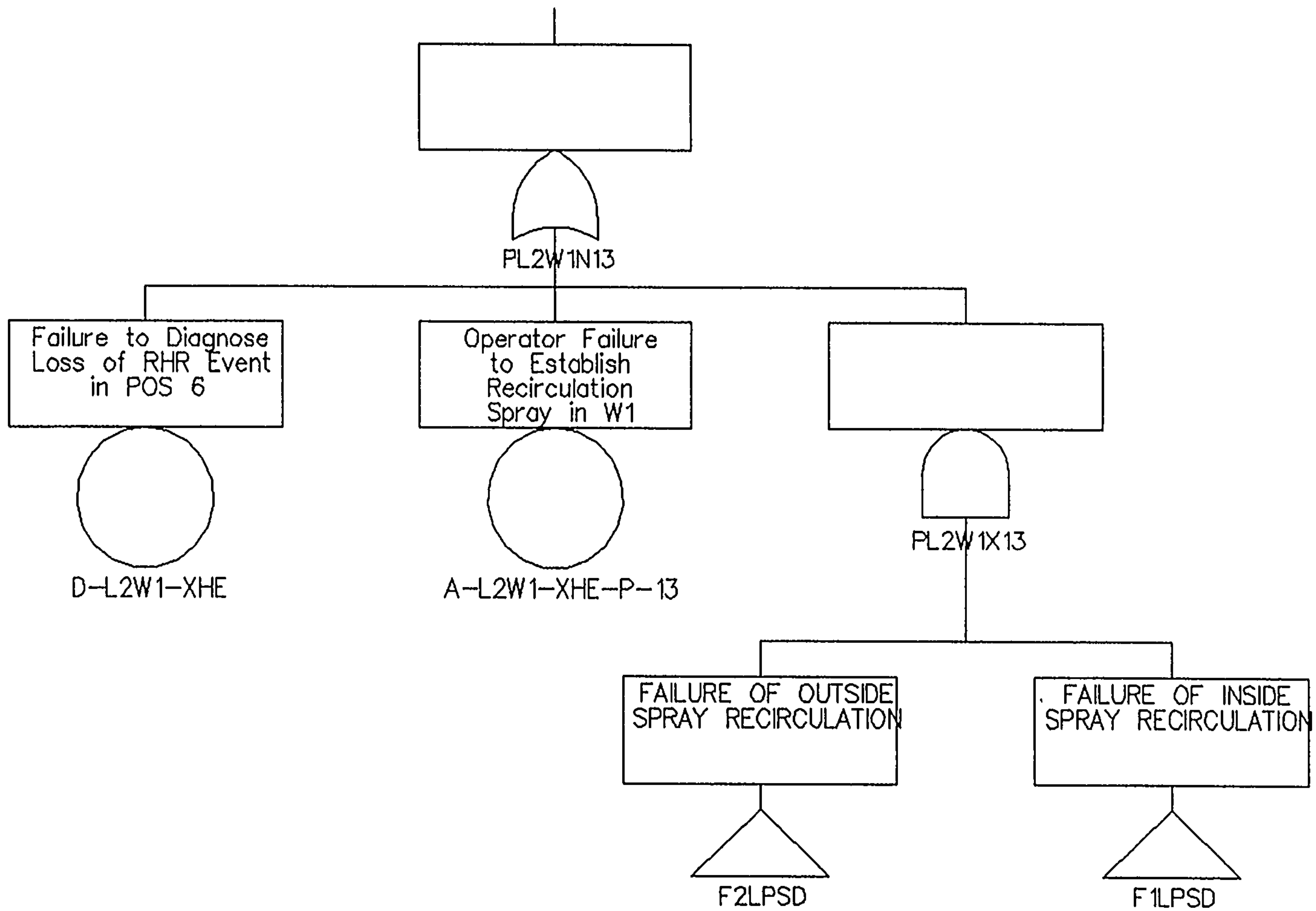
CL2W1N8
Operator Failure to Establish High P Recirc in Window 1
A-L2W1-XHE-C-8
Failure to Diagnose Loss of RHR Event in POS 8
D-L2W1-XHE
CL2W1D8
INSUF FLW FRM LW PRES SI PMP-CLD LGS RECIR MOE (HAS)
HAS
INSUF FLOW FRM LOW PRES SI PMP TO HOT LEGS RECIR MODE
HASHLG
CL2W1A8
CL2W1C8
Vent Exists
VENTL12
PL2W1N8
CL2W1B8
Safety Valves Not Remove in Window 1
VW1
Failure of Recirculation Spray in Window 1
PL2W1-8

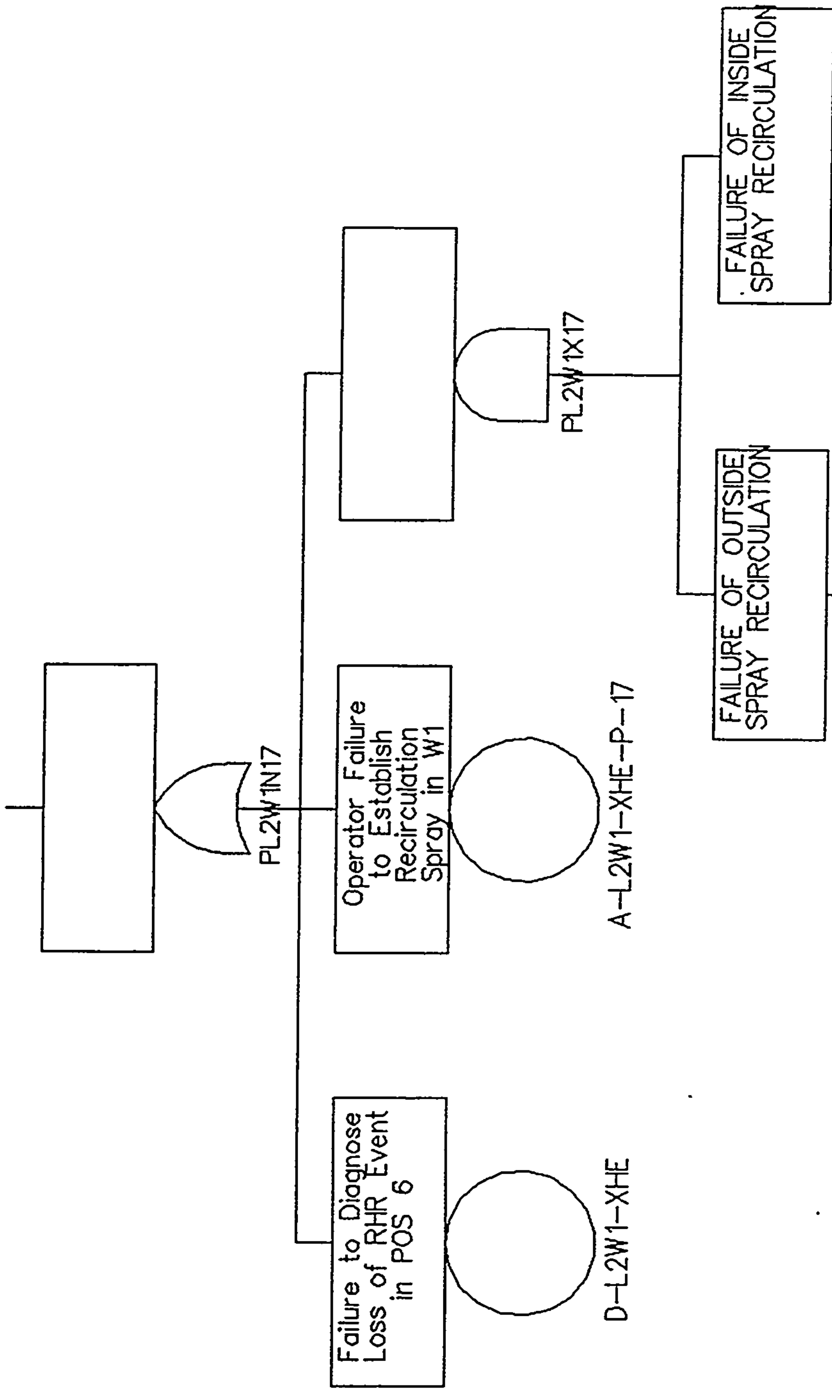

CL2W1N13
CL2W1A13
CL2W1B13
Safety Valves Not Remove in Window 1
VW1
Failure of Recirculation Spray in Window 1
PL2W1-13
CL2W1C13
Vent Exists
VENTL12
PL2W1N13
CL2W1D13
INSUF FLW FRM LW PRES SI PMP-CLD LGS RECIR MOE (HAS)
HAS
INSUF FLOW FRM LOW PRES SI PMP TO HOT LEGS RECIR MODE
HASHLG
Failure to Diagnose Loss of RHR Event in POS 6
D-L2W1-XHE
Operator Failure to Establish High P Recirc in Window 1
A-L2W1-XHE-C-13

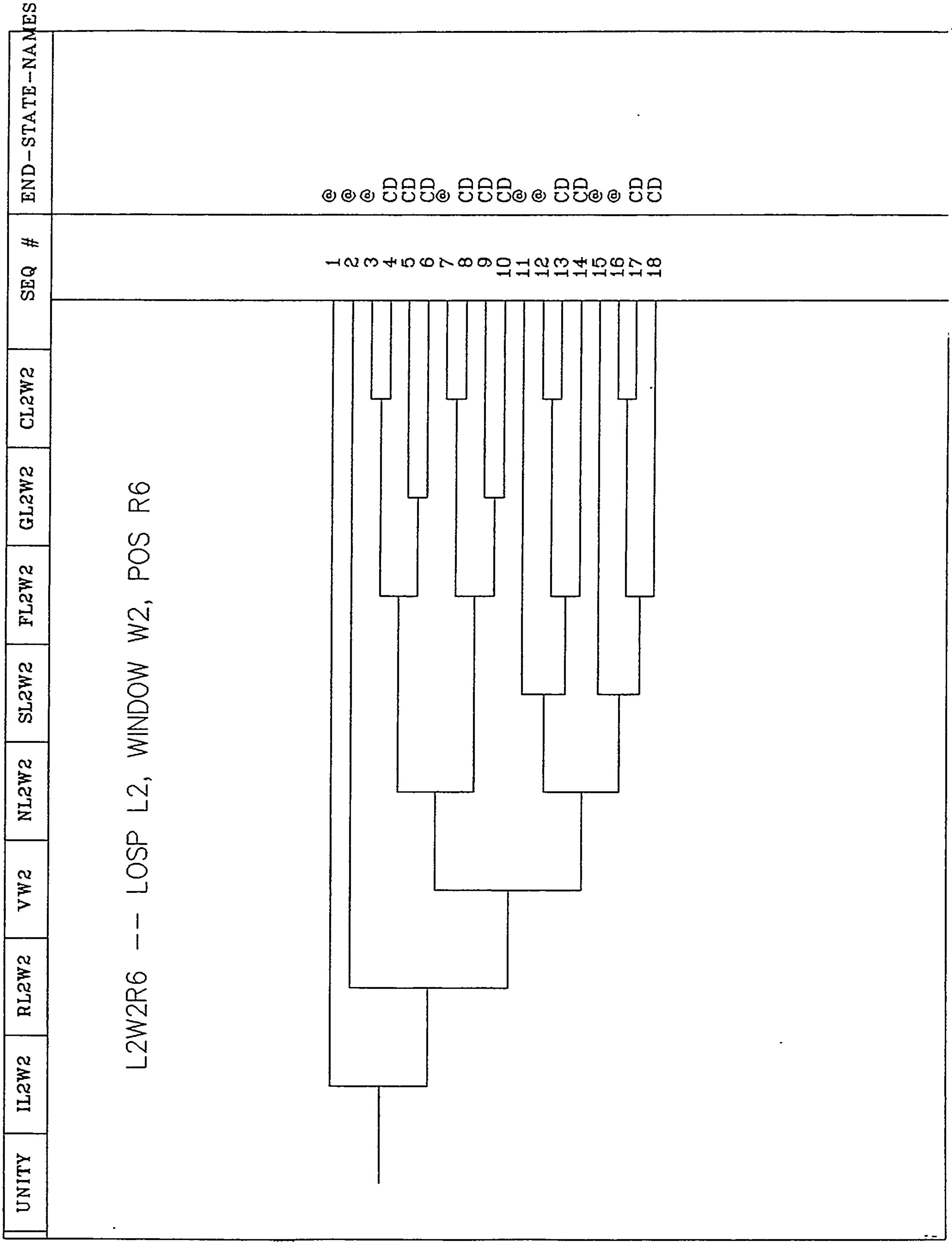

CL2W1N17
CL2W1A17
CL2W1B17
CL2W1C17
CL2W1D17
Operator Failure to Establish High P Recirc In Window 1
A-L2W1-XHE-C-17
Failure to Diagnose Loss of RHR Event In POS 8
D-L2W1-XHE
INSUF FLW FRM LW PRES SI PMP-CLD LGS RECIR MDE (HAS)
HAS
INSUF FLOW FRM LOW PRES SI PMP TO HOT LEGS RECIR MODE
HASHLG
Vent Exists
VENTL12
PL2W1N17
Safety Valves Not Remove In Window 1
VW1
Failure of Recirculation Spray In Window 1
PL2W1-17

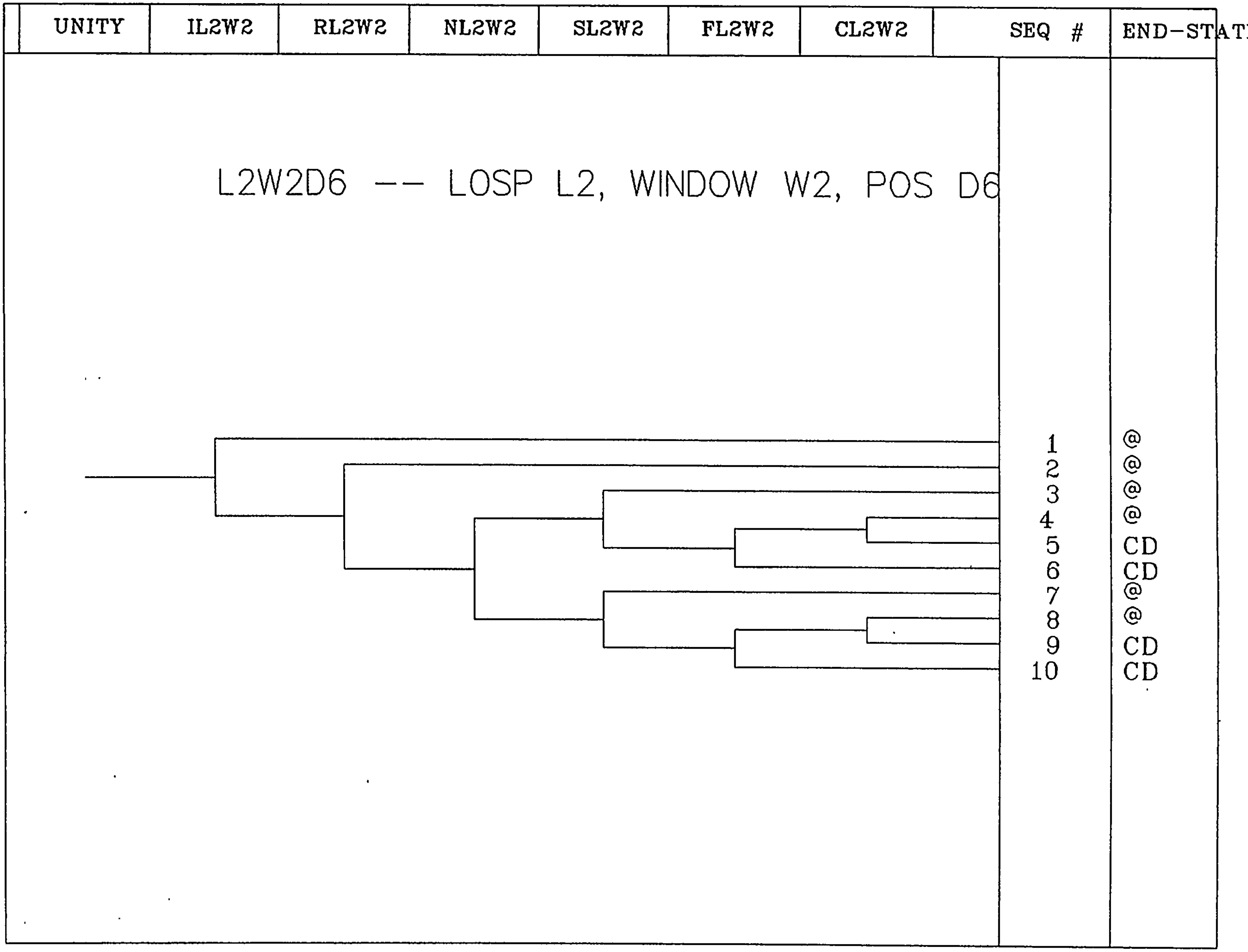

PL2W1N4
Failure to Diagnose Loss of RHR Event in POS 6
D-L2W1-XHE
Operator Failure to Establish Recirculation Spray in W1
A-L2W1-XHE-P-4
PL2W1X4
FAILURE OF OUTSIDE SPRAY RECIRCULATION
F2LPSD
FAILURE OF INSIDE SPRAY RECIRCULATION
F1LPSD


PL2W1N8
Failure to Diagnose Loss of RHR Event in POS 6
D-L2W1-XHE
Operator Failure to Establish Recirculation Spray in W1
A-L2W1-XHE-P-8
PL2W1X8
FAILURE OF OUTSIDE SPRAY RECIRCULATION
F2LPSD
FAILURE OF INSIDE SPRAY RECIRCULATION
F1LPSD

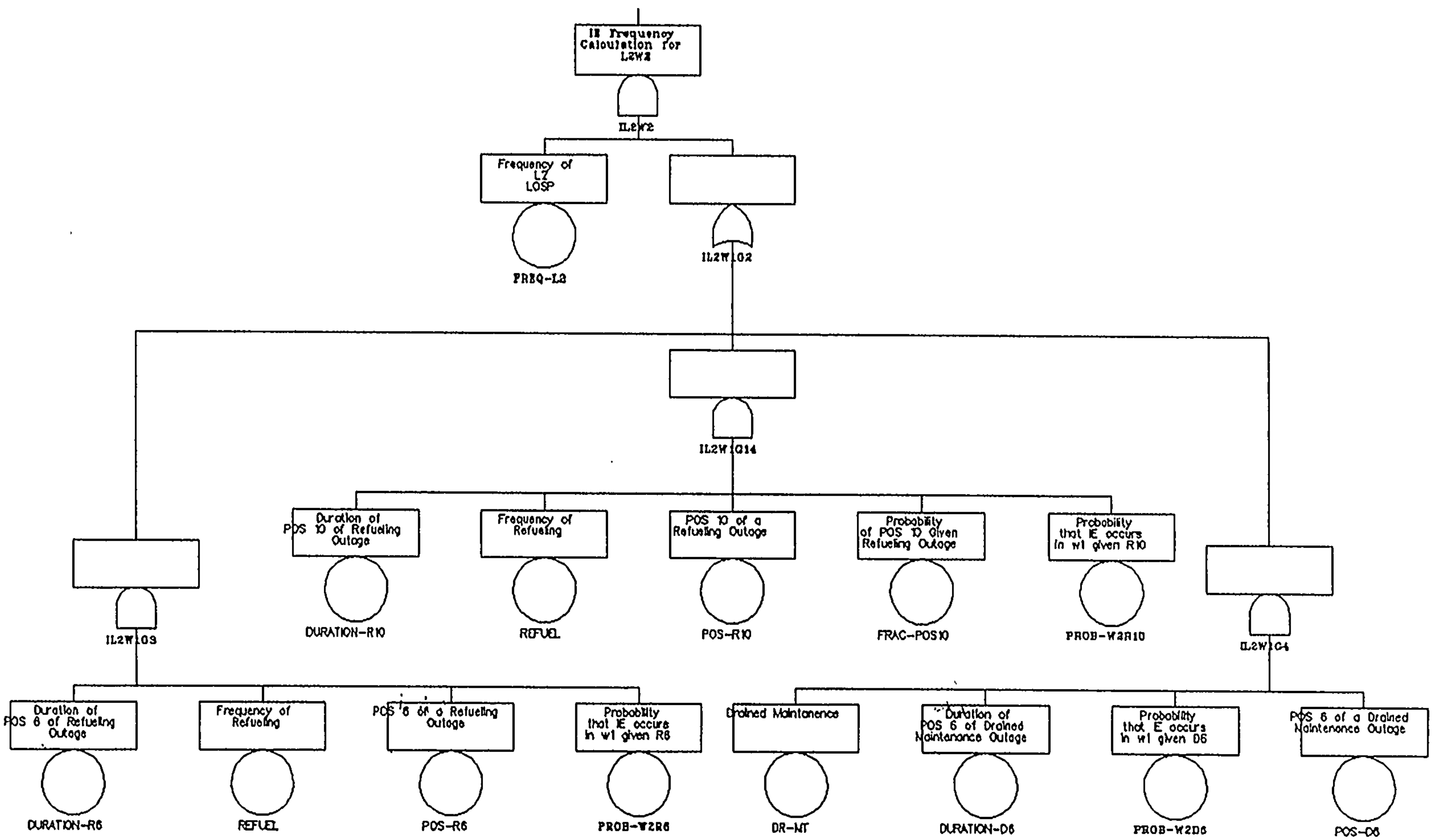

PL2W1N13
Failure to Diagnose Loss of RHR Event in POS 6
D-L2W1-XHE
Operator Failure to Establish Recirculation Spray in W1
A-L2W1-XHE-P-13
PL2W1X13
FAILURE OF OUTSIDE SPRAY RECIRCULATION
F2LPSD
FAILURE OF INSIDE SPRAY RECIRCULATION
F1LPSD


PL2W1N17
Failure to Diagnose Loss of RHR Event in POS 6
D-L2W1-XHE
Operator Failure to Establish Recirculation Spray in W1
A-L2W1-XHE-P-17
PL2W1X17
FAILURE OF OUTSIDE SPRAY RECIRCULATION
F2LPSD
FAILURE OF INSIDE SPRAY RECIRCULATION
F1LPSD

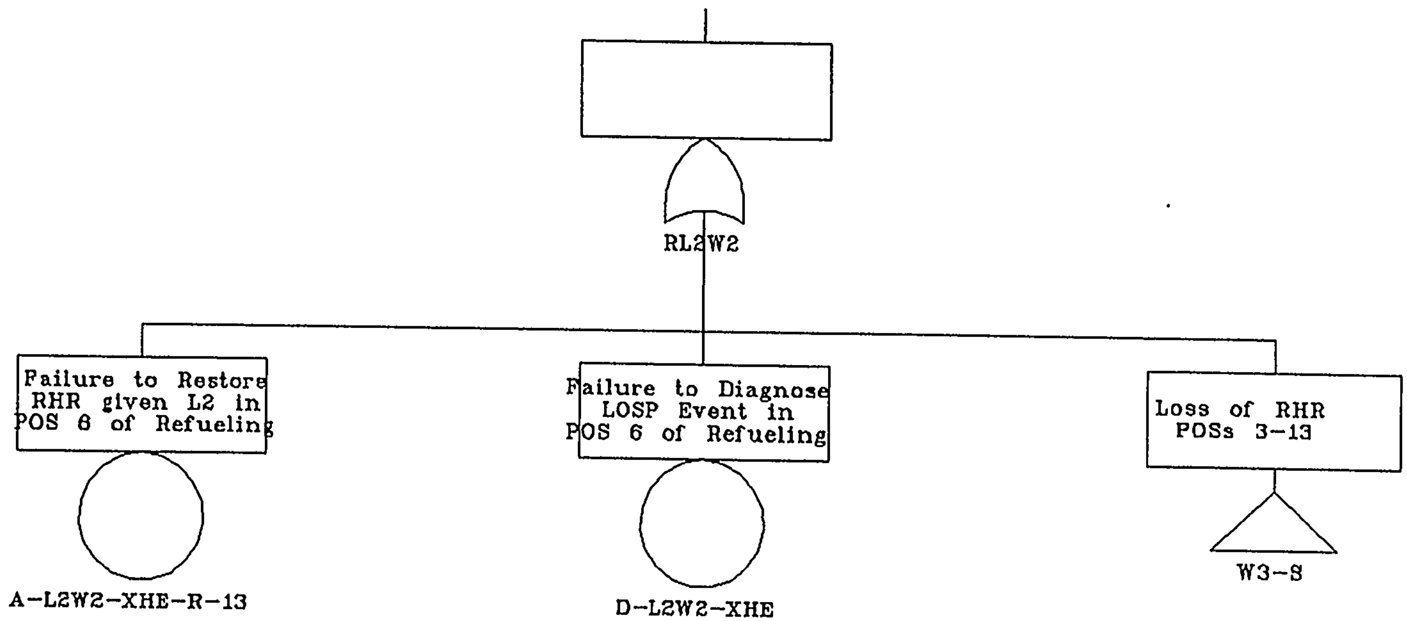

L2W2R6 -- LOSP L2, WINDOW W2, POS R6
UNITY
IL2W2
RL2W2
VW2
NL2W2
SL2W2
FL2W2
GL2W2
CL2W2
SEQ #
END-STATE-NAMES
1 @
2 @
3 @
4 CD
5 CD
6 CD
7 @
8 CD
9 CD
10 CD
11 @
12 @
13 CD
14 CD
15 @
16 @
17 CD
18 CD


UNITY
IL2W2
RL2W2
NL2W2
SL2W2
FL2W2
CL2W2
SEQ #
END-STATE
L2W2D6 -- LOSP L2, WINDOW W2, POS D6
1 @
2 @
3 @
4 @
5 CD
6 CD
7 @
8 @
9 CD
10 CD

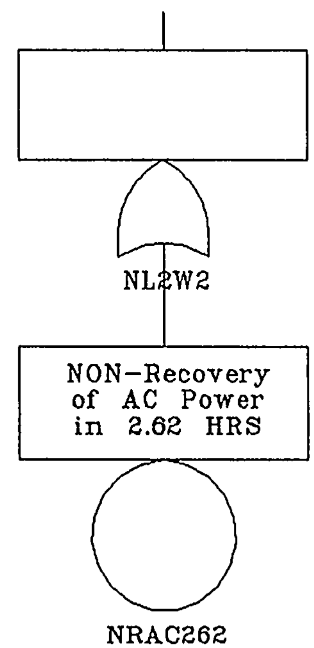
I top event for L2 LOSP – L2 in window 2



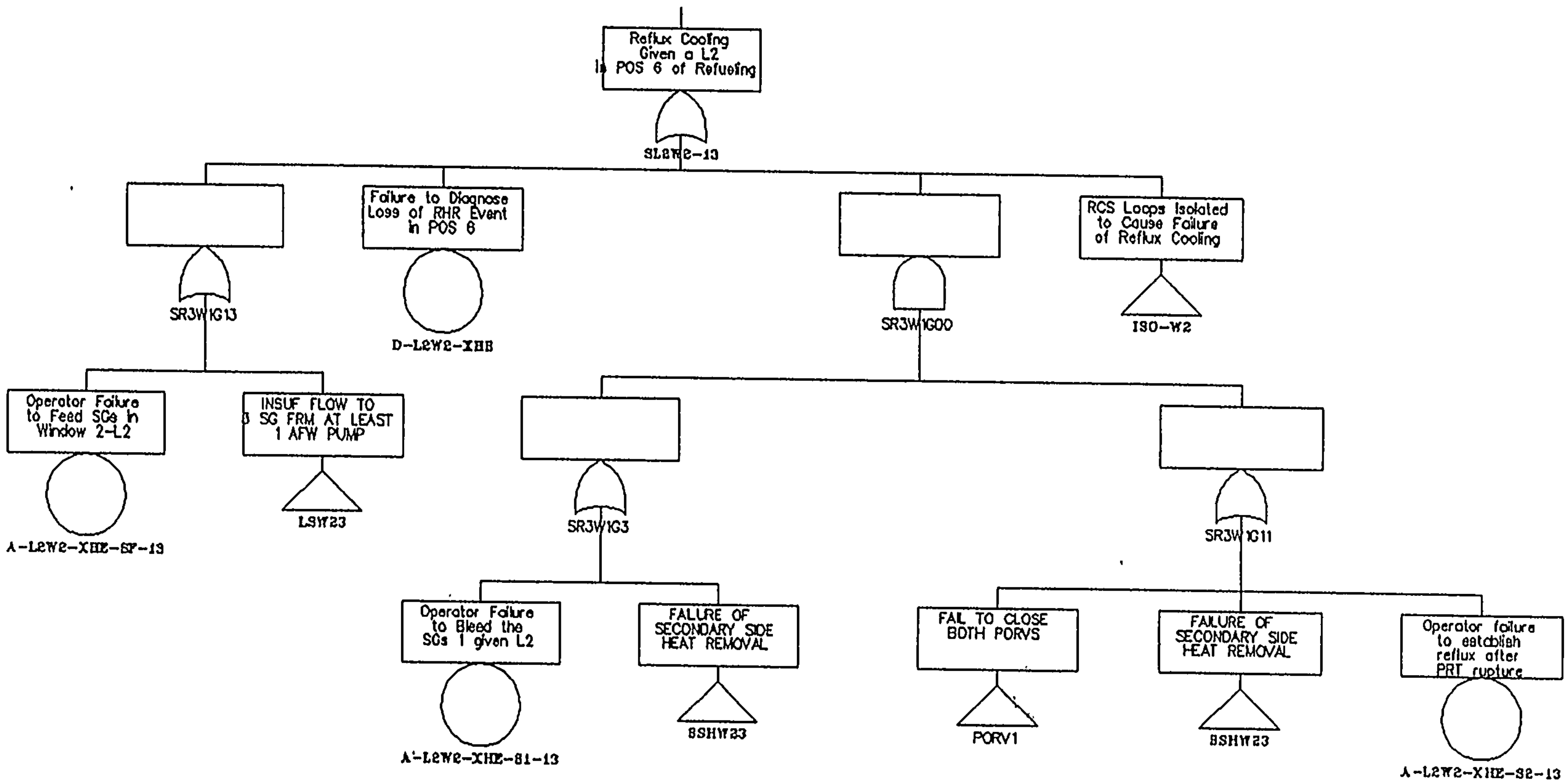
Restore RHR given L2 in POS 6 - Refueling



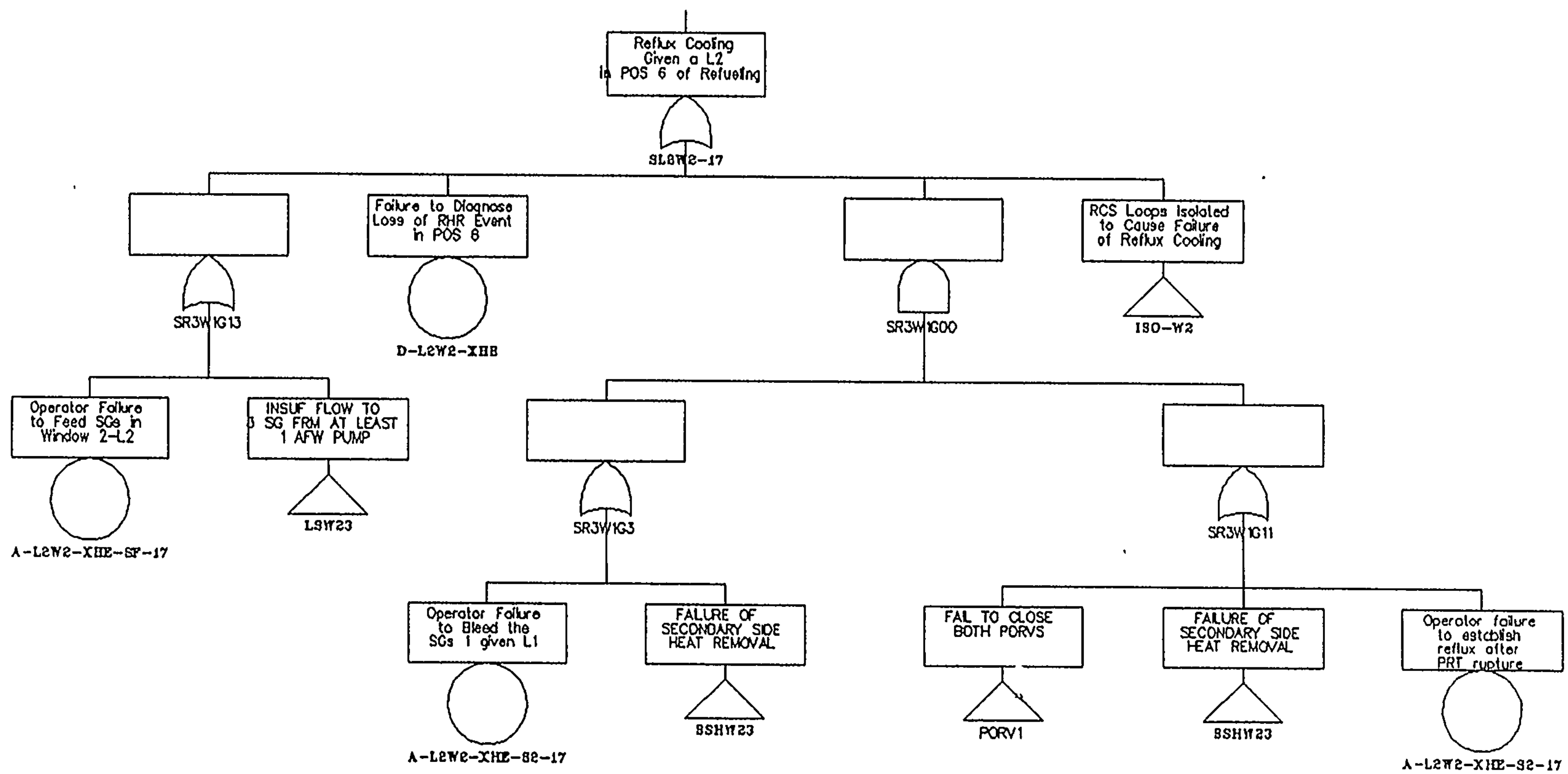
Non-Recovery of AC Power in W2



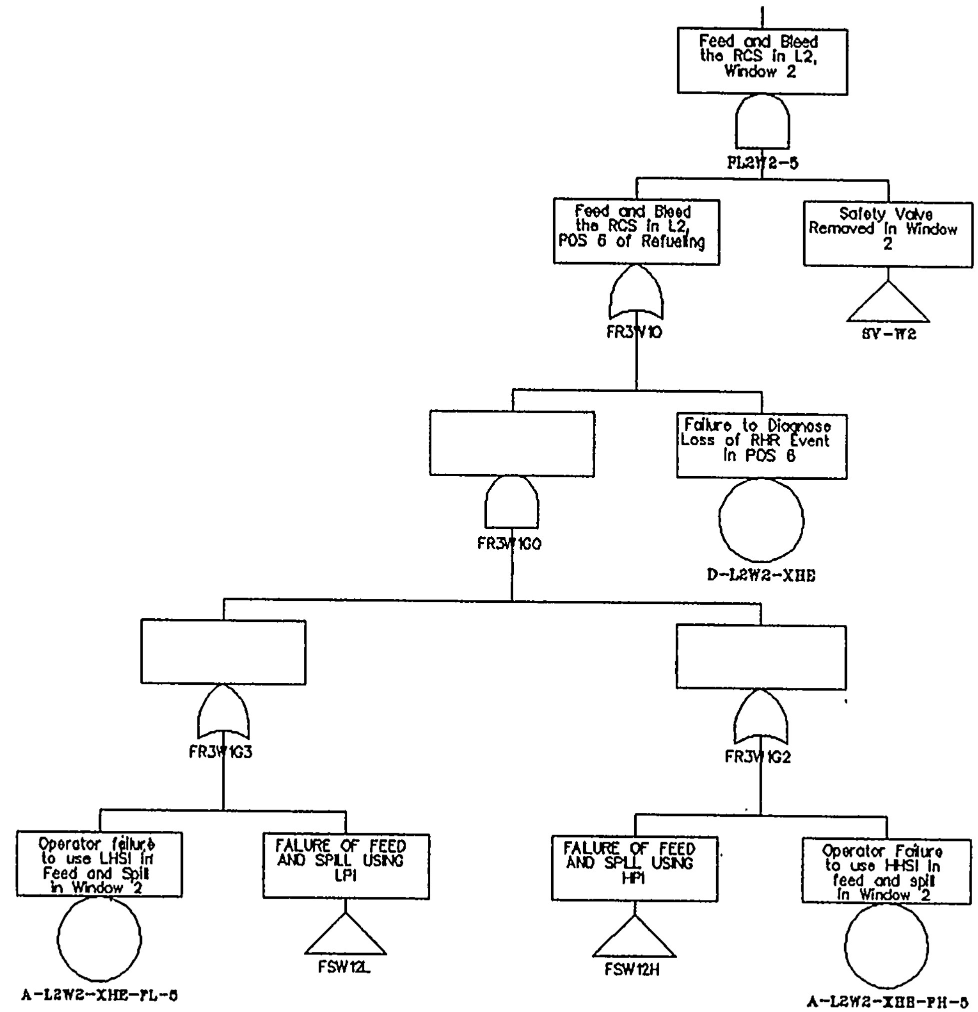
Reflux Cooling in window 2



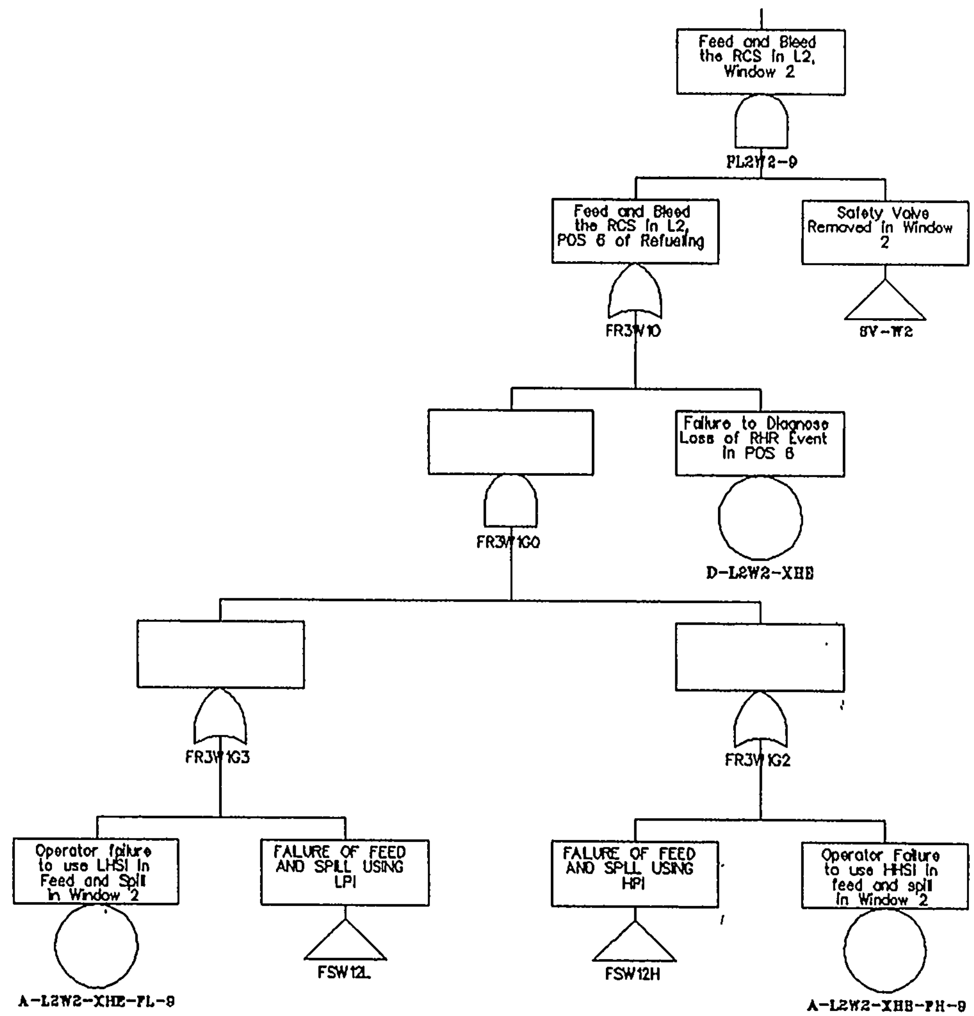
Reflux Cooling in window 2

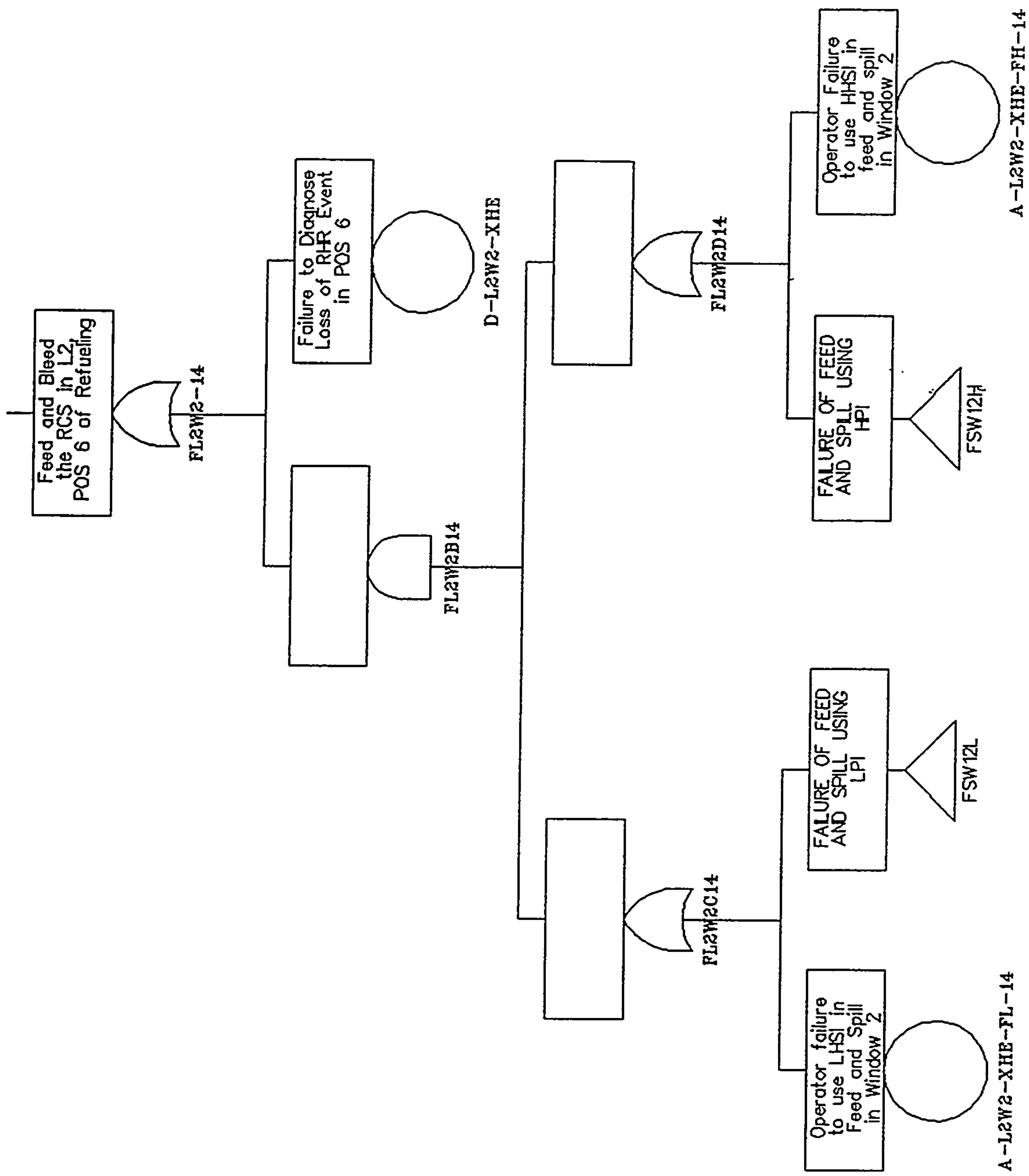


Feed and Bleed the RCS in L2, Window 2

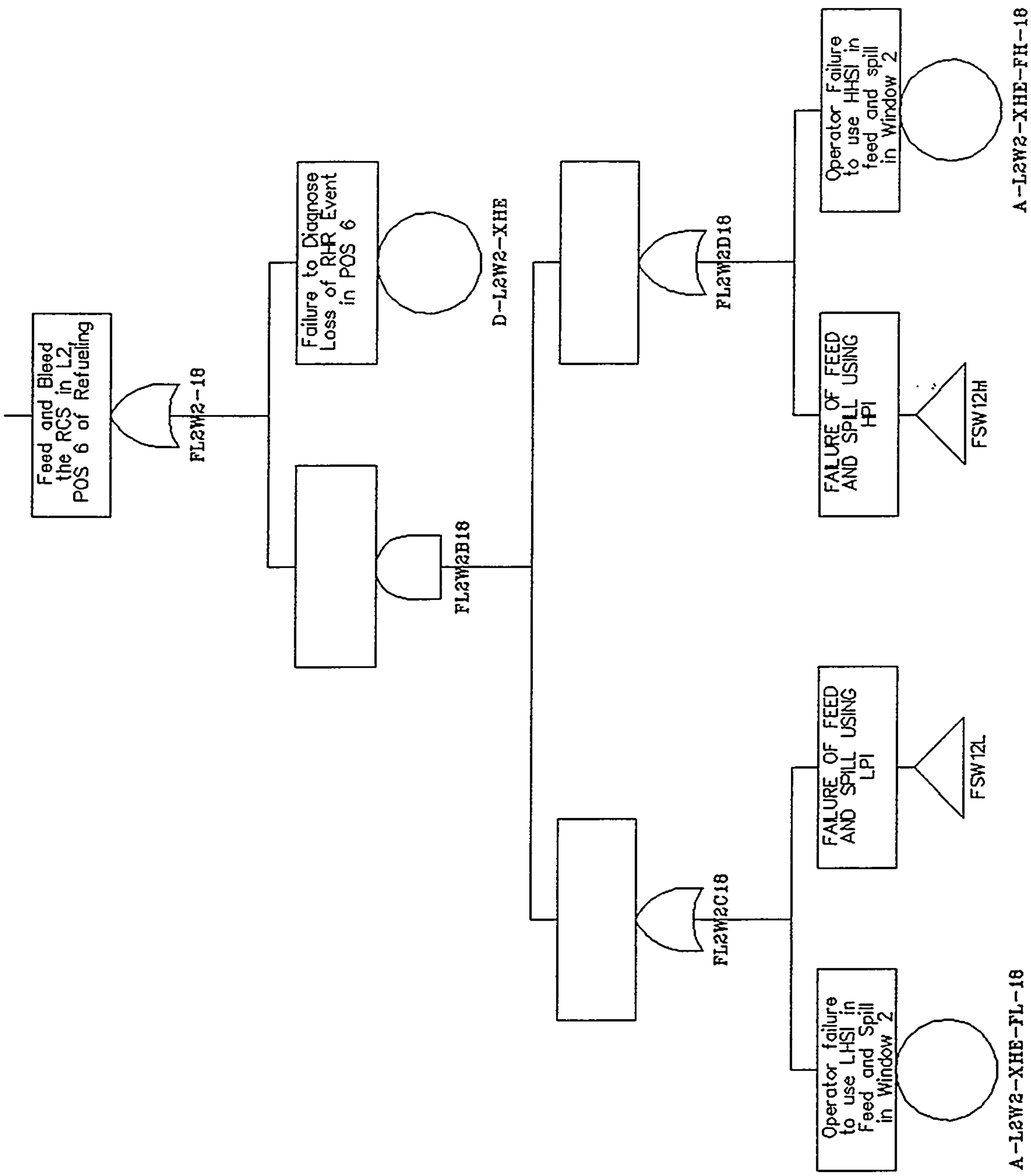


Feed and Bleed the RCS in L2, Window 2



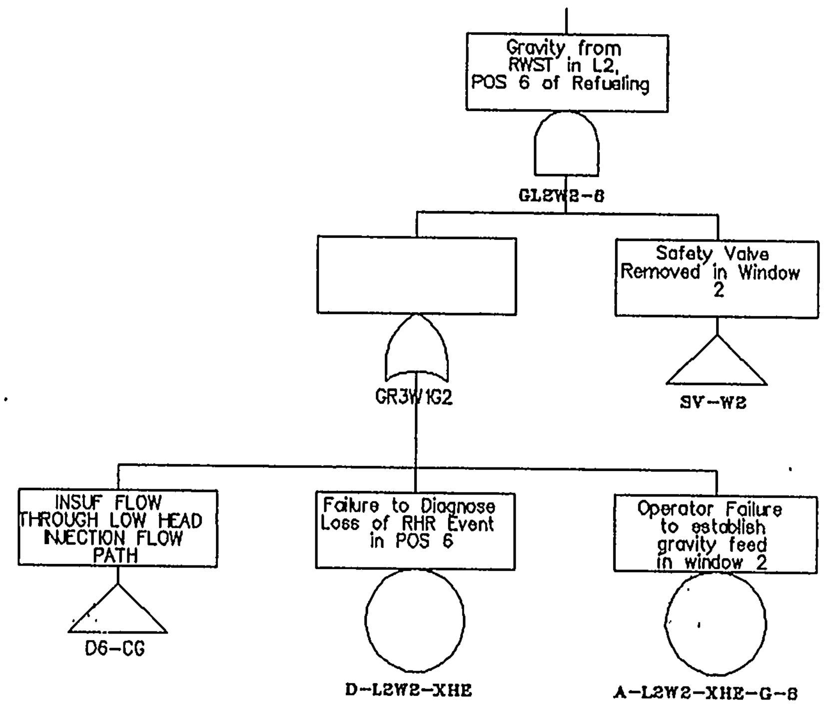


Feed and Bleed the RCS in L2, POS 6 of Refueling
FL2W2-14
Failure to Diagnose Loss of RHR Event in POS 6
D-L2W2-XHE
FL2W2B14
FL2W2D14
FL2W2C14
Operator Failure to use HHSI in feed and spill in Window 2
A-L2W2-XHE-FH-14
FALURE OF FEED AND SPILL USING HPI
FSW12H
FALURE OF FEED AND SPILL USING LPI
FSW12L
Operator failure to use LHSI in Feed and Spill in Window 2
A-L2W2-XHE-FL-14

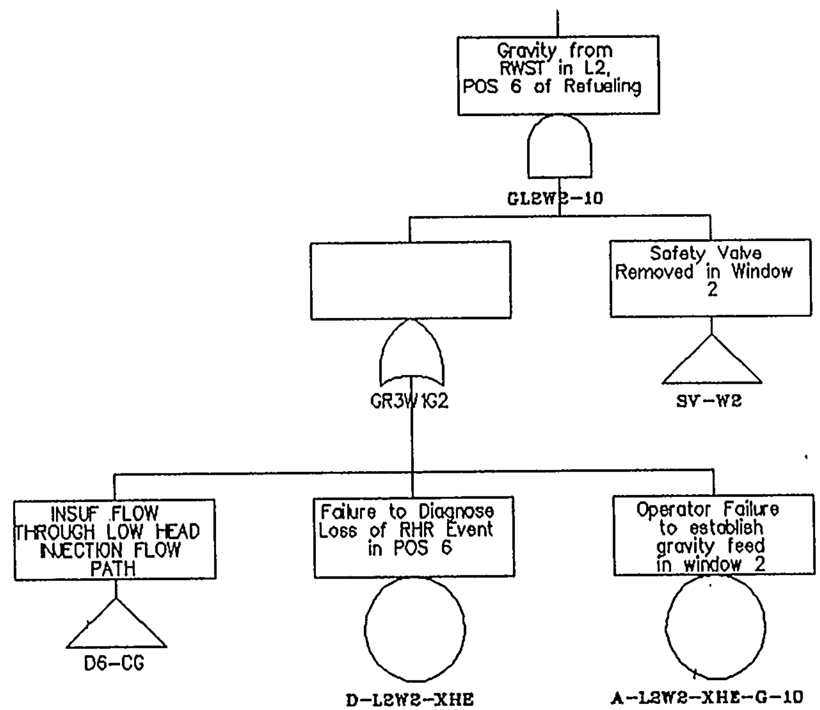


Feed and Bleed the RCS in L2, POS 6 of Refueling
FL2W2-18
Failure to Diagnose Loss of RHR Event in POS 6
D-L2W2-XHE
FL2W2B18
FL2W2D18
FAILURE OF FEED AND SPILL USING HPI
FSW12H
Operator Failure to use HHSI in feed and spill in Window 2
A-L2W2-XHE-FH-18
FL2W2C18
FAILURE OF FEED AND SPILL USING LPI
FSW12L
Operator failure to use LHSI in Feed and Spill in Window 2
A-L2W2-XHE-FL-18

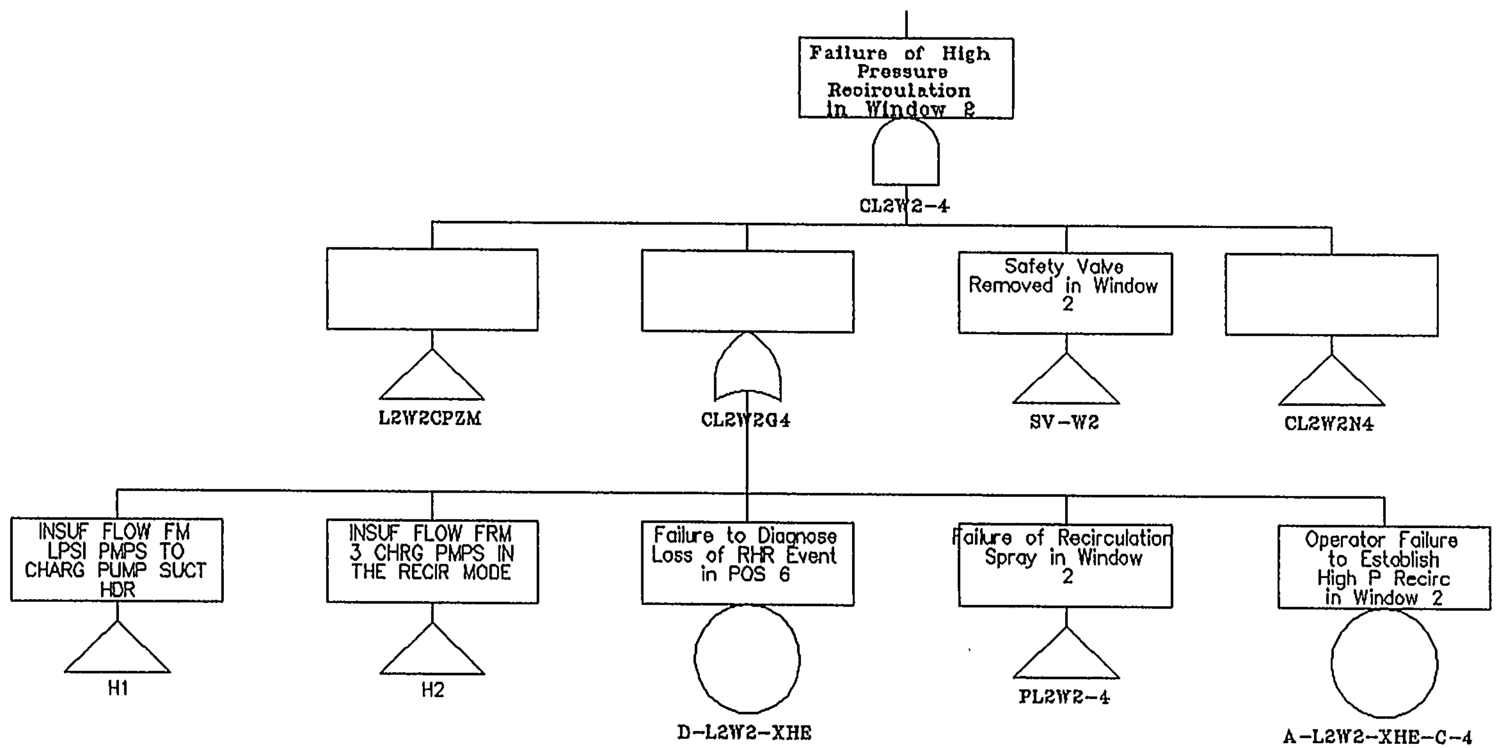
Gravity from RWST in L2, Window 2



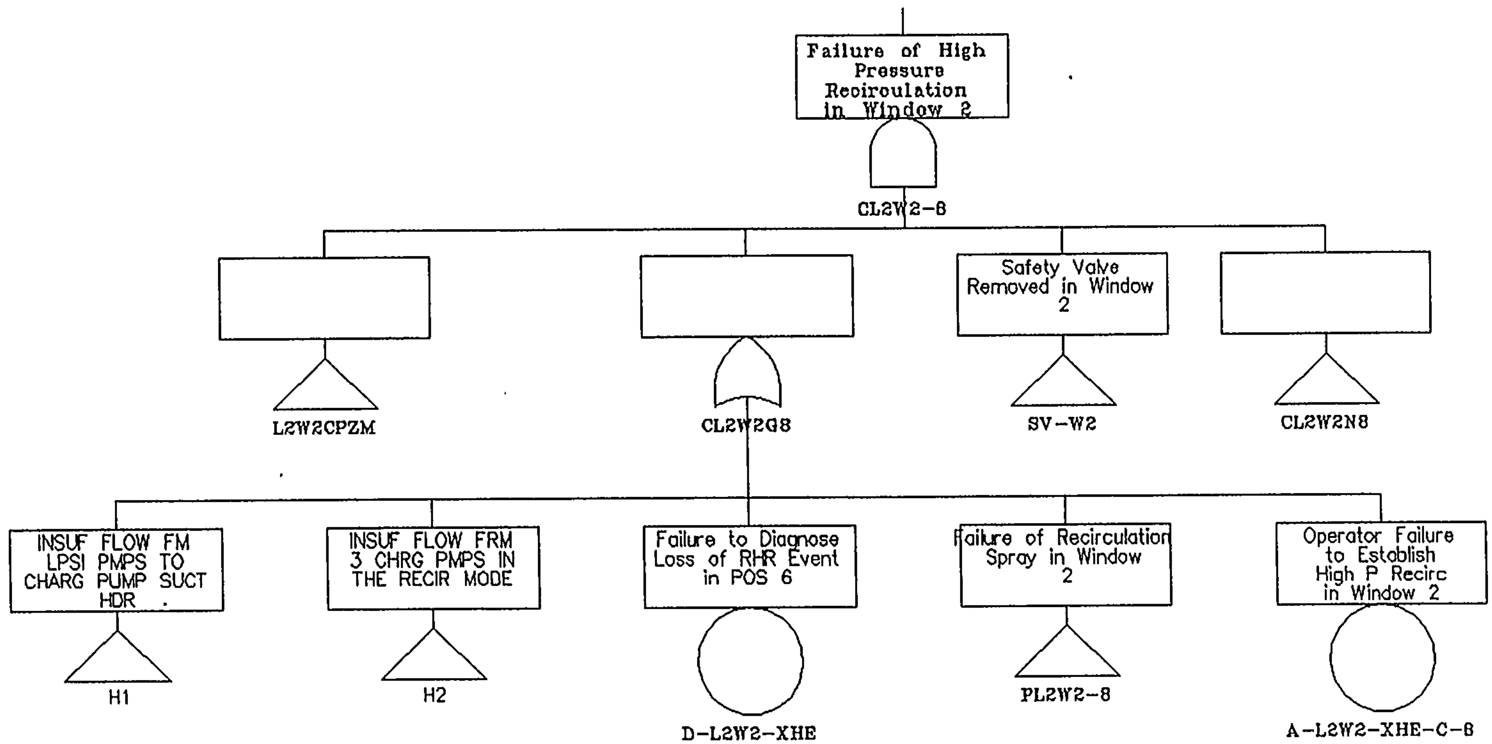
Gravity from RWST in L2, Window 2



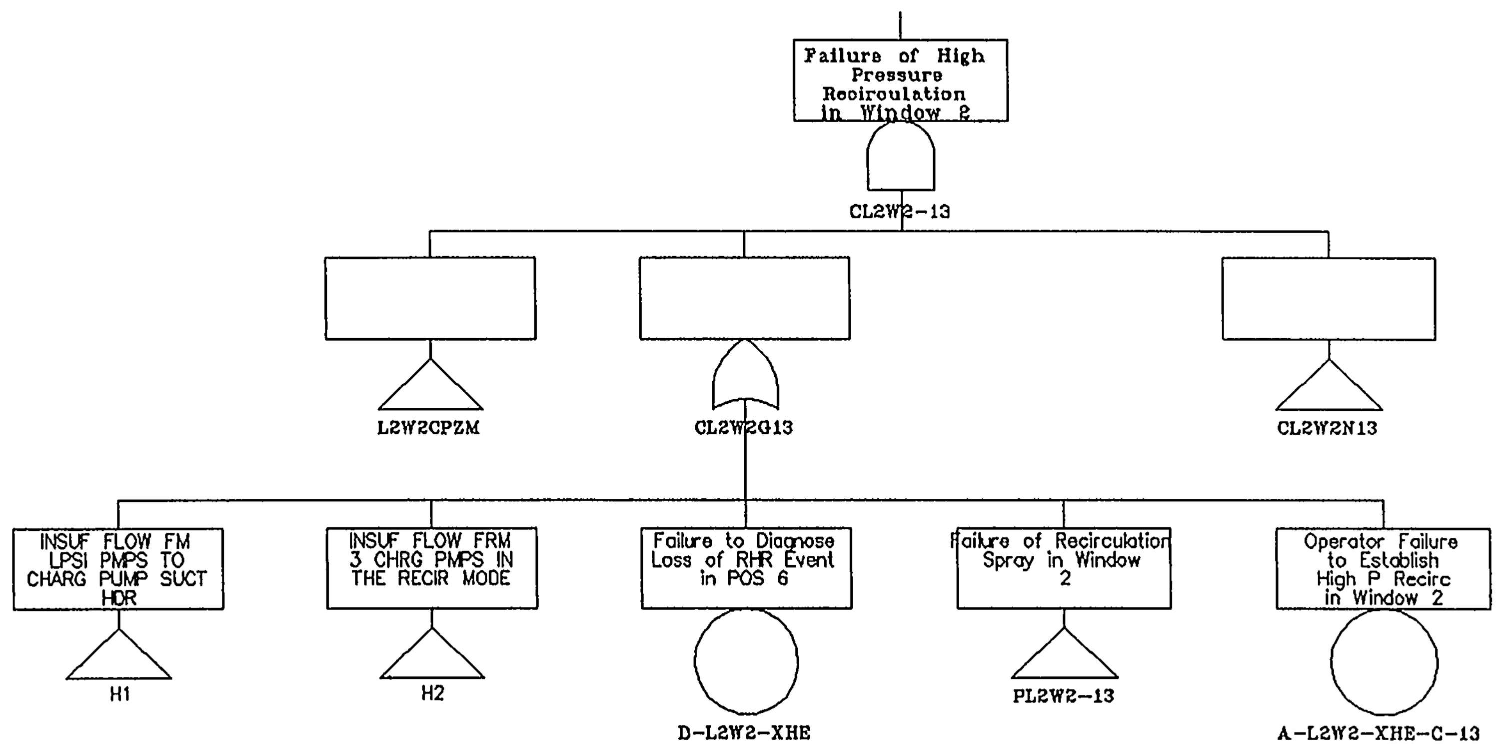
Failure of High Pressure Recirculation in Window 2



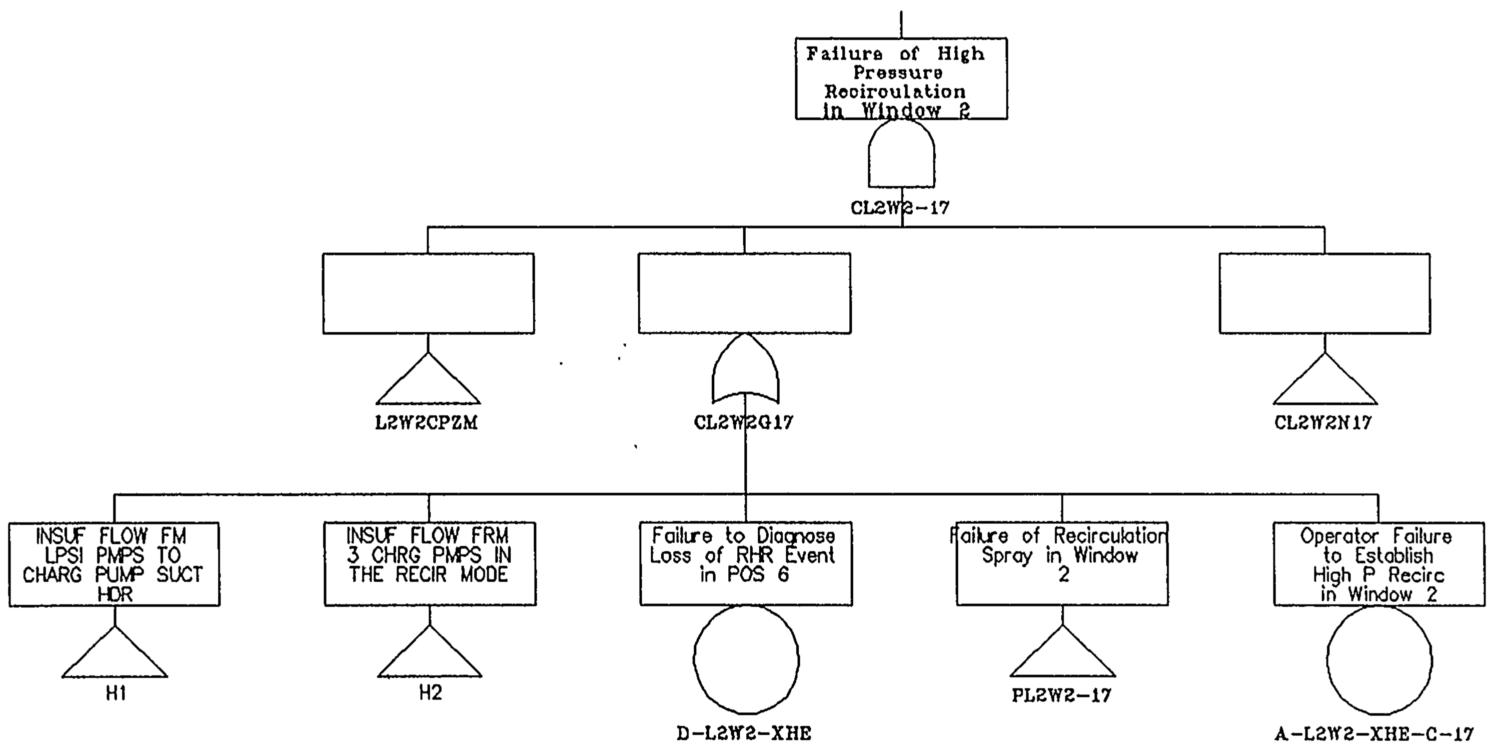
Failure of High Pressure Recirculation in Window 2



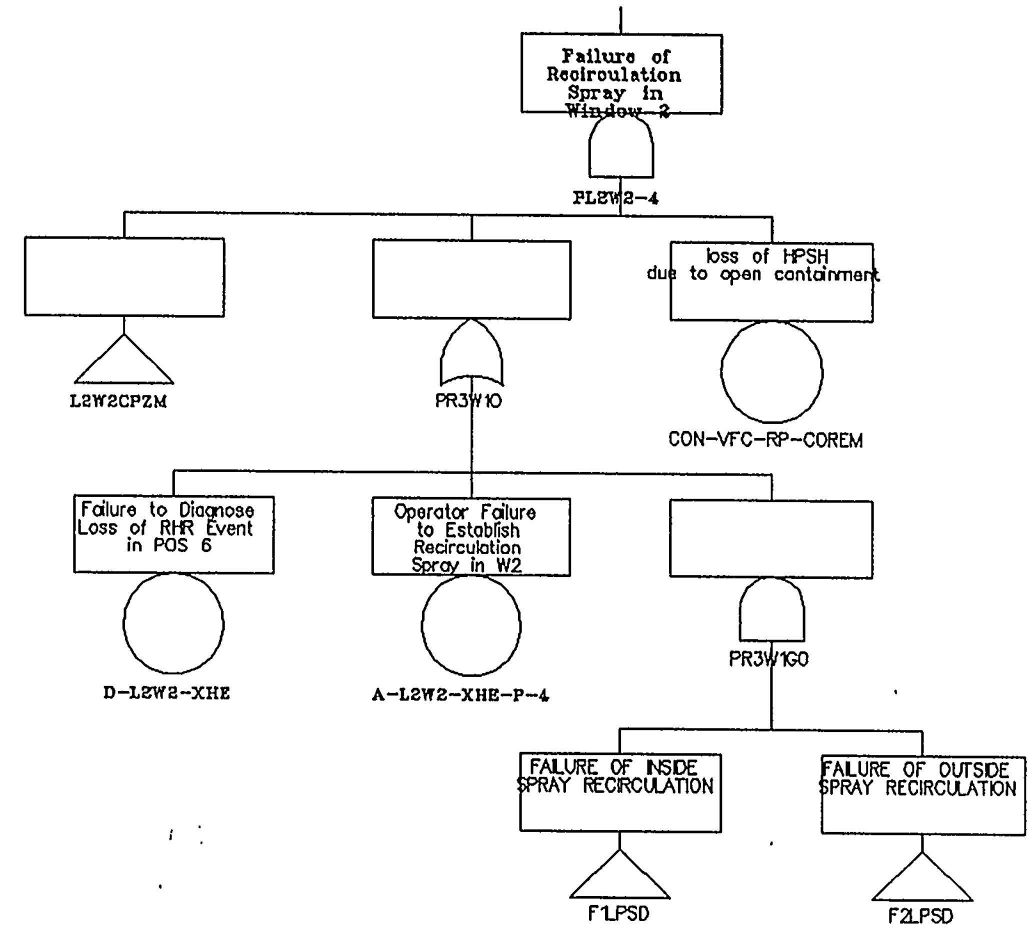
Failure of High Pressure Recirculation in Window 2



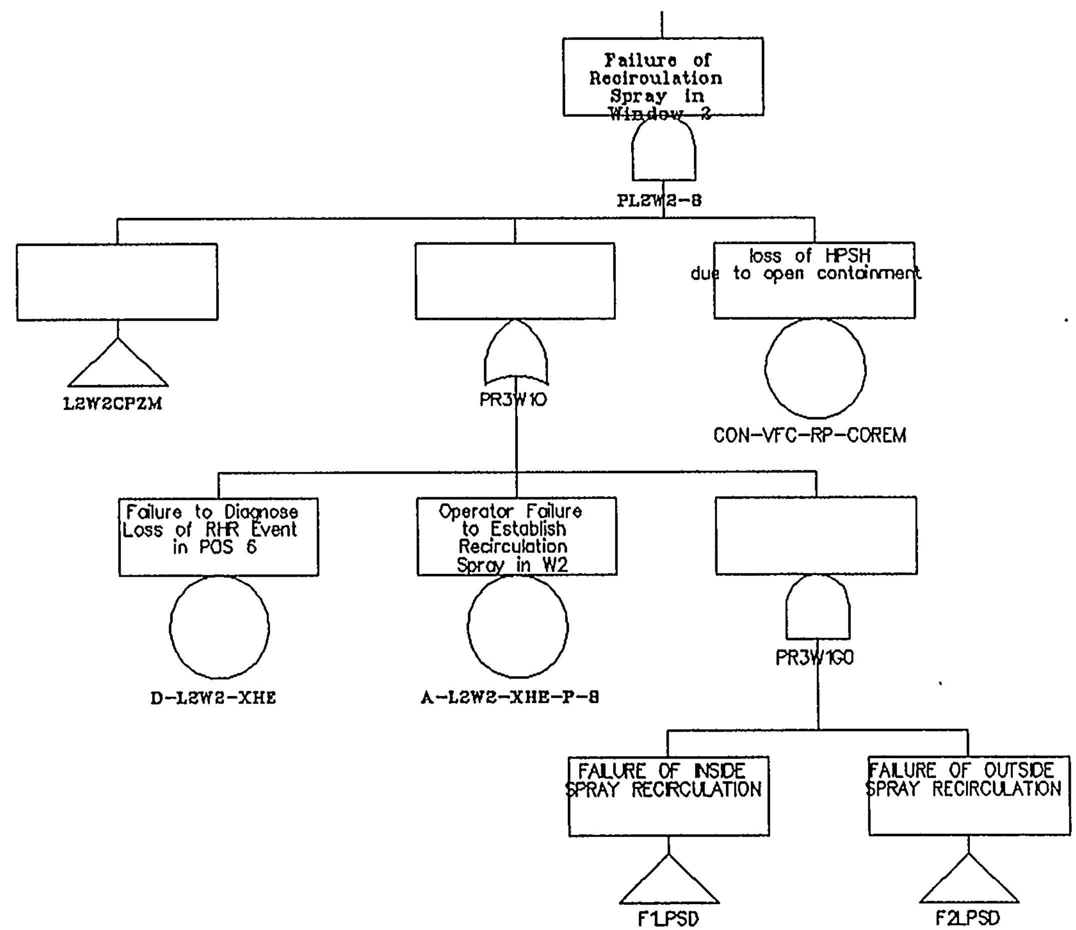
Failure of High Pressure Recirculation in Window 2



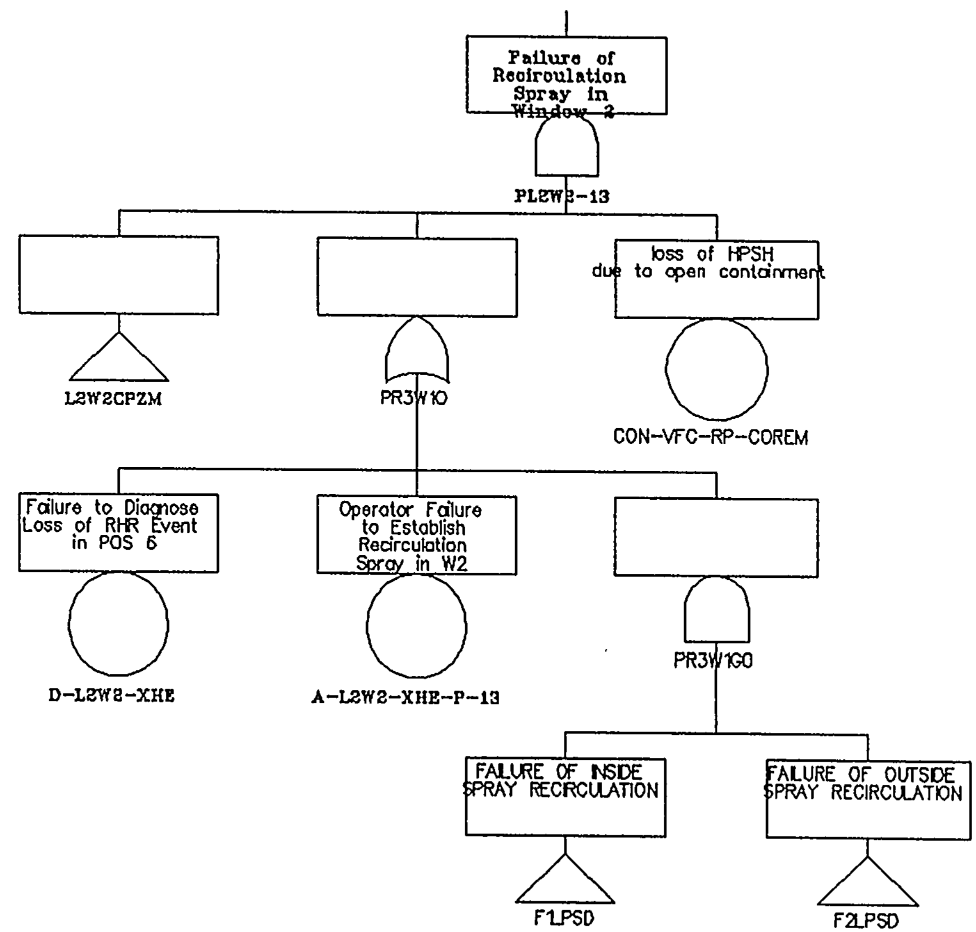
Failure of Recirculation Spray in Window 2—cause HPR failure



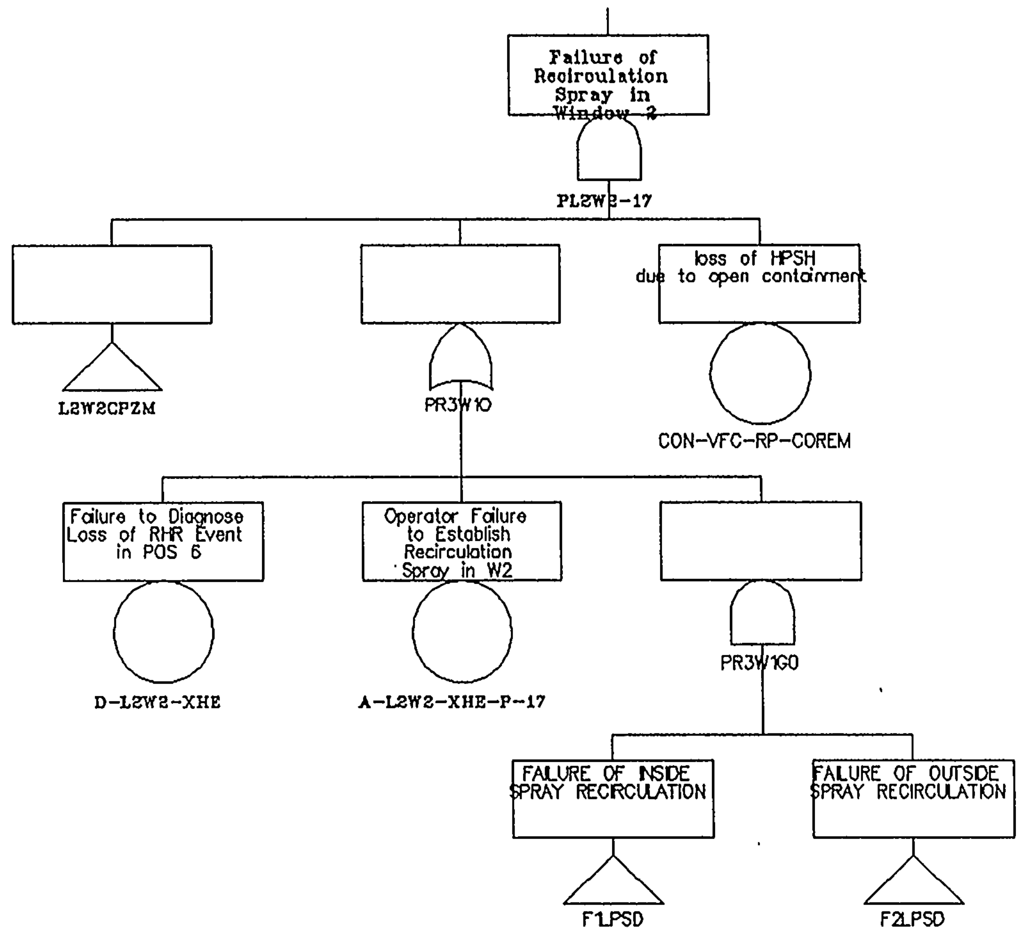
Failure of Recirculation Spray in Window 2-cause HPR failure

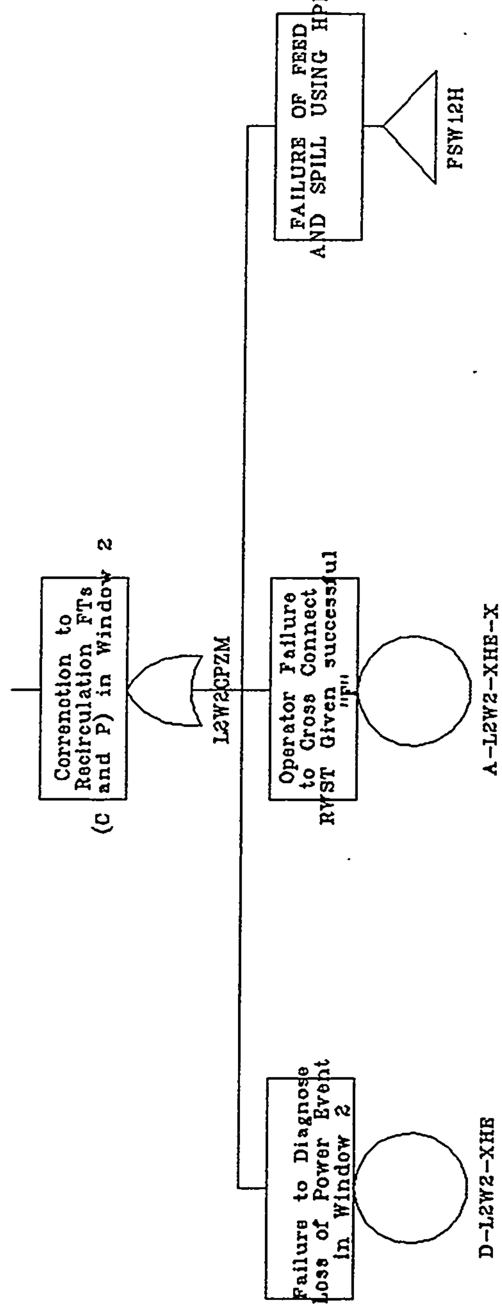


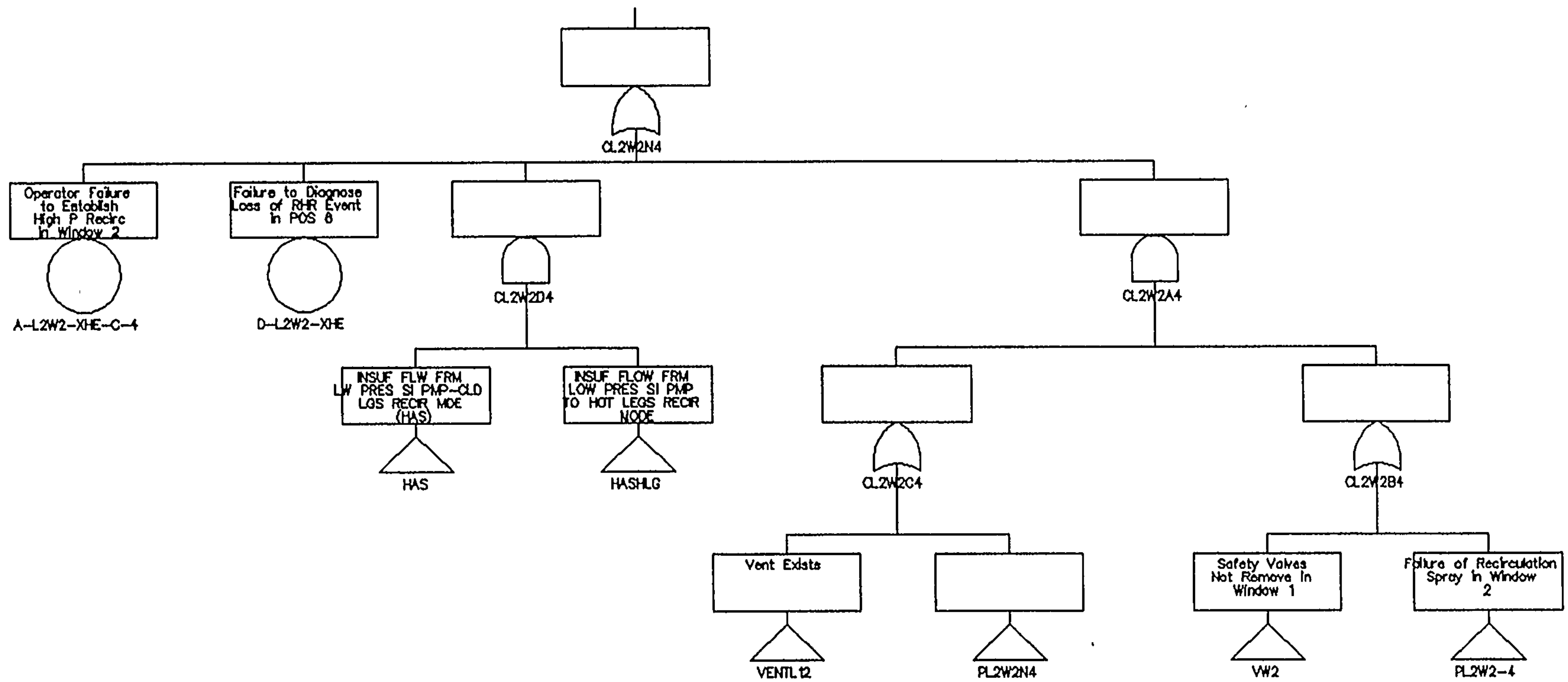
Failure of Recirculation Spray in Window 2–cause HPR failure

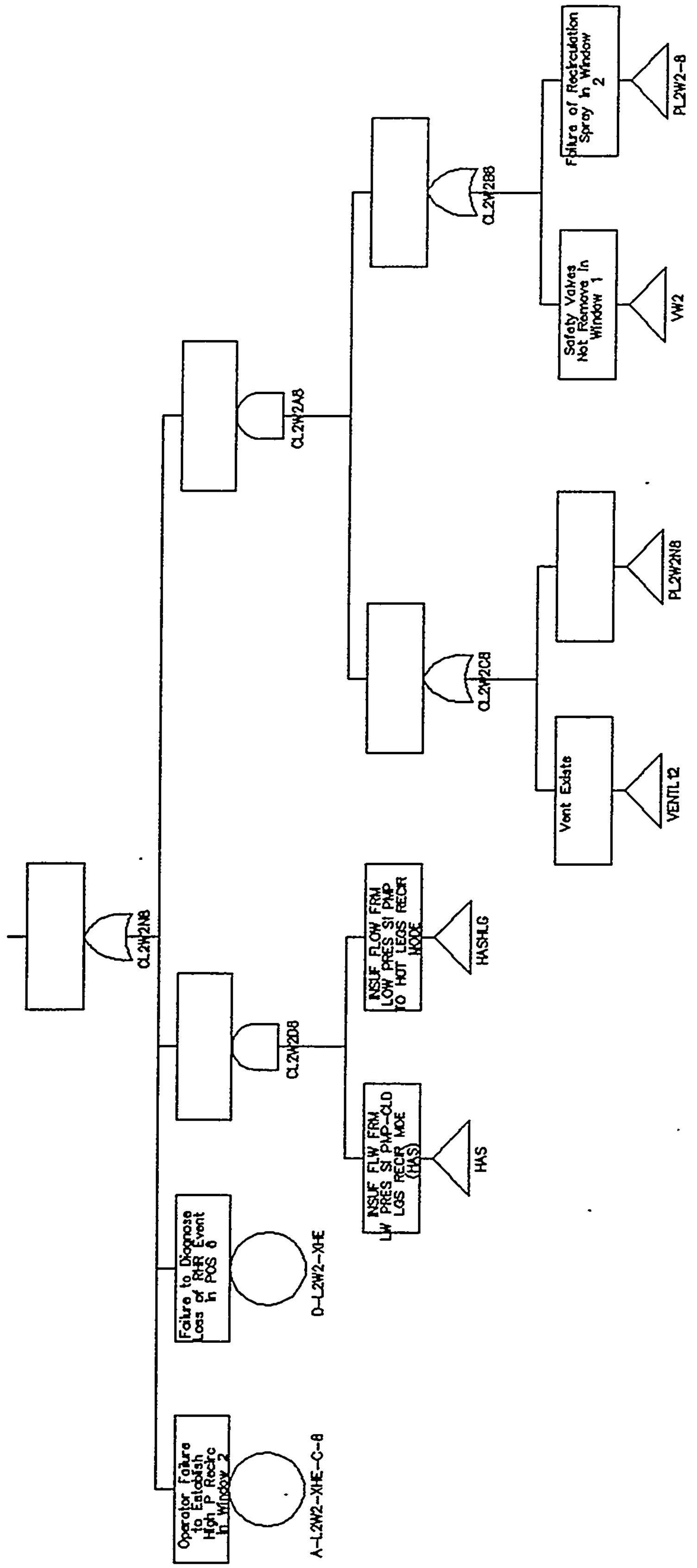


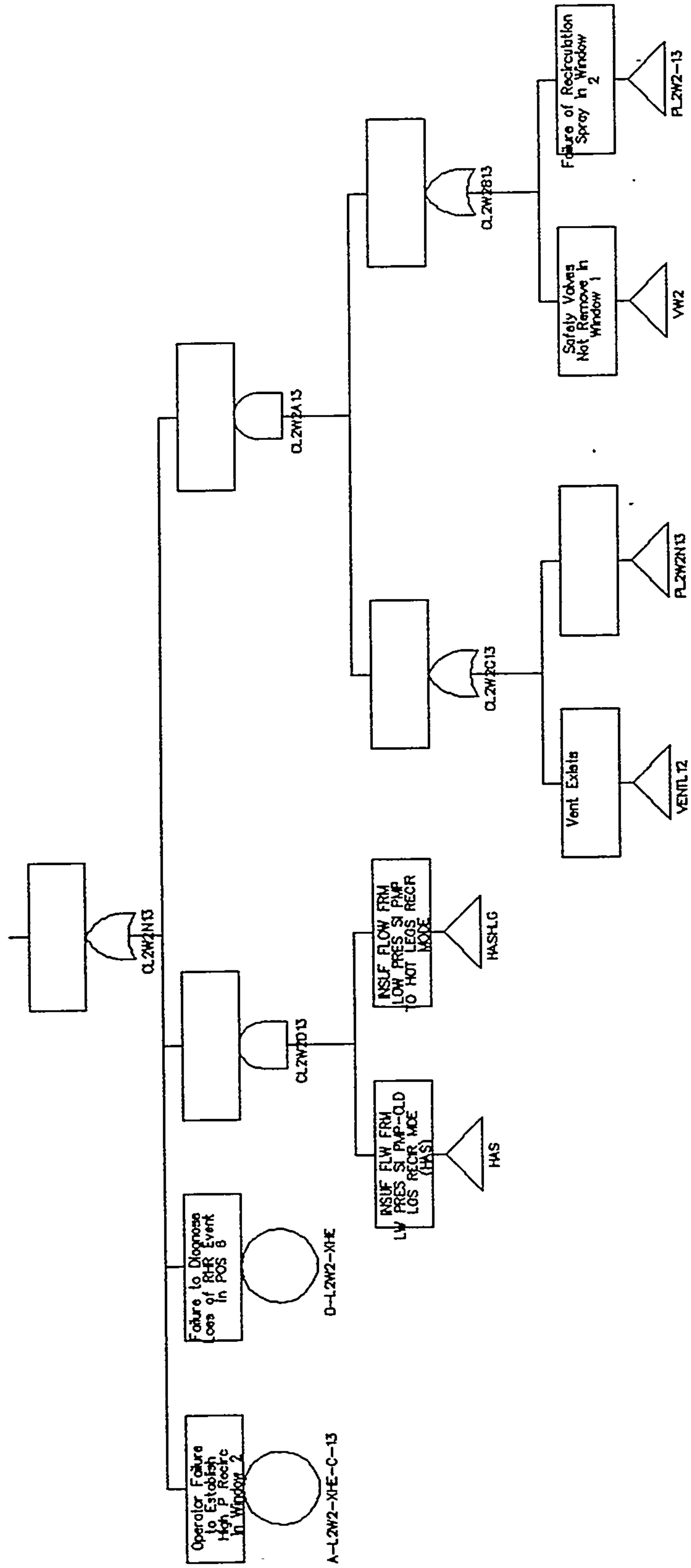
Failure of Recirculation Spray in Window 2–cause HPR failure

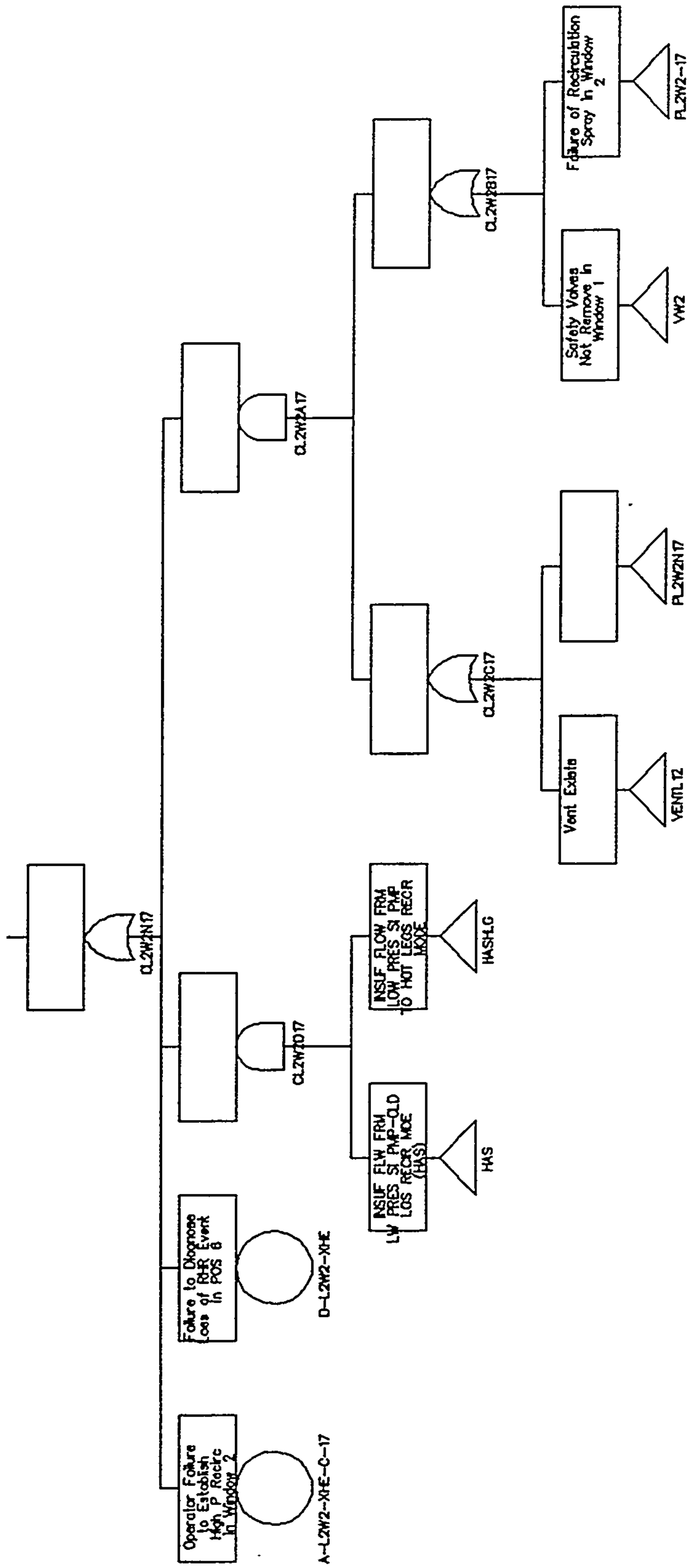



Correnotion to Recirculation FTs (C and P) in Window 2
L2W2CPZM
FAILURE OF FEED AND SPILL USING HPI
FSW12H
Operator Failure to Cross Connect RWST Given successful "F"
A-L2W2-XHE-X
Failure to Diagnose Loss of Power Event in Window 2
D-L2W2-XHE

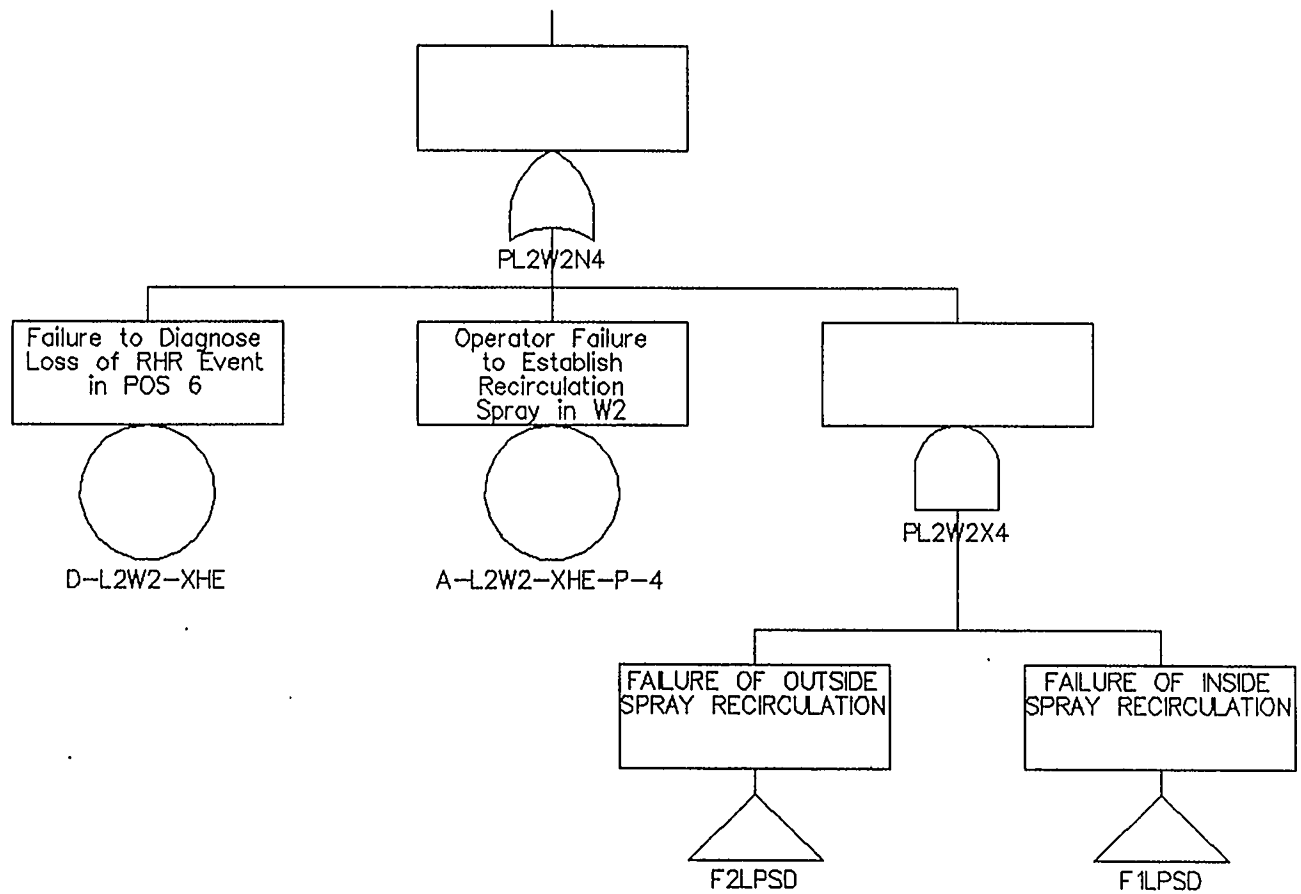

CL2W2N4
Operator Failure to Establish High P Recirc in Window 2
A-L2W2-XHE-C-4
Failure to Diagnose Loss of RHR Event in POS 8
D-L2W2-XHE
CL2W2D4
INSUF FLW FRM LW PRES SI PMP-CLD LGS RECIR MDE (HAS)
HAS
INSUF FLOW FRM LOW PRES SI PMP TO HOT LEGS RECIR MODE
HASHLG
CL2W2A4
CL2W2C4
Vent Exists
VENTL12
PL2W2N4
CL2W2B4
Safety Valves Not Remove In Window 1
VW2
Failure of Recirculation Spray In Window 2
PL2W2-4

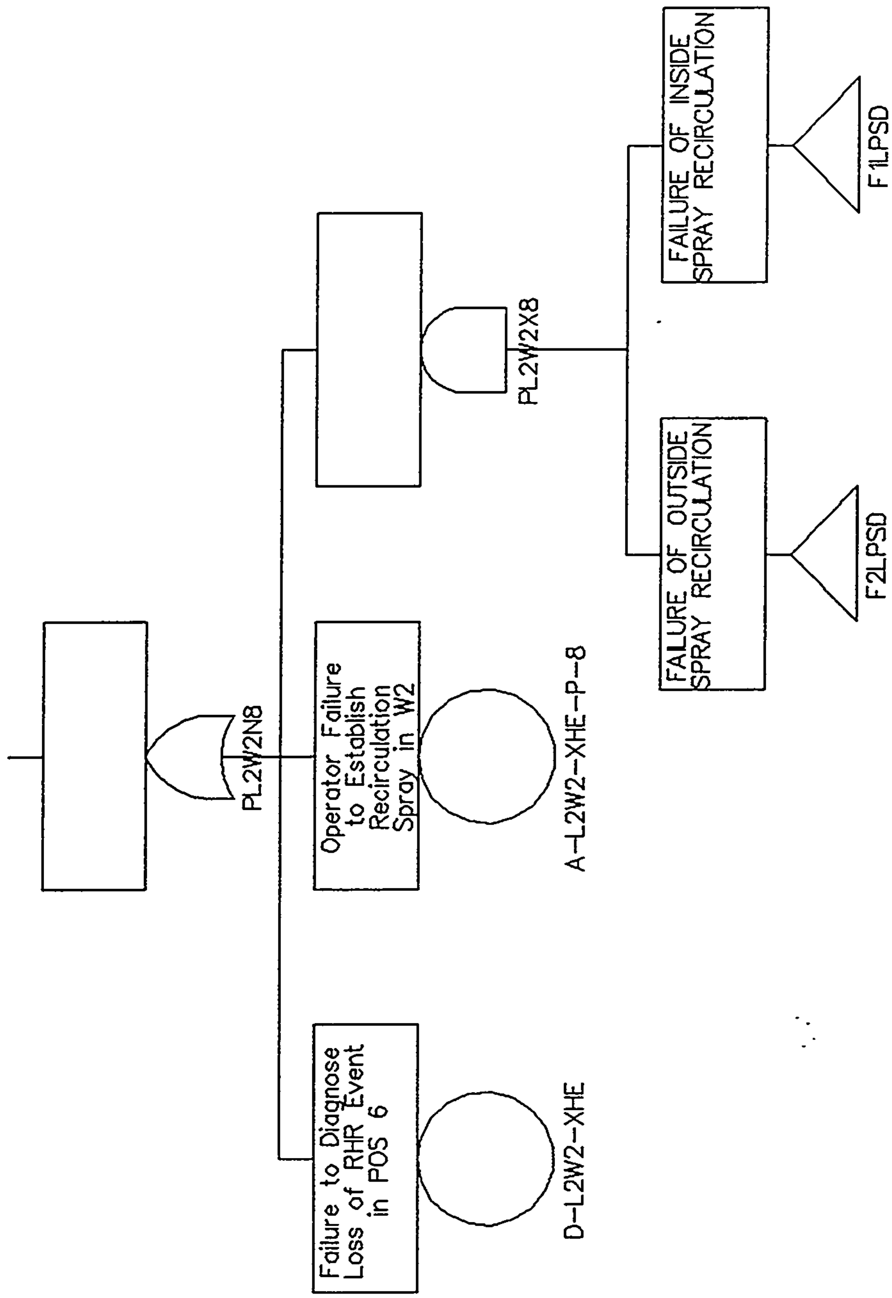

CL2W2N8
Operator Failure to Establish High P Recirc In Window 2
A-L2W2-XHE-C-8
Failure to Diagnose Loss of RHR Event In POS 8
D-L2W2-XHE
CL2W2D8
INSUF FLW FRM LW PRES SI PMP-CLD LGS RECIR MDE (HAS)
HAS
INSUF FLOW FRM LOW PRES SI PMP TO HOT LEGS RECIR MODE
HASHLG
CL2W2A8
CL2W2C8
Vent Exists
VENTL12
PL2W2N8
CL2W2B8
Safety Valves Not Remove In Window 1
VW2
Failure of Recirculation Spray In Window 2
PL2W2-8

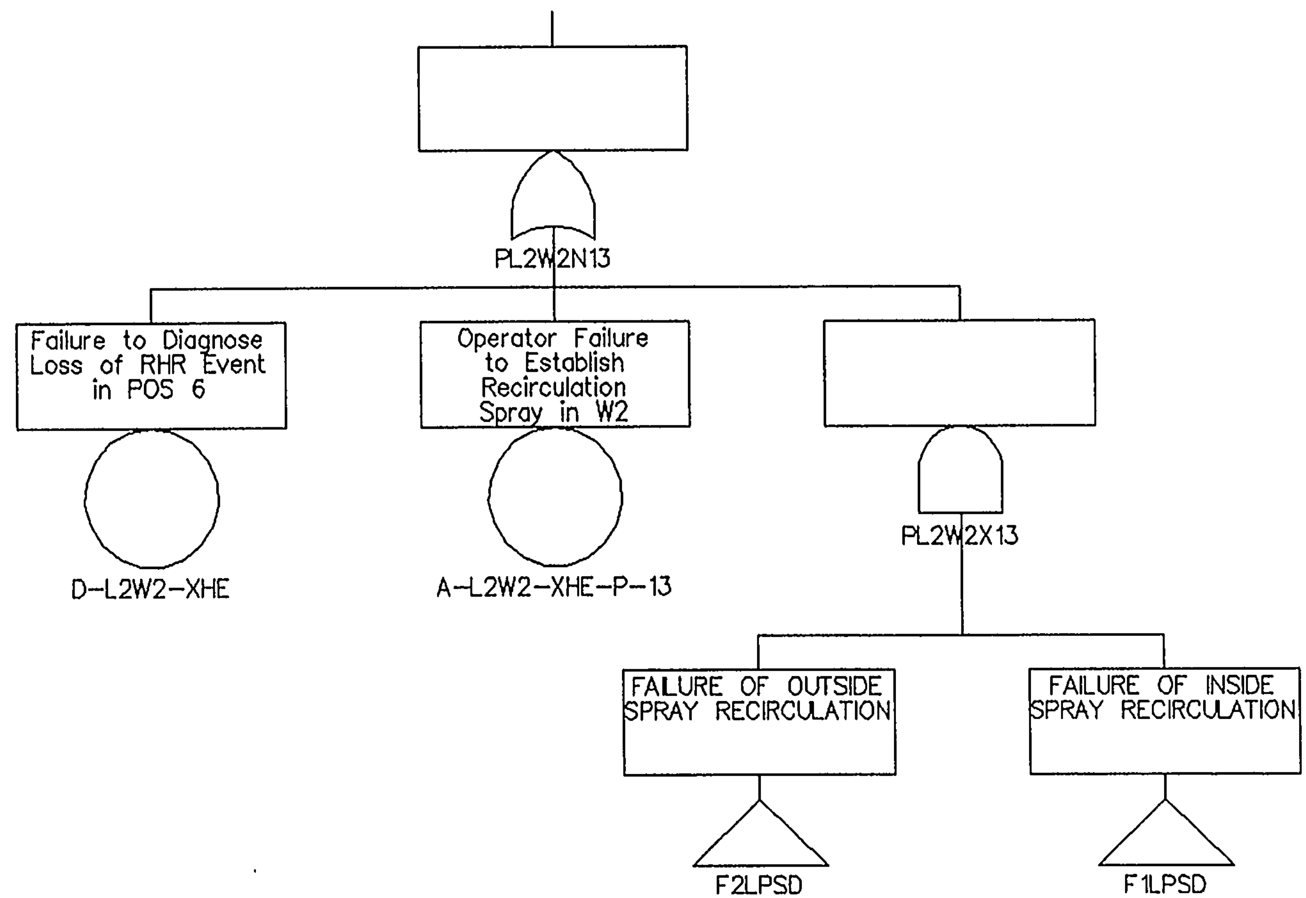

CL2W2N13
CL2W2A13
CL2W2B13
Failure of Recirculation Spray in Window 2
PL2W2-13
Safety Valves Not Remove in Window 1
VW2
CL2W2C13
PL2W2N13
Vent Exists
VENTL12
CL2W2D13
INSUF FLOW FRM LOW PRES SI PMP TO HOT LEGS RECR MODE
HASHLG
INSUF FLW FRM LW PRES SI PMP-CLD LGS RECR MOE (HAS)
HAS
Failure to Diagnose Loss of RHR Event In POS 8
D-L2W2-XHE
Operator Failure to Establish High P Recirc In Window 2
A-L2W2-XHE-C-13

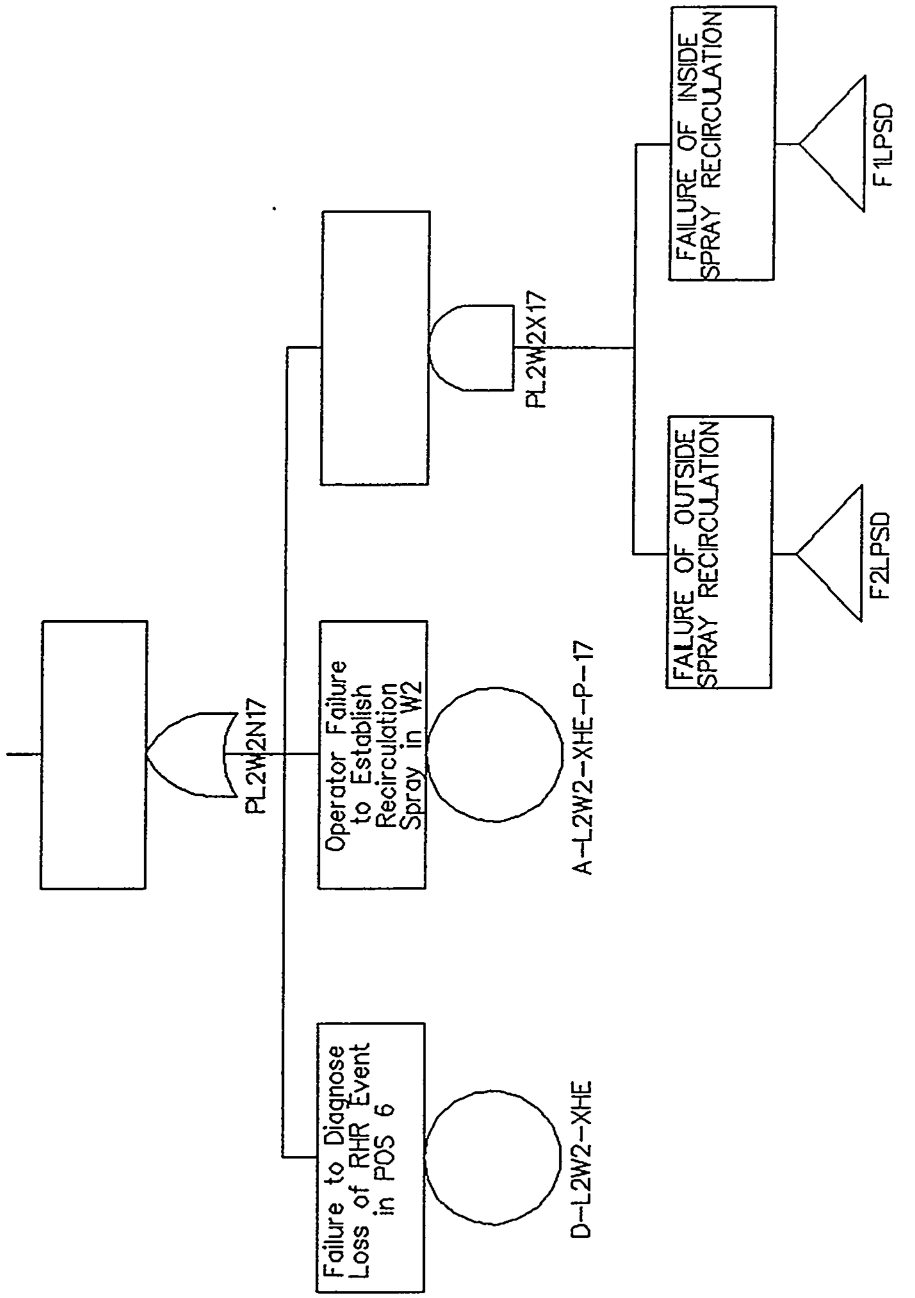


CL2W2N17
Operator Failure to Establish High P Recirc In Window 2
A-L2W2-XHE-C-17
Failure to Diagnose Loss of RHR Event In POS 8
D-L2W2-XHE
CL2W2D17
INSUF FLW FRM LW PRES SI PMP-CLD LGS RECIR MDE (HAS)
HAS
INSUF FLOW FRM LOW PRES SI PMP TO HOT LEGS RECIR MODE
HASHLG
CL2W2A17
CL2W2C17
Vent Exists
VENTL12
PL2W2N17
CL2W2B17
Safety Valves Not Remove In Window 1
VW2
Failure of Recirculation Spray In Window 2
PL2W2-17

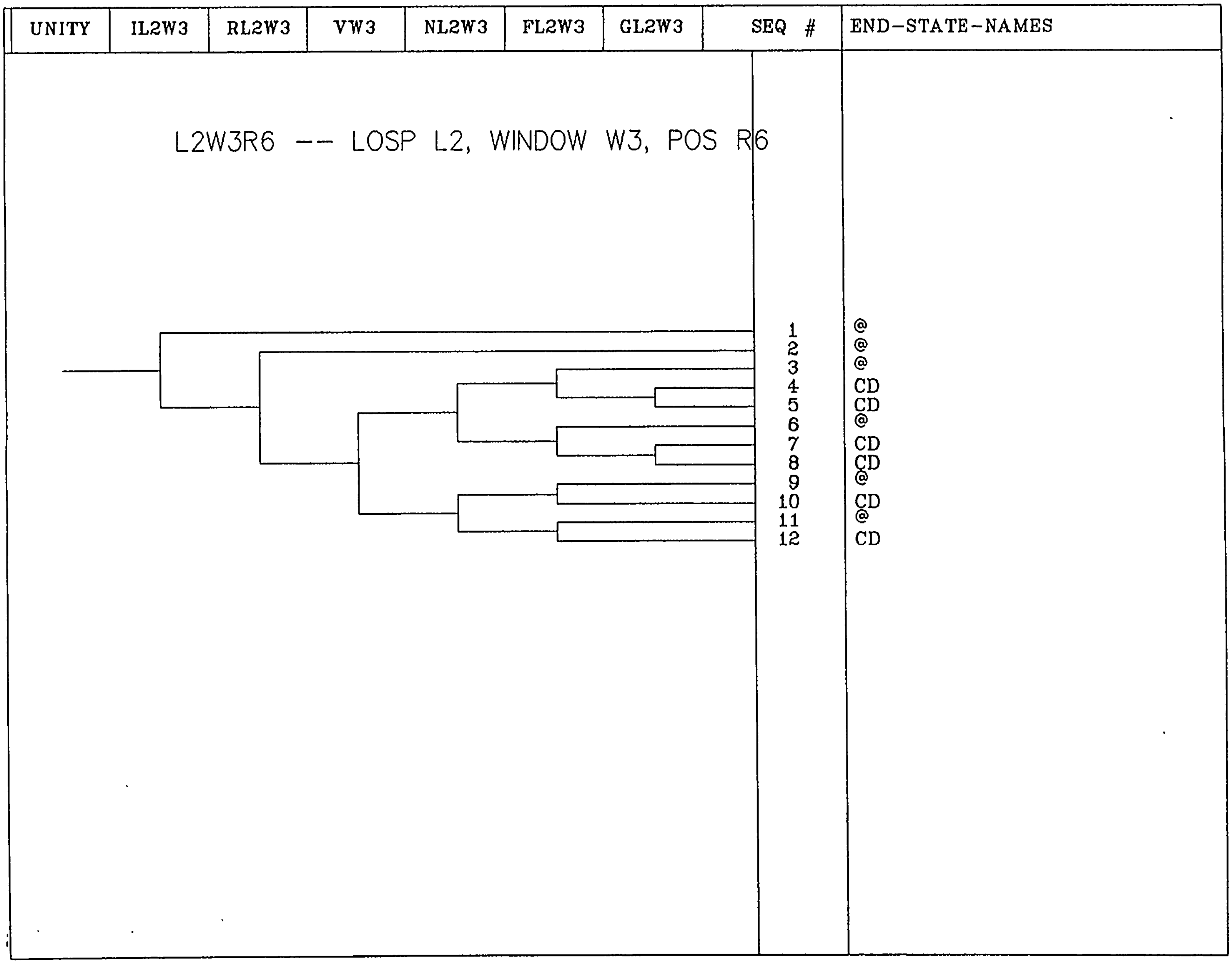

PL2W2N4
Failure to Diagnose Loss of RHR Event in POS 6
D-L2W2-XHE
Operator Failure to Establish Recirculation Spray in W2
A-L2W2-XHE-P-4
PL2W2X4
FAILURE OF OUTSIDE SPRAY RECIRCULATION
F2LPSD
FAILURE OF INSIDE SPRAY RECIRCULATION
F1LPSD

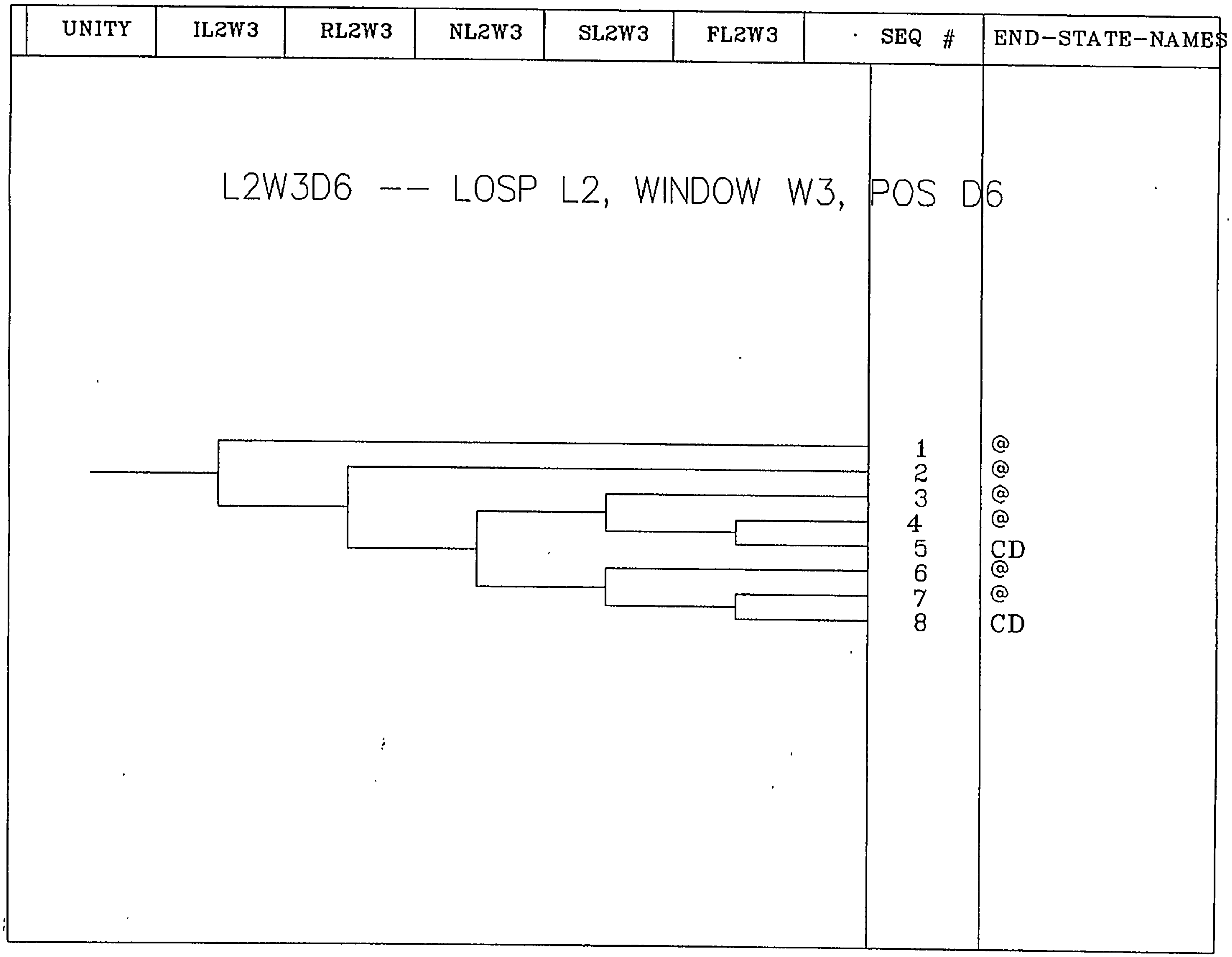

PL2W2N8
Operator Failure to Establish Recirculation Spray in W2
A-L2W2-XHE-P-8
Failure to Diagnose Loss of RHR Event in POS 6
D-L2W2-XHE
PL2W2X8
FAILURE OF INSIDE SPRAY RECIRCULATION
F1LPSD
FAILURE OF OUTSIDE SPRAY RECIRCULATION
F2LPSD

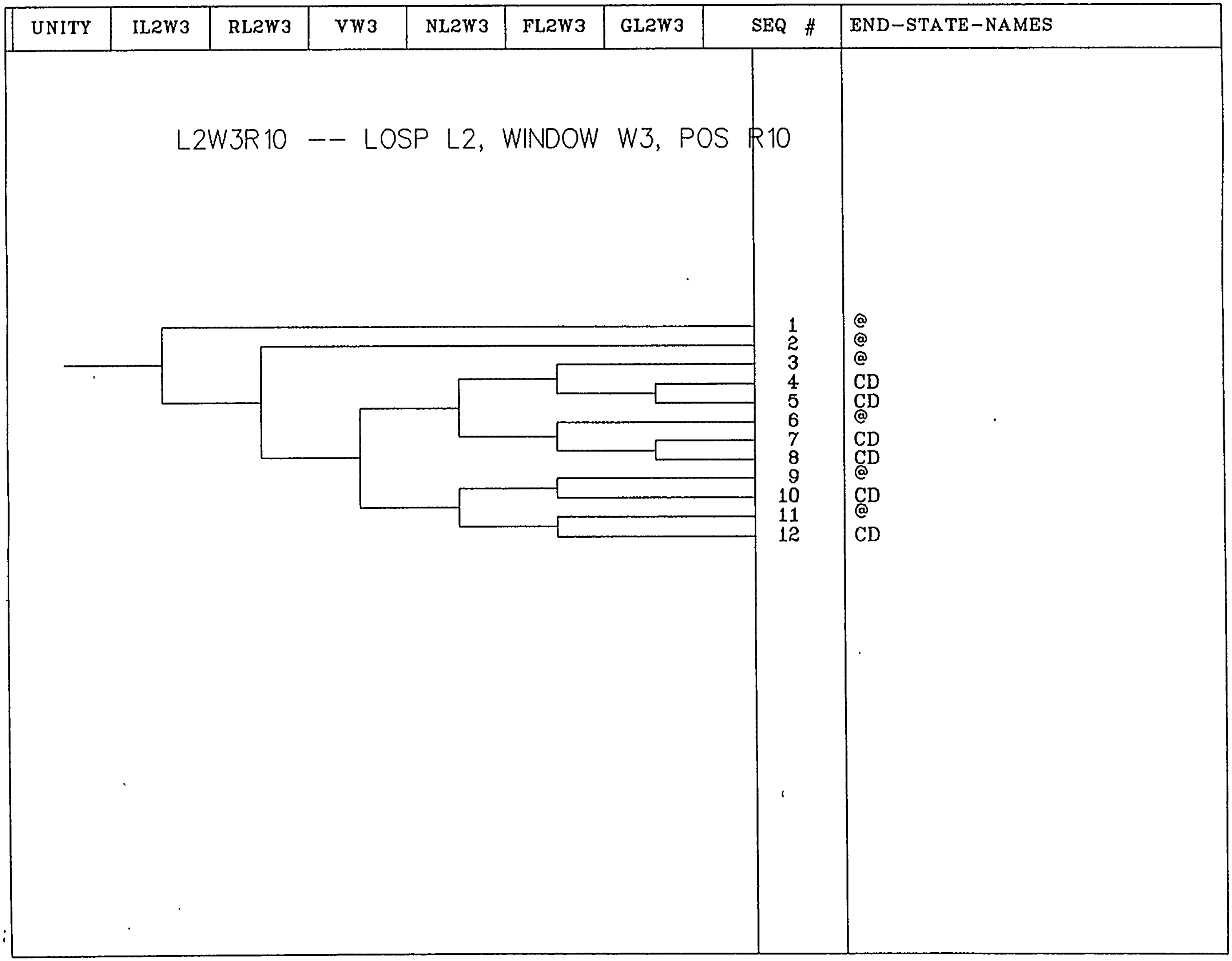

PL2W2N13
Failure to Diagnose Loss of RHR Event in POS 6
D-L2W2-XHE
Operator Failure to Establish Recirculation Spray in W2
A-L2W2-XHE-P-13
PL2W2X13
FAILURE OF OUTSIDE SPRAY RECIRCULATION
F2LPSD
FAILURE OF INSIDE SPRAY RECIRCULATION
F1LPSD



Failure to Diagnose Loss of RHR Event in POS 6
D-L2W2-XHE
Operator Failure to Establish Recirculation Spray in W2
A-L2W2-XHE-P-17
PL2W2N17
PL2W2X17
FAILURE OF OUTSIDE SPRAY RECIRCULATION
F2LPSD
FAILURE OF INSIDE SPRAY RECIRCULATION
F1LPSD

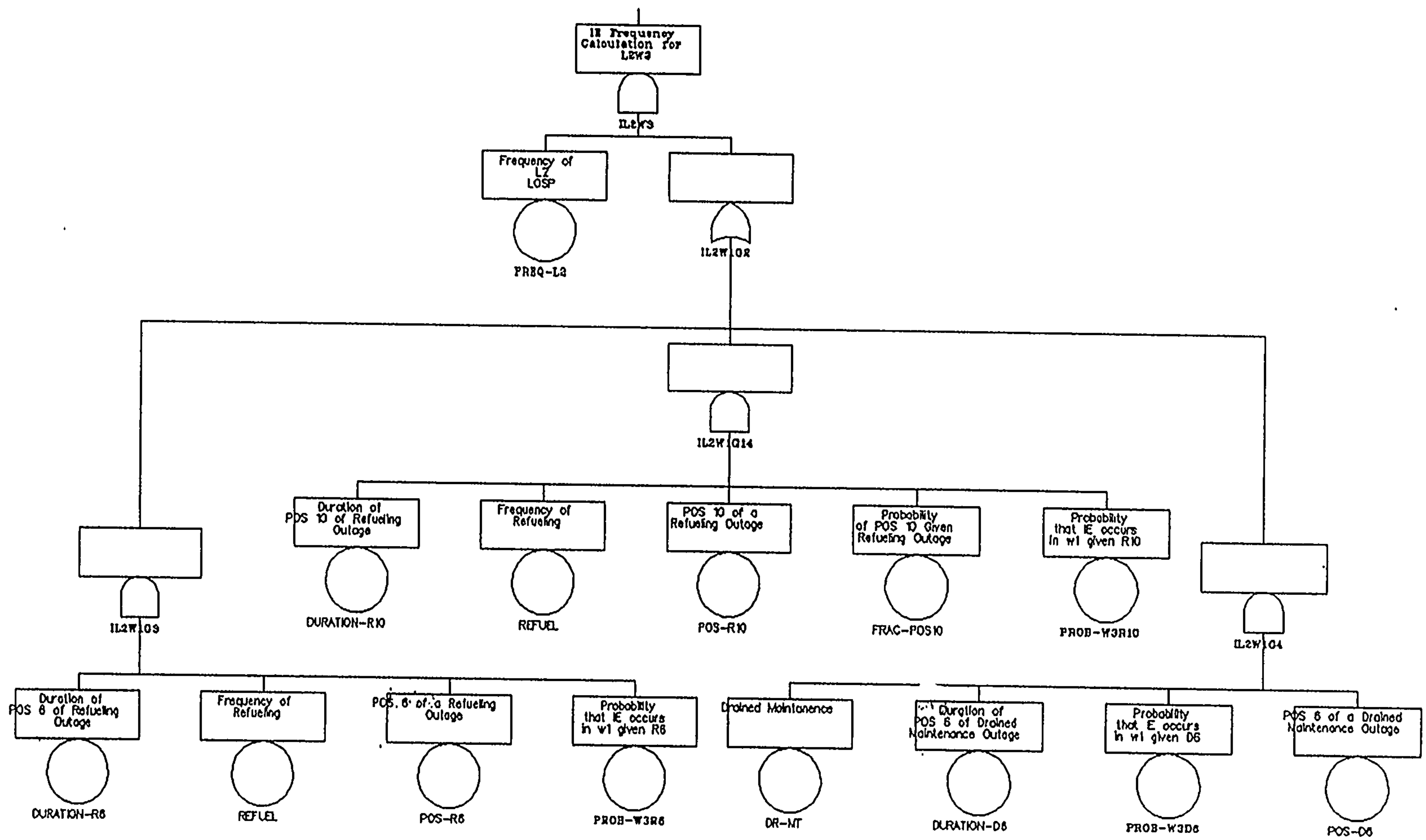

UNITY
IL2W3
RL2W3
VW3
NL2W3
FL2W3
GL2W3
SEQ #
END-STATE-NAMES
L2W3R6 -- LOSP L2, WINDOW W3, POS R6
1 @
2 @
3 @
4 CD
5 CD
6 @
7 CD
8 CD
9 @
10 CD
11 @
12 CD


UNITY
IL2W3
RL2W3
NL2W3
SL2W3
FL2W3
SEQ #
END-STATE-NAMES
L2W3D6 -- LOSP L2, WINDOW W3, POS D6
1 @
2 @
3 @
4 @
5 CD
6 @
7 @
8 CD

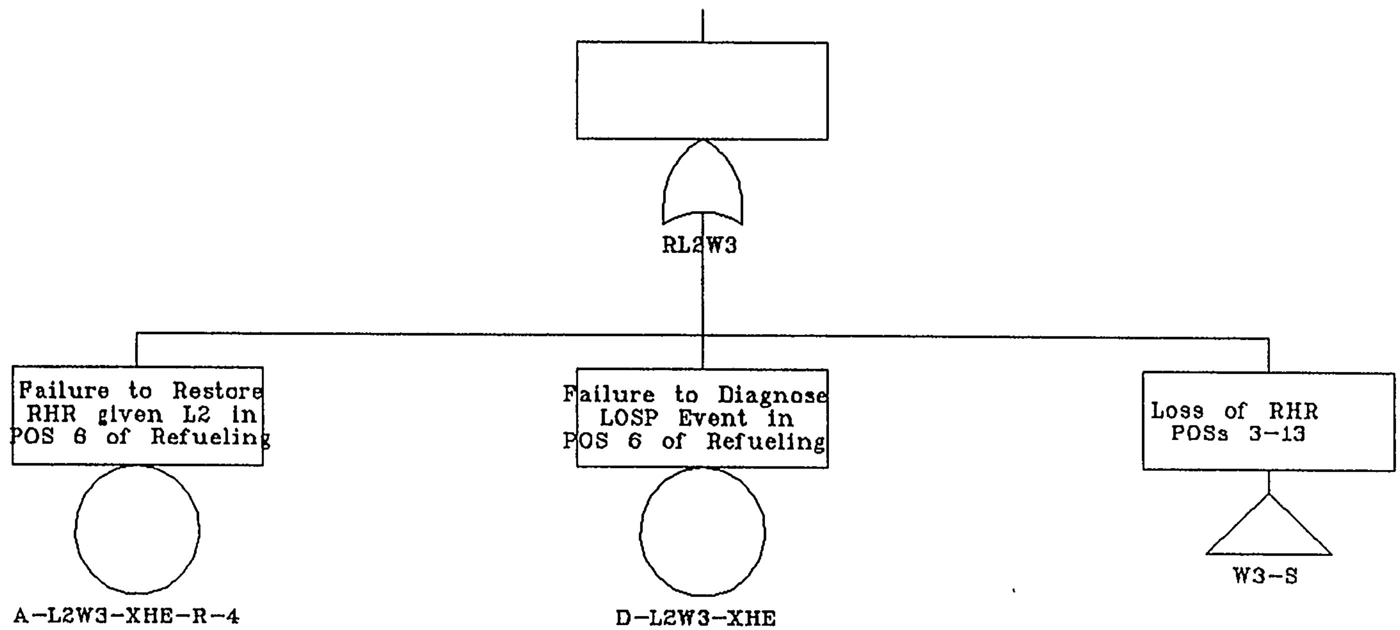


UNITY
IL2W3
RL2W3
VW3
NL2W3
FL2W3
GL2W3
SEQ #
END-STATE-NAMES
L2W3R10 -- LOSP L2, WINDOW W3, POS R10
1 @
2 @
3 @
4 CD
5 CD
6 @
7 CD
8 CD
9 @
10 CD
11 @
12 CD

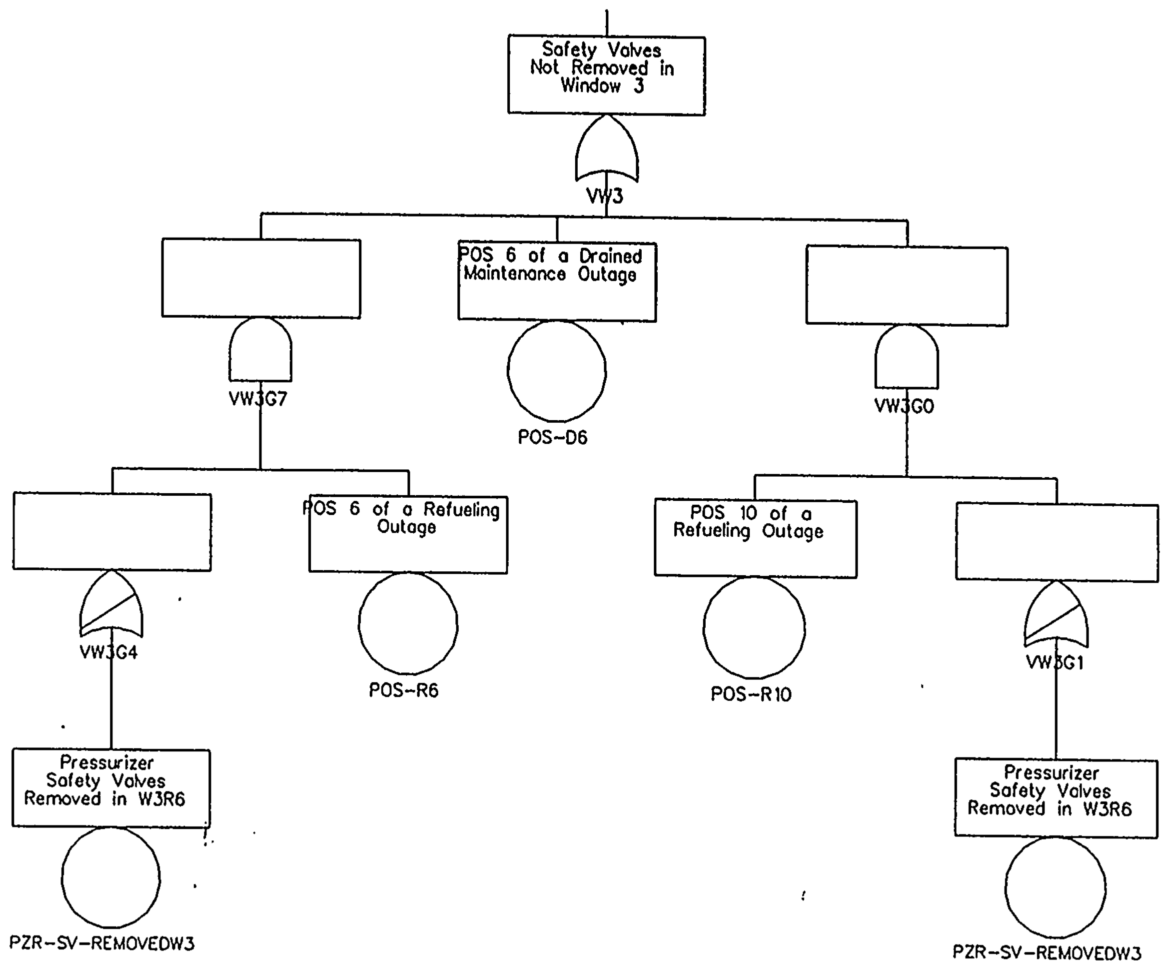
I top event for L2 LOSP – L2 in window 3



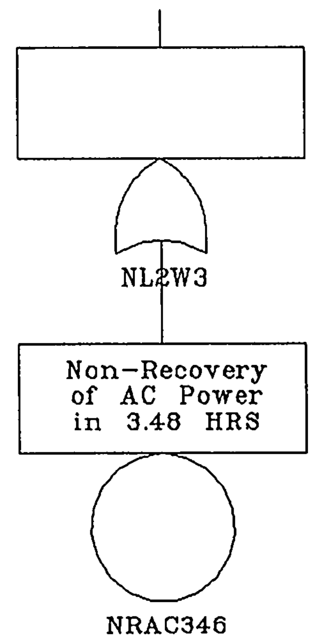
Restore RHR given L2 in POS 6 – Refueling



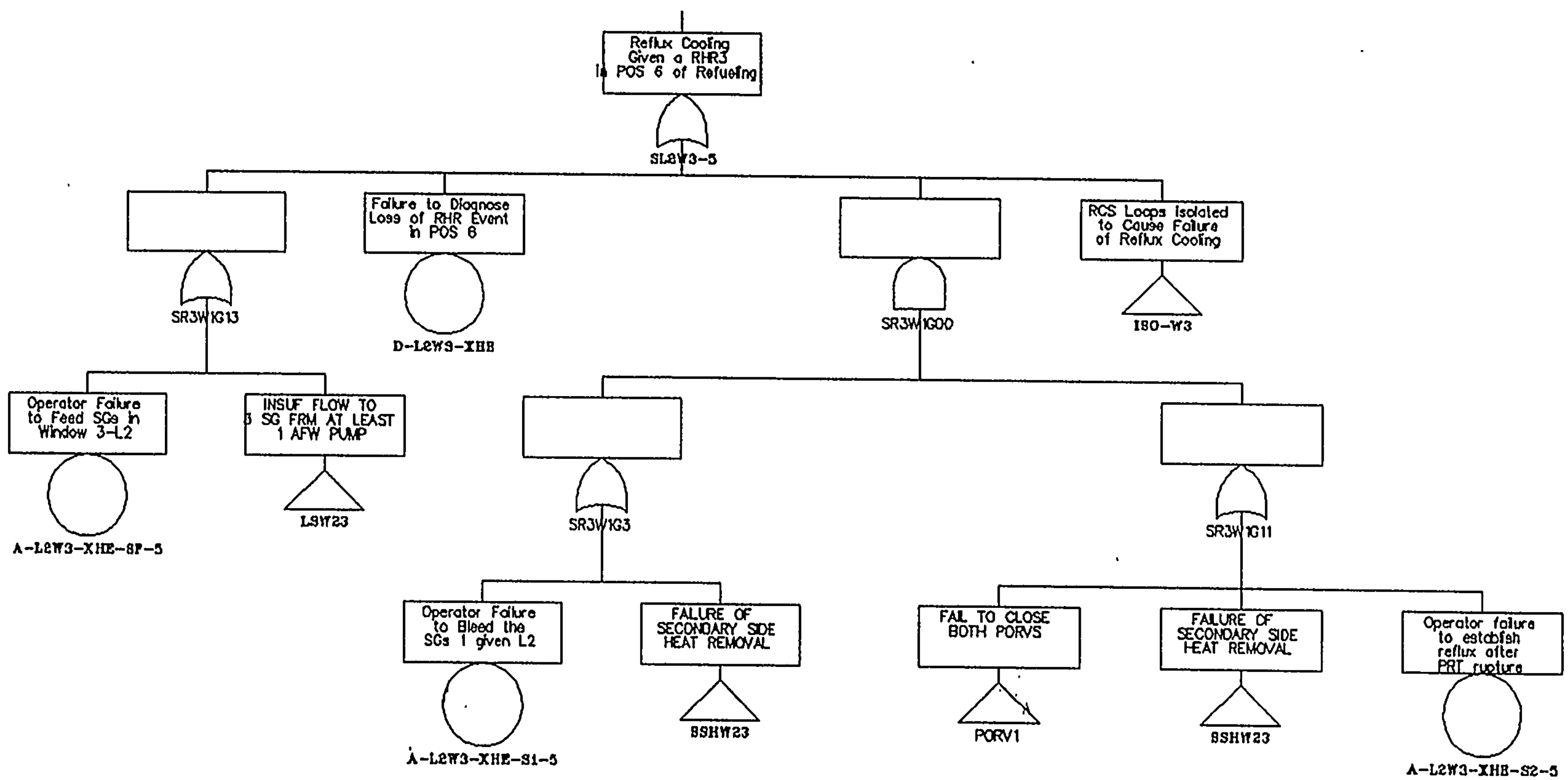
Safety Valves Not Removed in Window 3



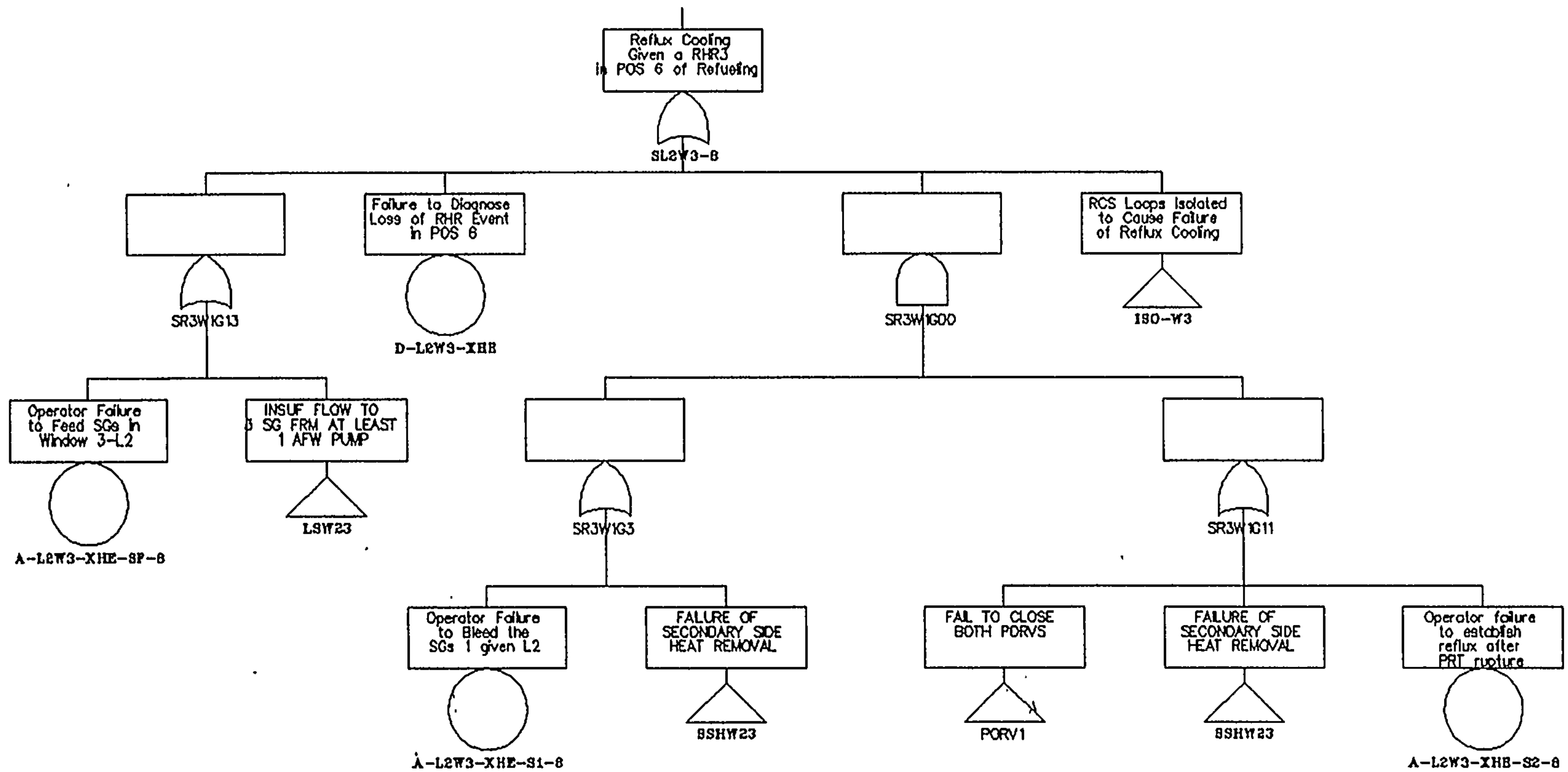
Non-Recovery of AC Power



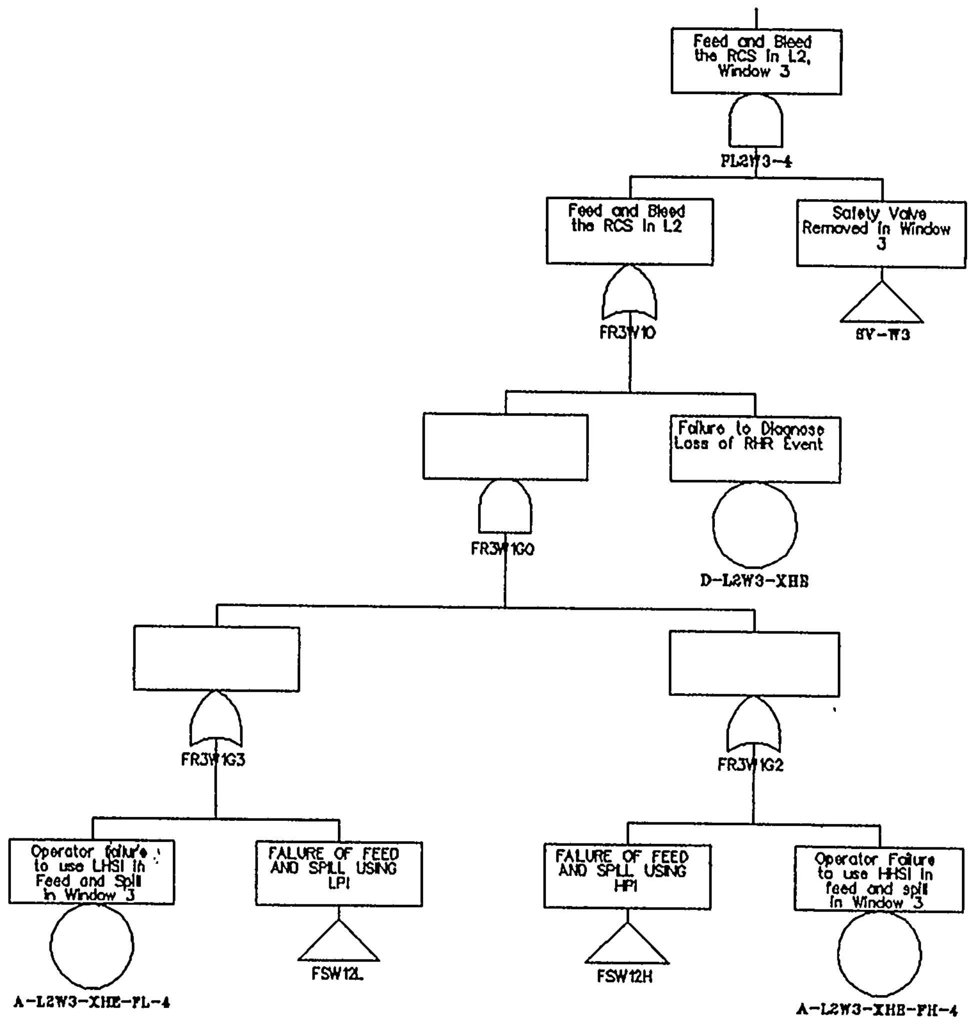
Reflux Cooling in window 3



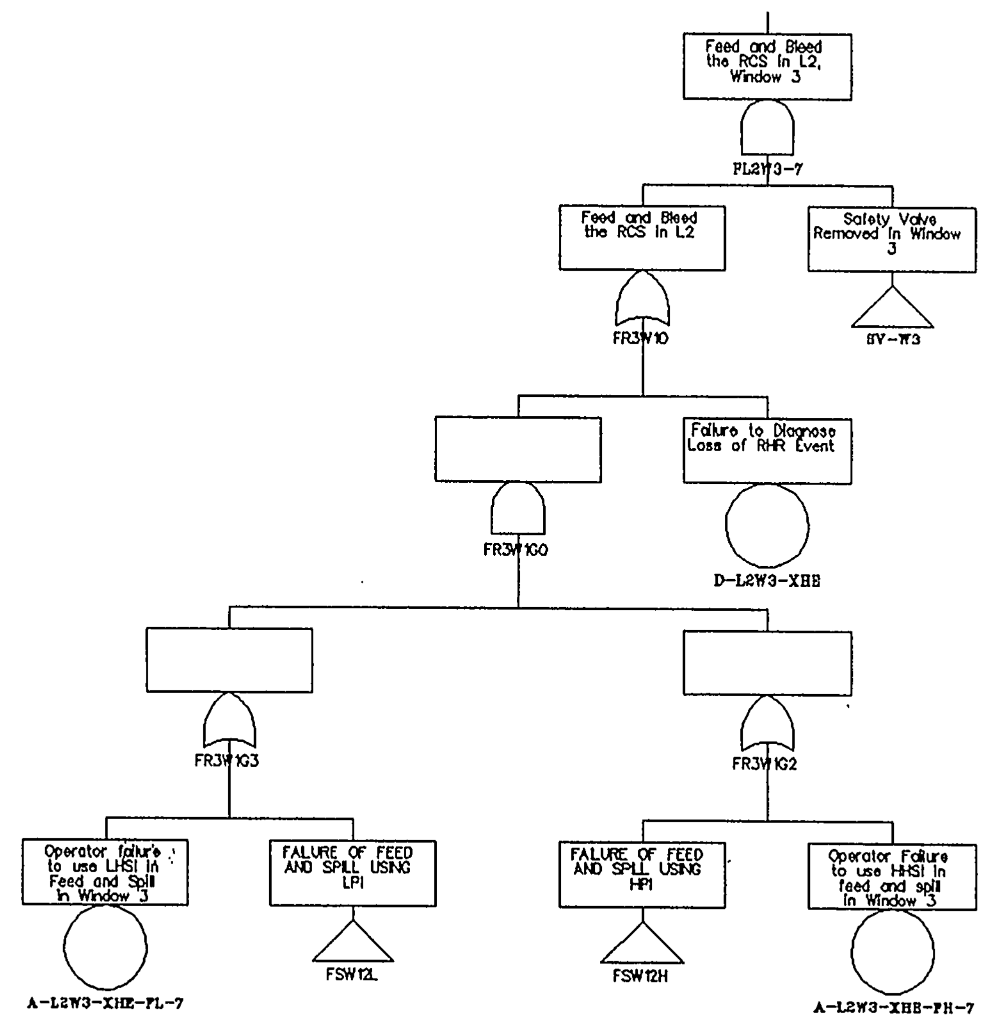
Reflux Cooling in window 3



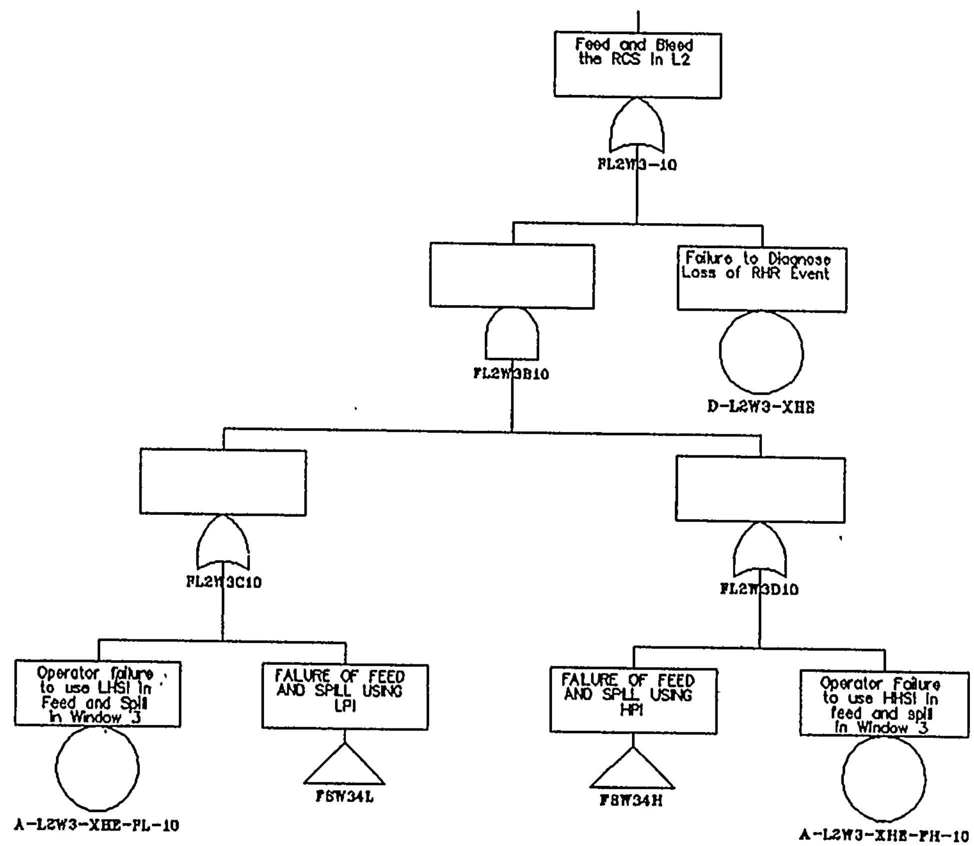
Feed and Bleed the RCS in L2, Window 3



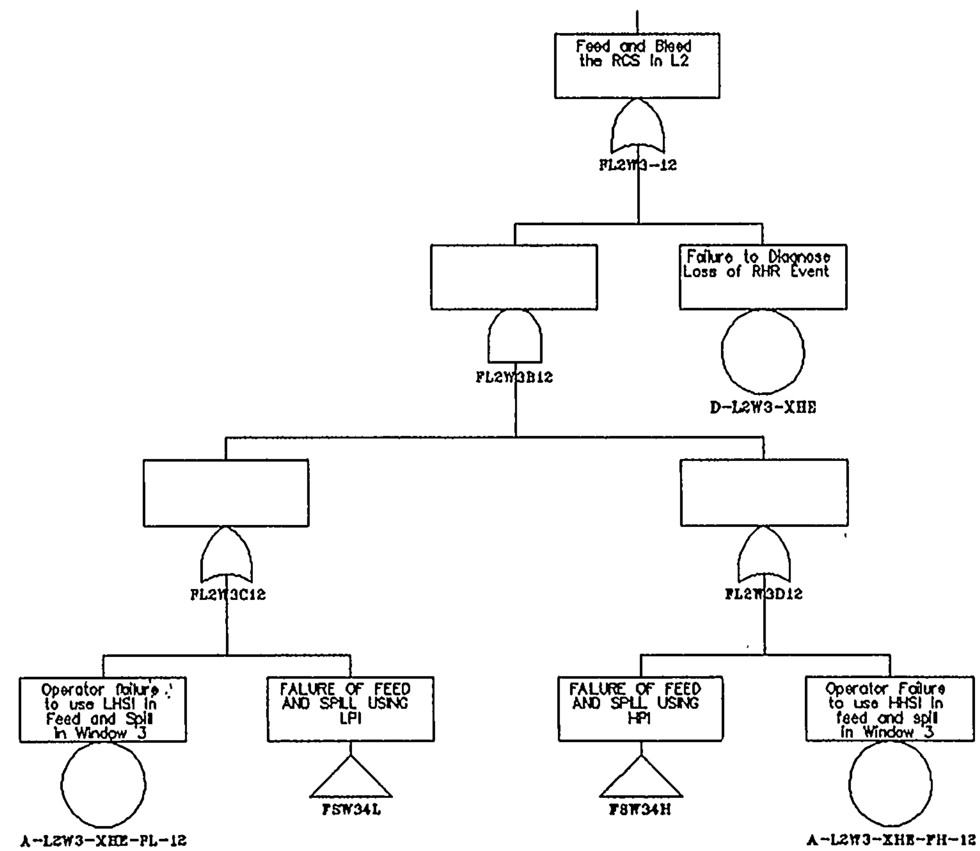
Feed and Bleed the RCS in L2, Window 3



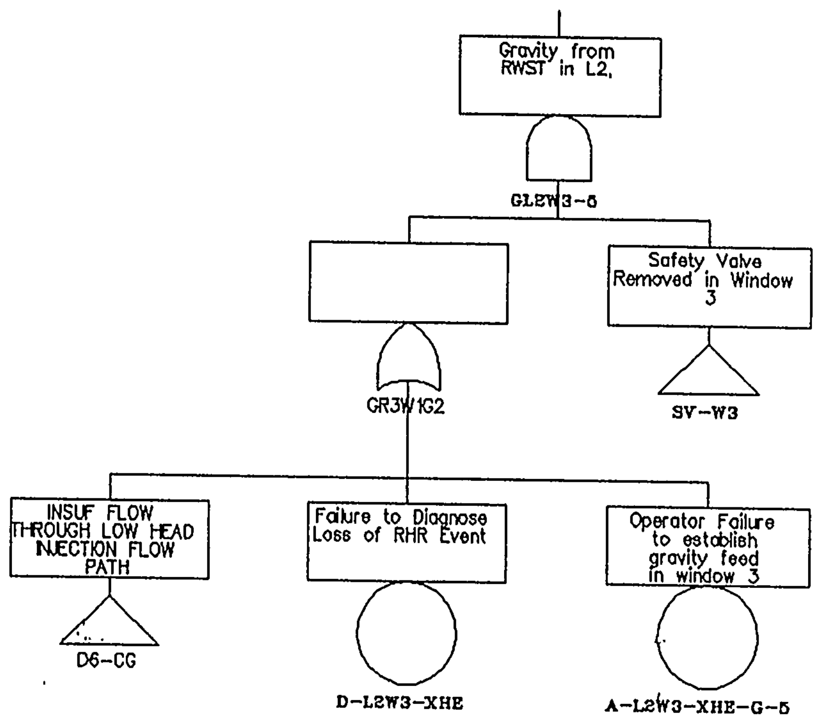
Feed and Bleed the RCS in L2, Window 3



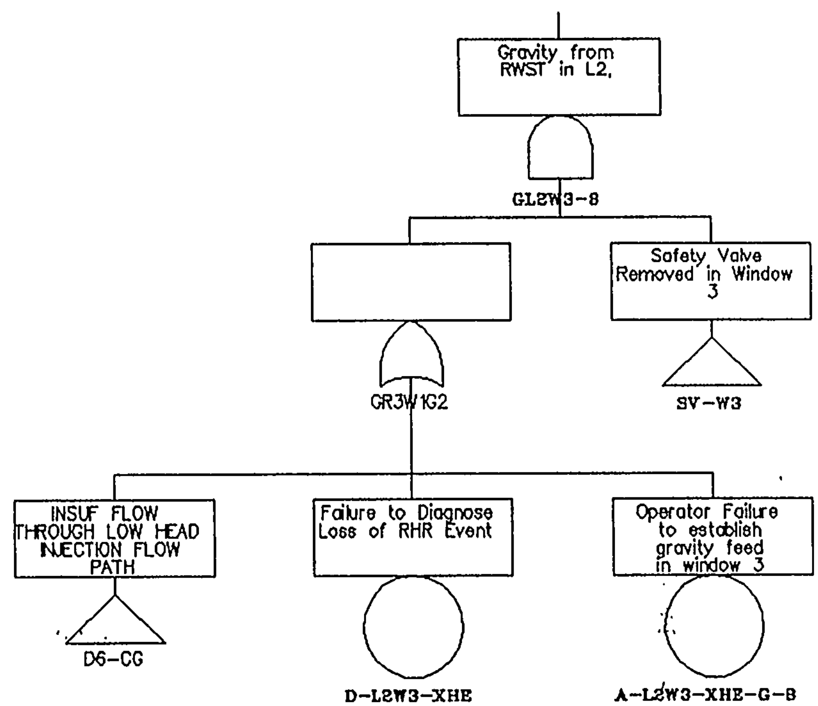
Feed and Bleed the RCS in L2, Window 3

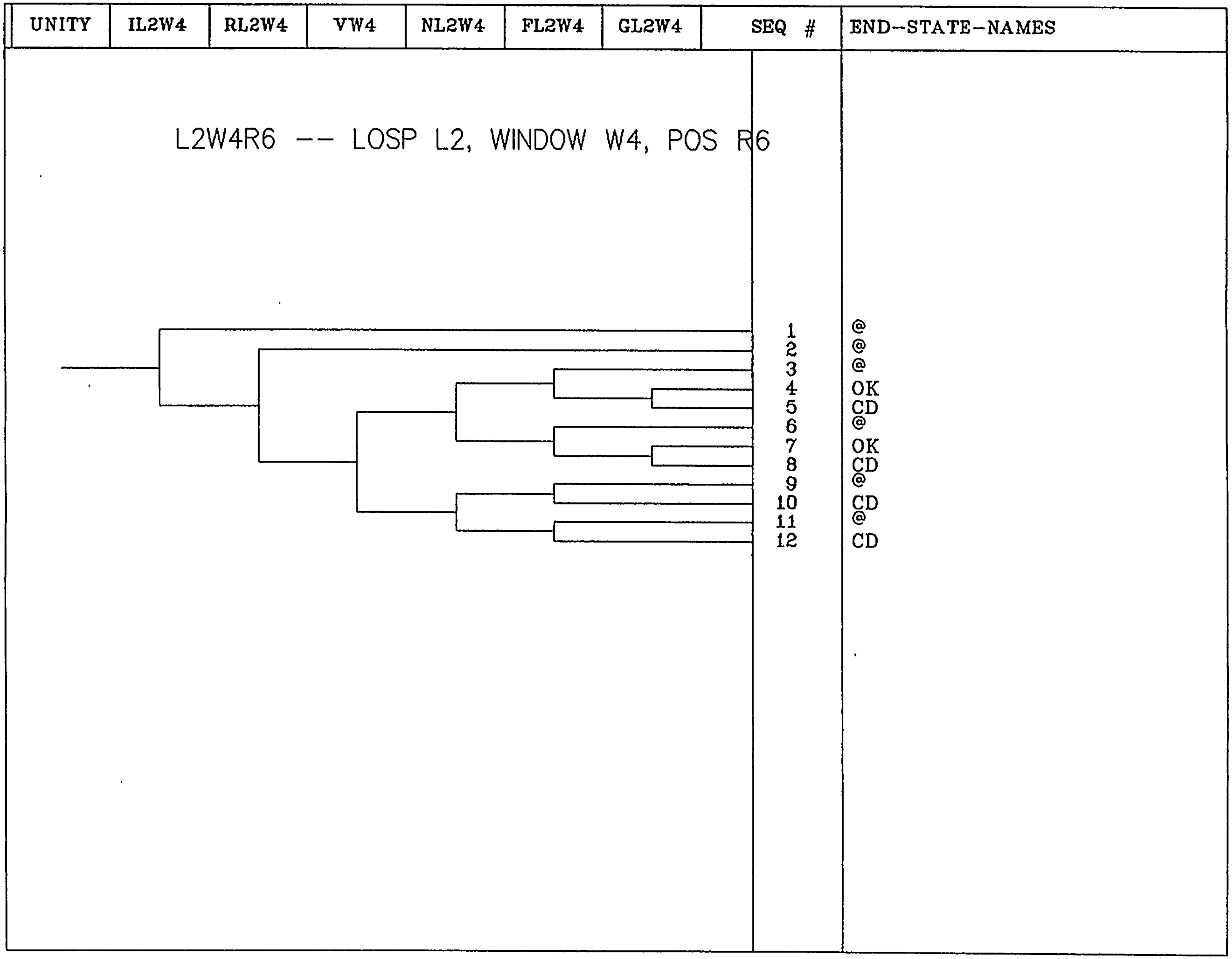


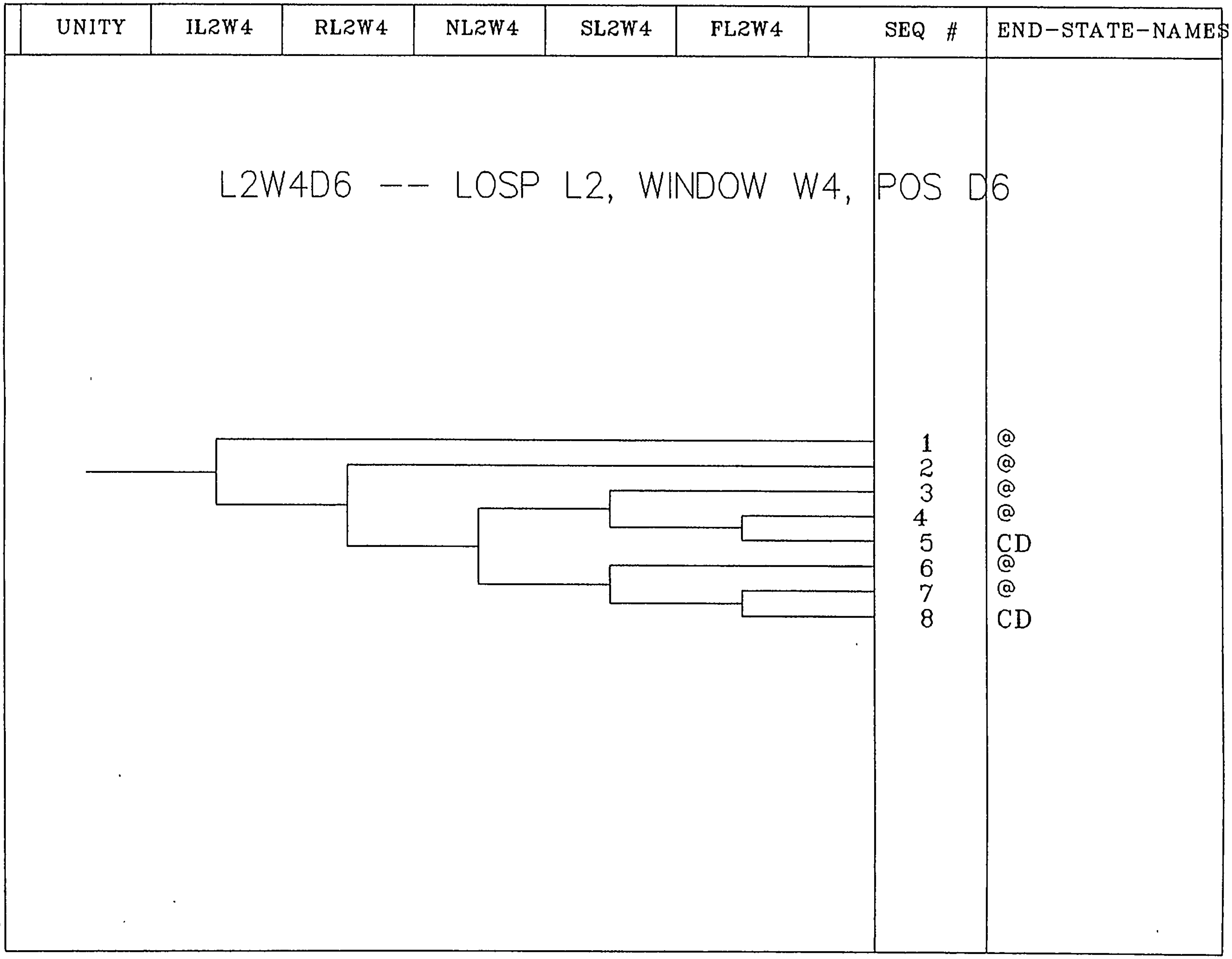
Gravity from RWST in L2, Window 3

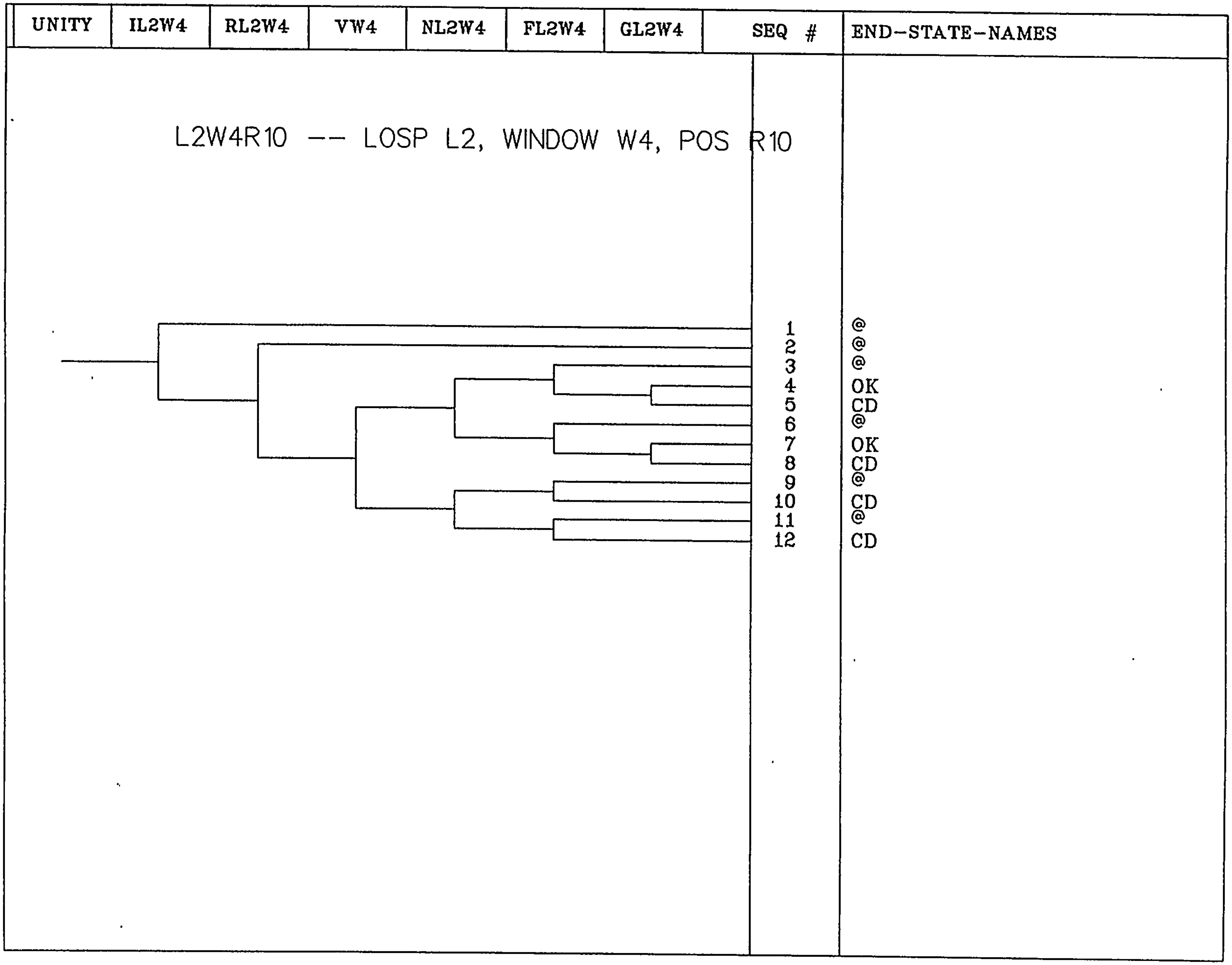


Gravity from RWST in L2, Window 3

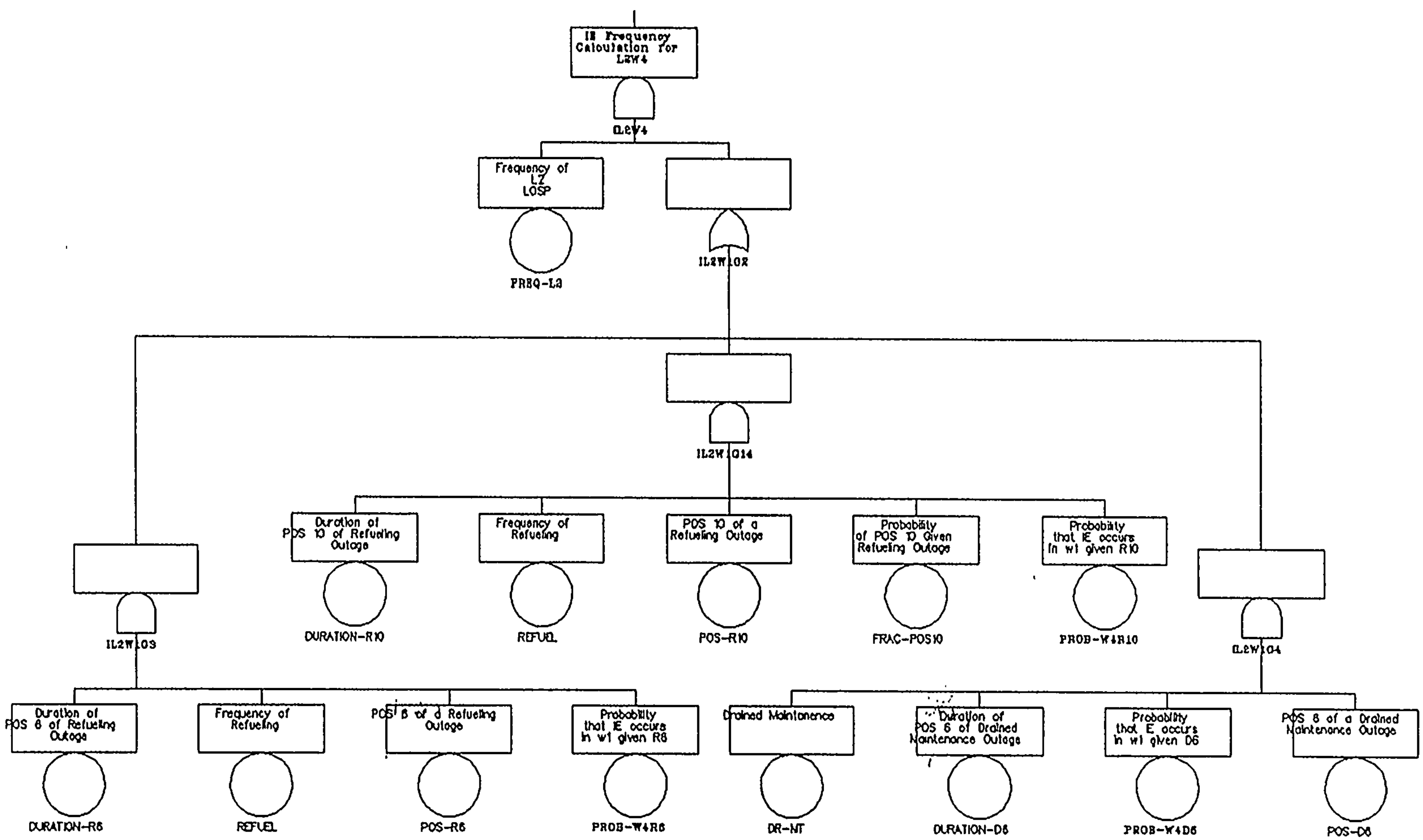



UNITY
IL2W4
RL2W4
VW4
NL2W4
FL2W4
GL2W4
SEQ #
END-STATE-NAMES
L2W4R6 -- LOSP L2, WINDOW W4, POS R6
1 @
2 @
3 @
4 OK
5 CD
6 @
7 OK
8 CD
9 @
10 CD
11 @
12 CD

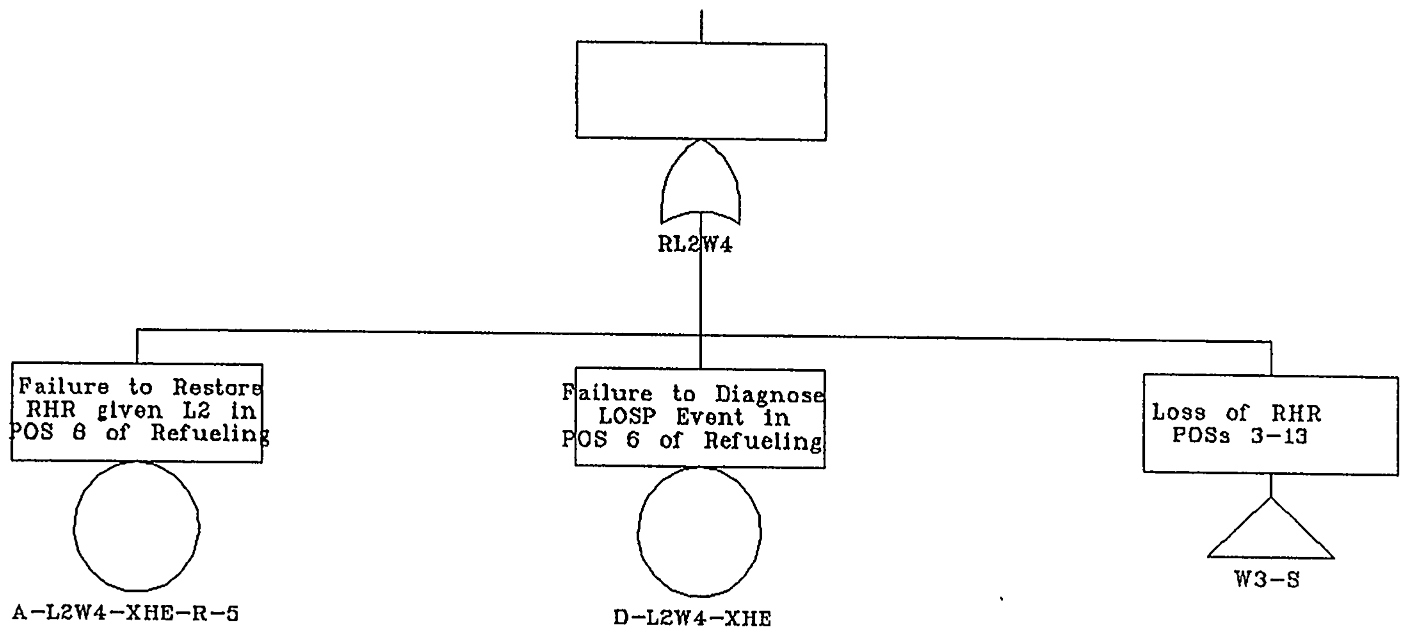

UNITY
IL2W4
RL2W4
NL2W4
SL2W4
FL2W4
SEQ #
END-STATE-NAMES
L2W4D6 -- LOSP L2, WINDOW W4, POS D6
1 @
2 @
3 @
4 @
5 CD
6 @
7 @
8 CD


UNITY
IL2W4
RL2W4
VW4
NL2W4
FL2W4
GL2W4
SEQ #
END-STATE-NAMES
L2W4R10 -- LOSP L2, WINDOW W4, POS R10
1 @
2 @
3 @
4 OK
5 CD
6 @
7 OK
8 CD
9 @
10 CD
11 @
12 CD

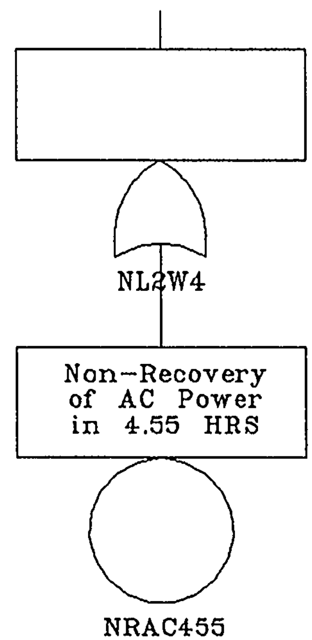
I top event for L2 LOSP – L2 in window 4



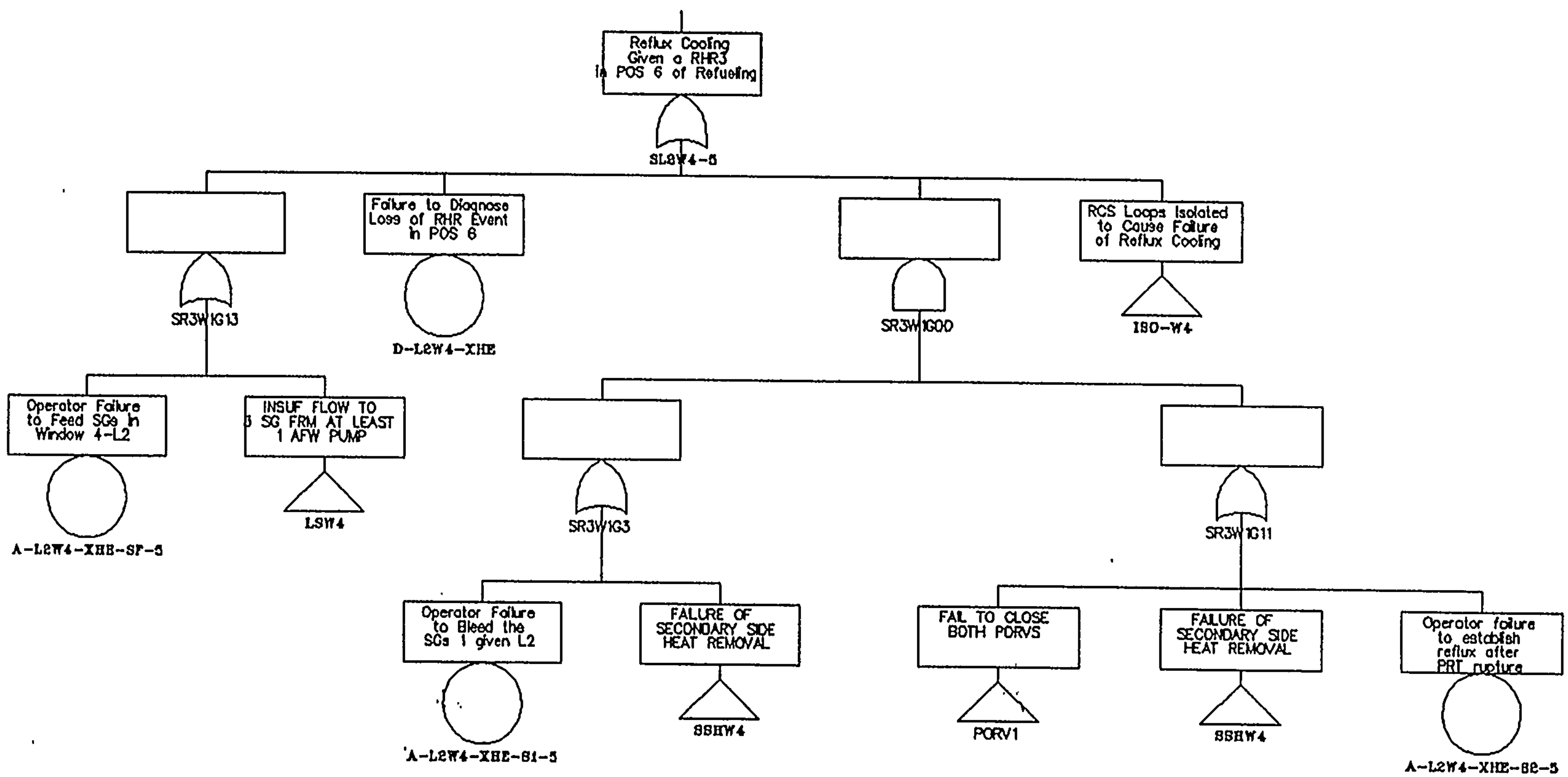
Restore RHR given L2 in POS 6 – Refueling



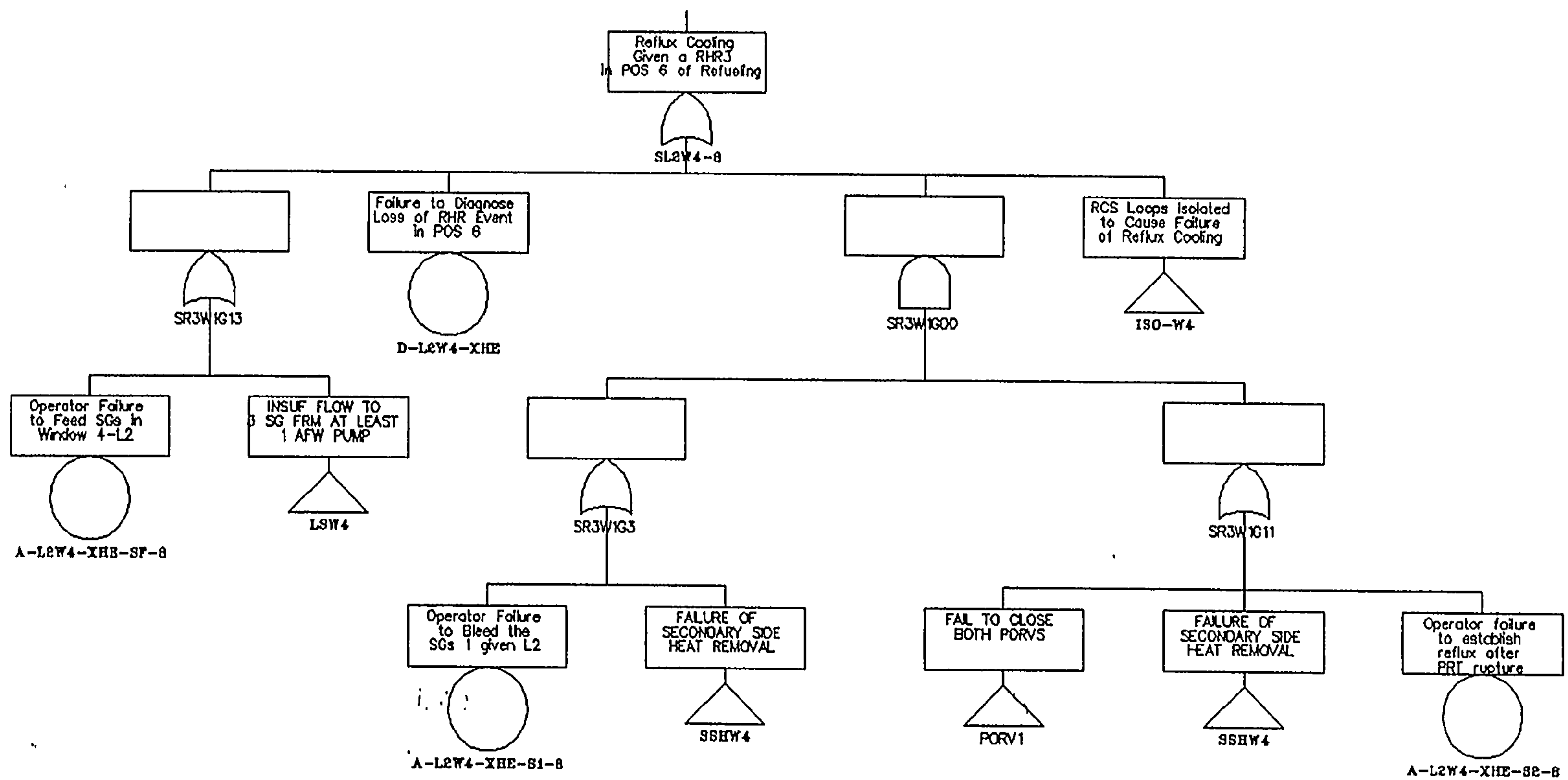
Non-Recovery of AC Power



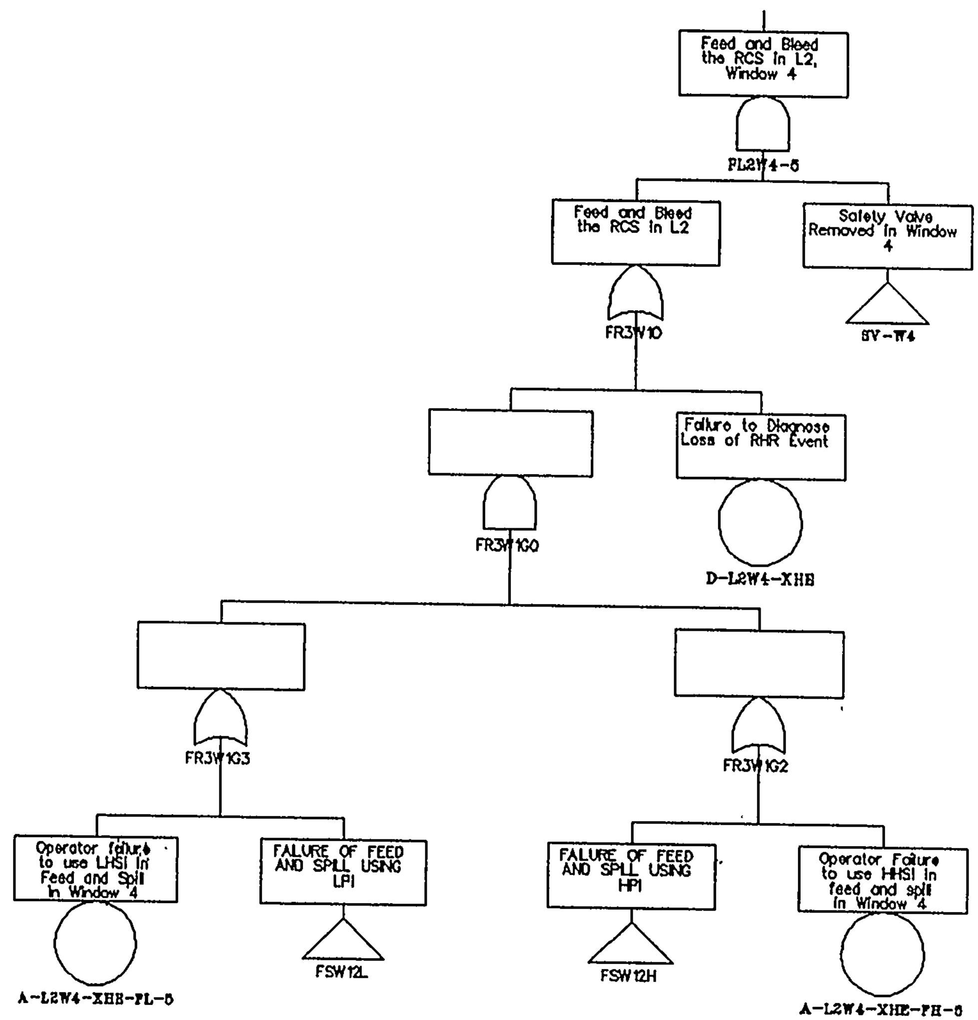
Reflux Cooling in window 4



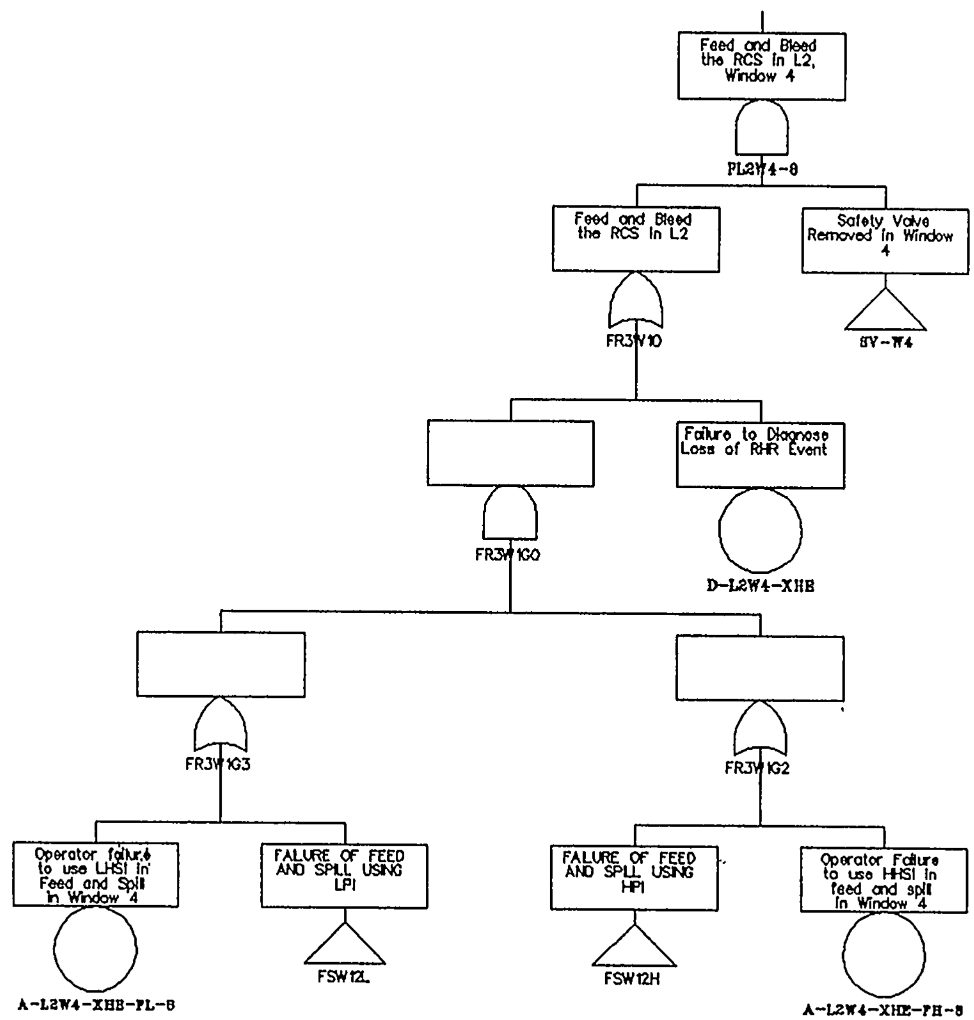
Reflux Cooling in window 4



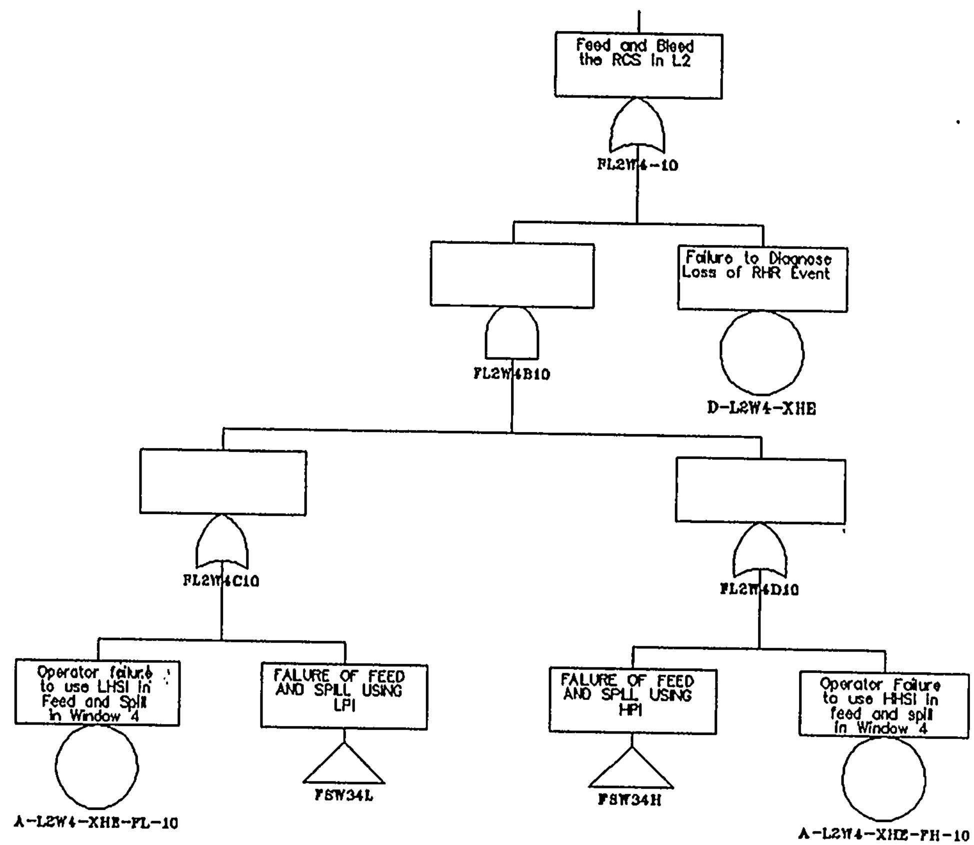
Feed and Bleed the RCS in L2, Window 4



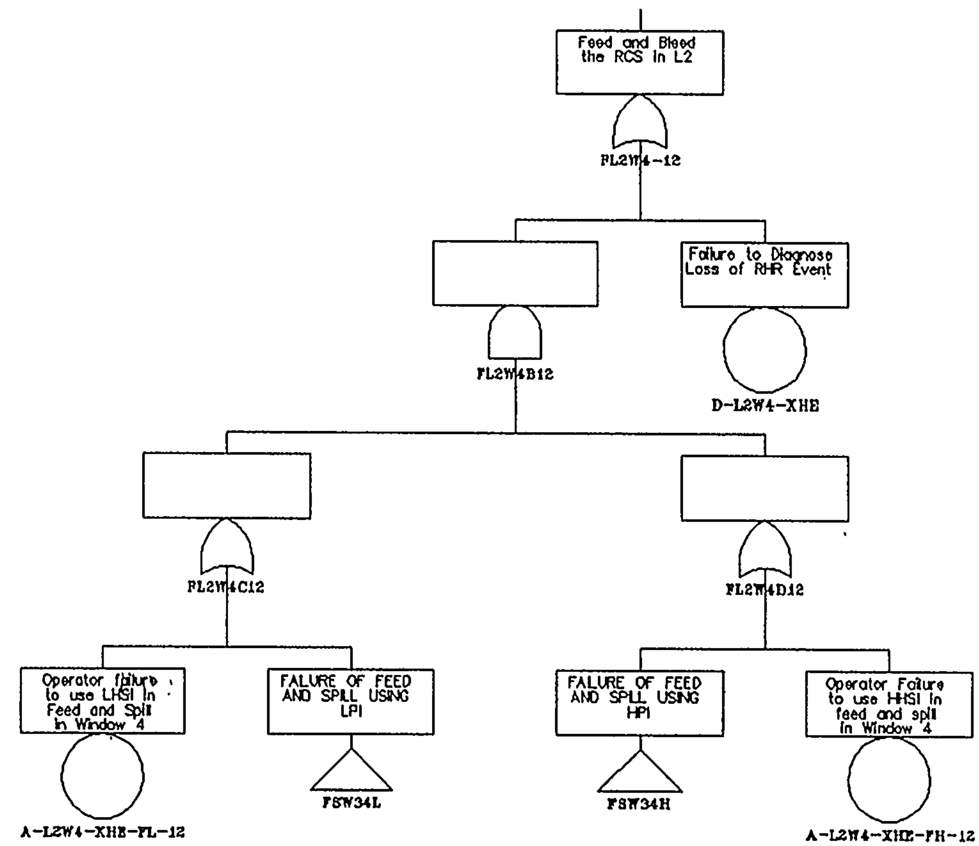
Feed and Bleed the RCS in L2, Window 4



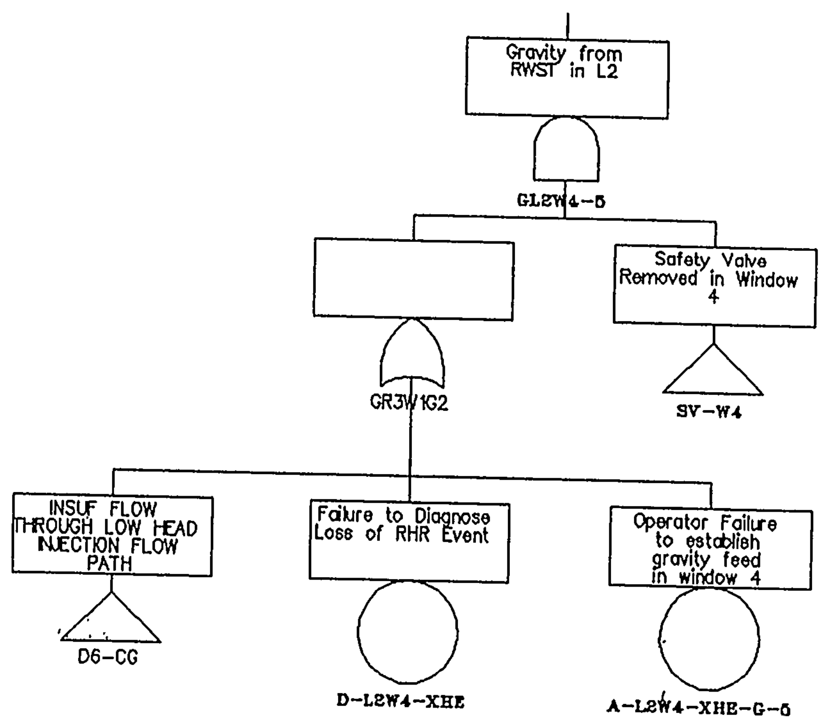
Feed and Bleed the RCS in L2, Window 4



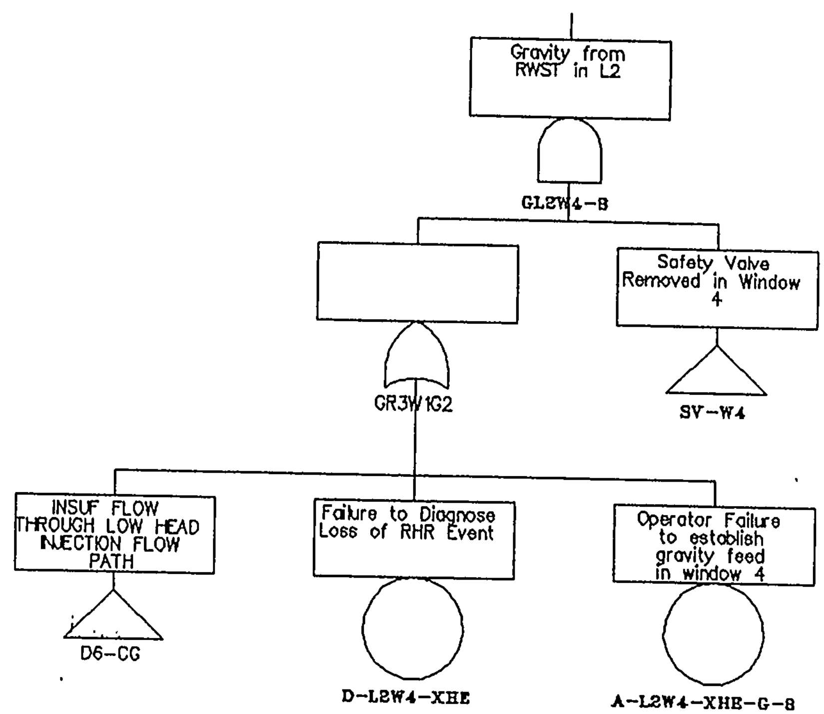
Feed and Bleed the RCS in L2, Window 4



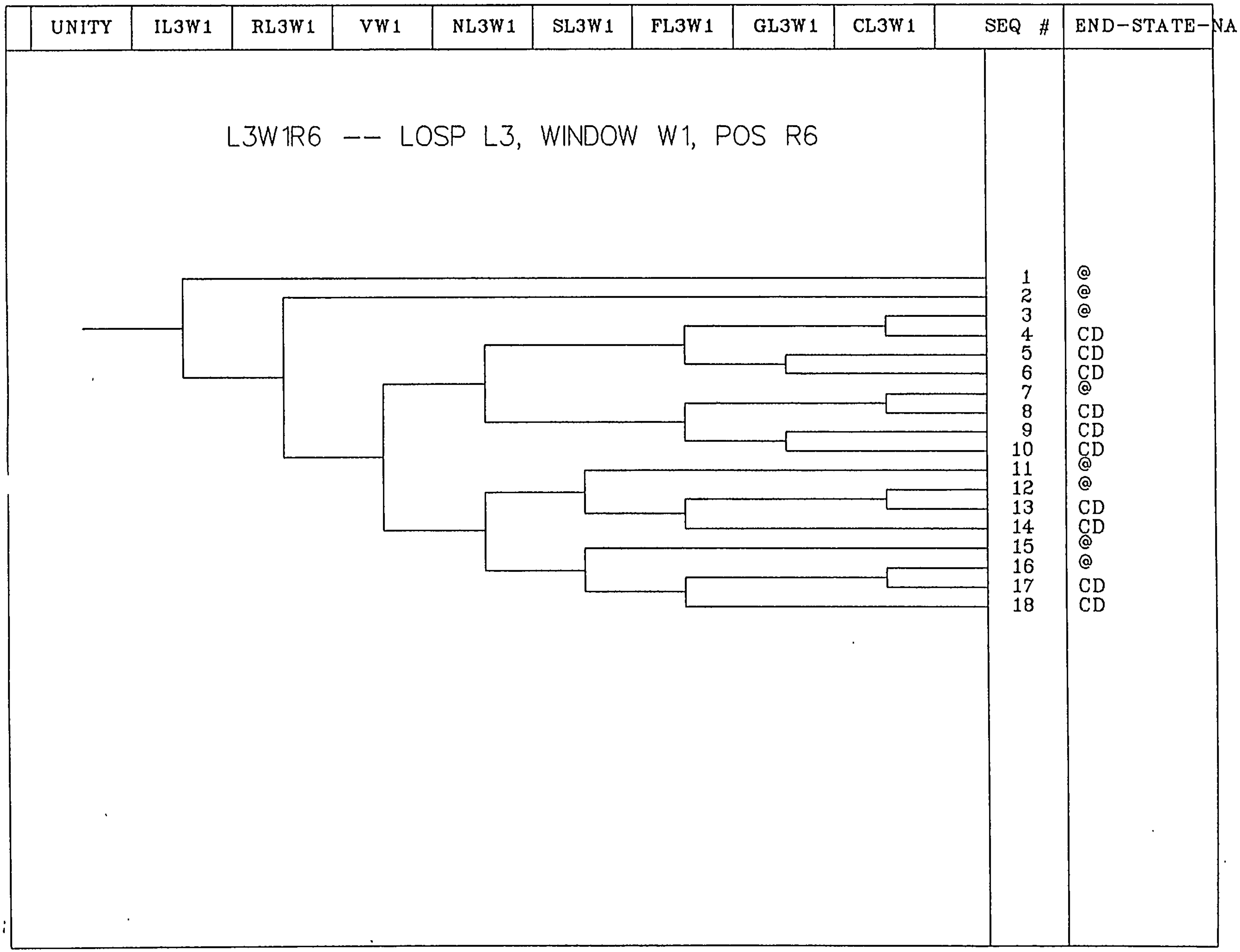
Gravity from RWST in L2, Window 4

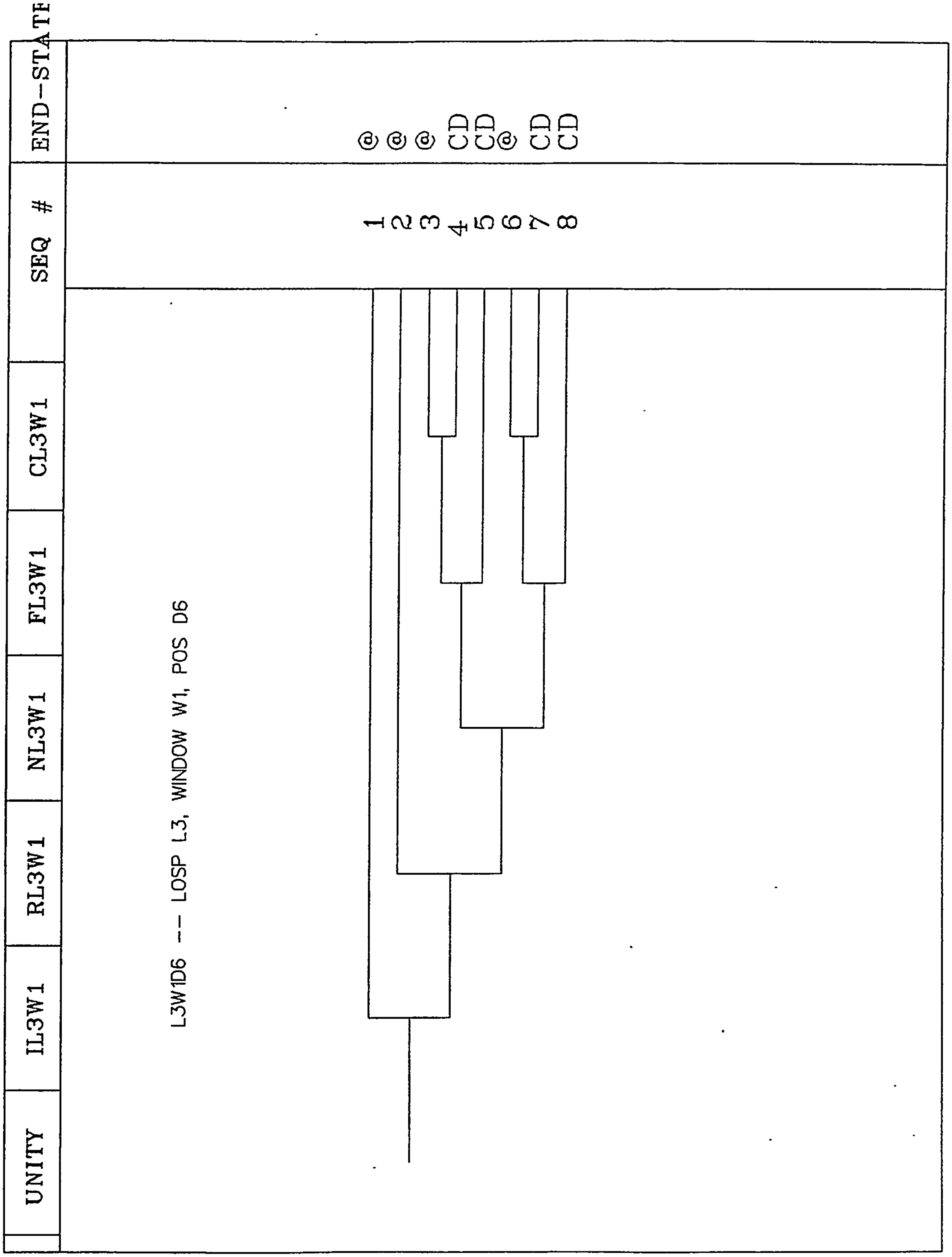


Gravity from RWST in L2, Window 4

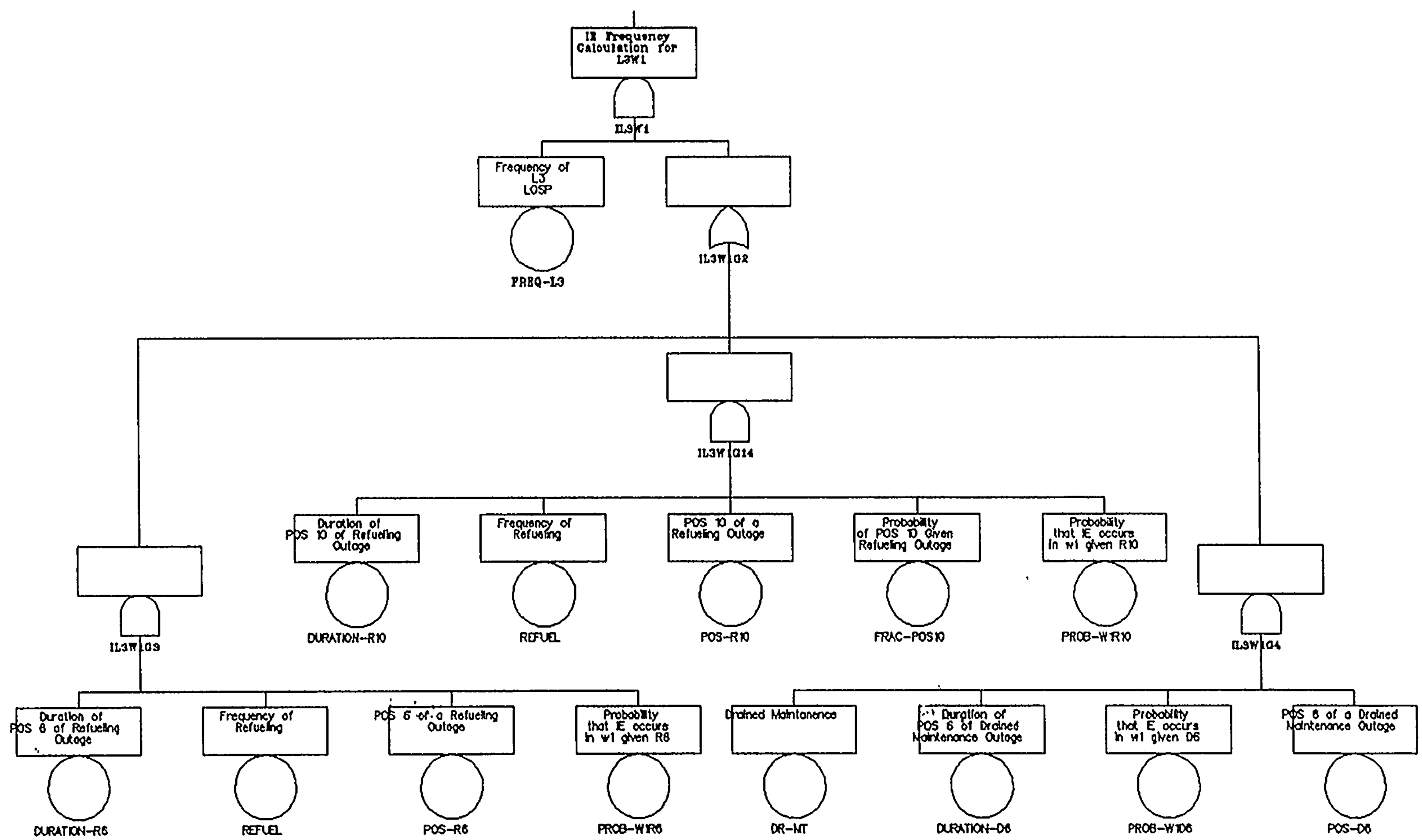


Appendix E.8 Event Trees and High Level Fault Trees for Unit 1 Blackout(L3)

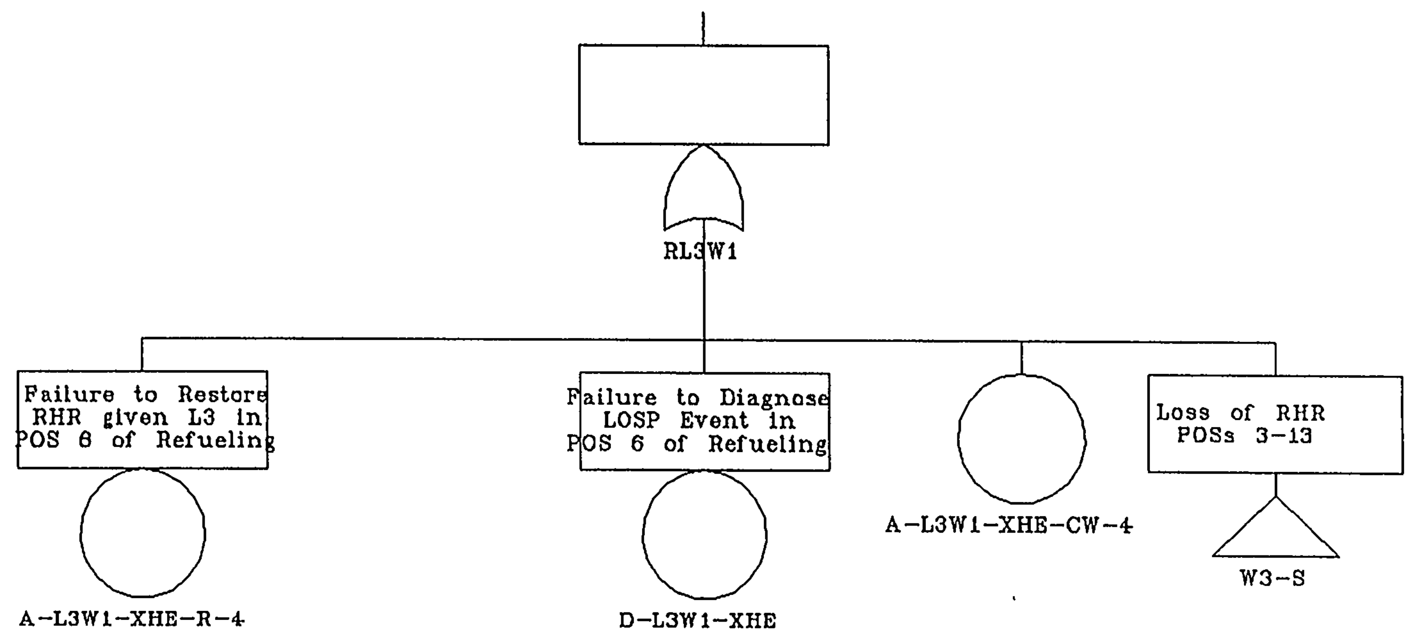

UNITY
IL3W1
RL3W1
VW1
NL3W1
SL3W1
FL3W1
GL3W1
CL3W1
SEQ #
END-STATE-NAM
L3W1R6 -- LOSP L3, WINDOW W1, POS R6
1 @
2 @
3 @
4 CD
5 CD
6 CD
7 @
8 CD
9 CD
10 CD
11 @
12 @
13 CD
14 CD
15 @
16 @
17 CD
18 CD


END-STATE
SEQ #
CL3W1
FL3W1
NL3W1
RL3W1
IL3W1
UNITY
L3W1D6 -- LOSP L3, WINDOW W1, POS D6
1 @
2 @
3 @
4 CD
5 CD
6 @
7 CD
8 CD

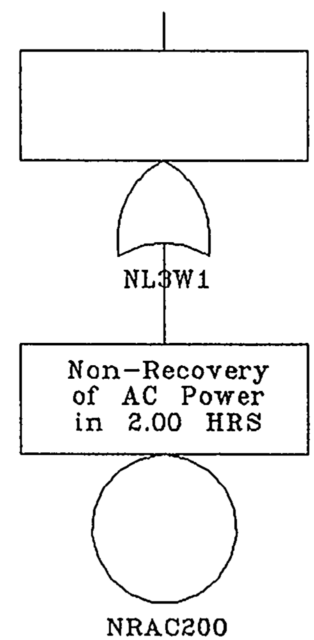
I top event for L3 LOSP – L3 in window 1



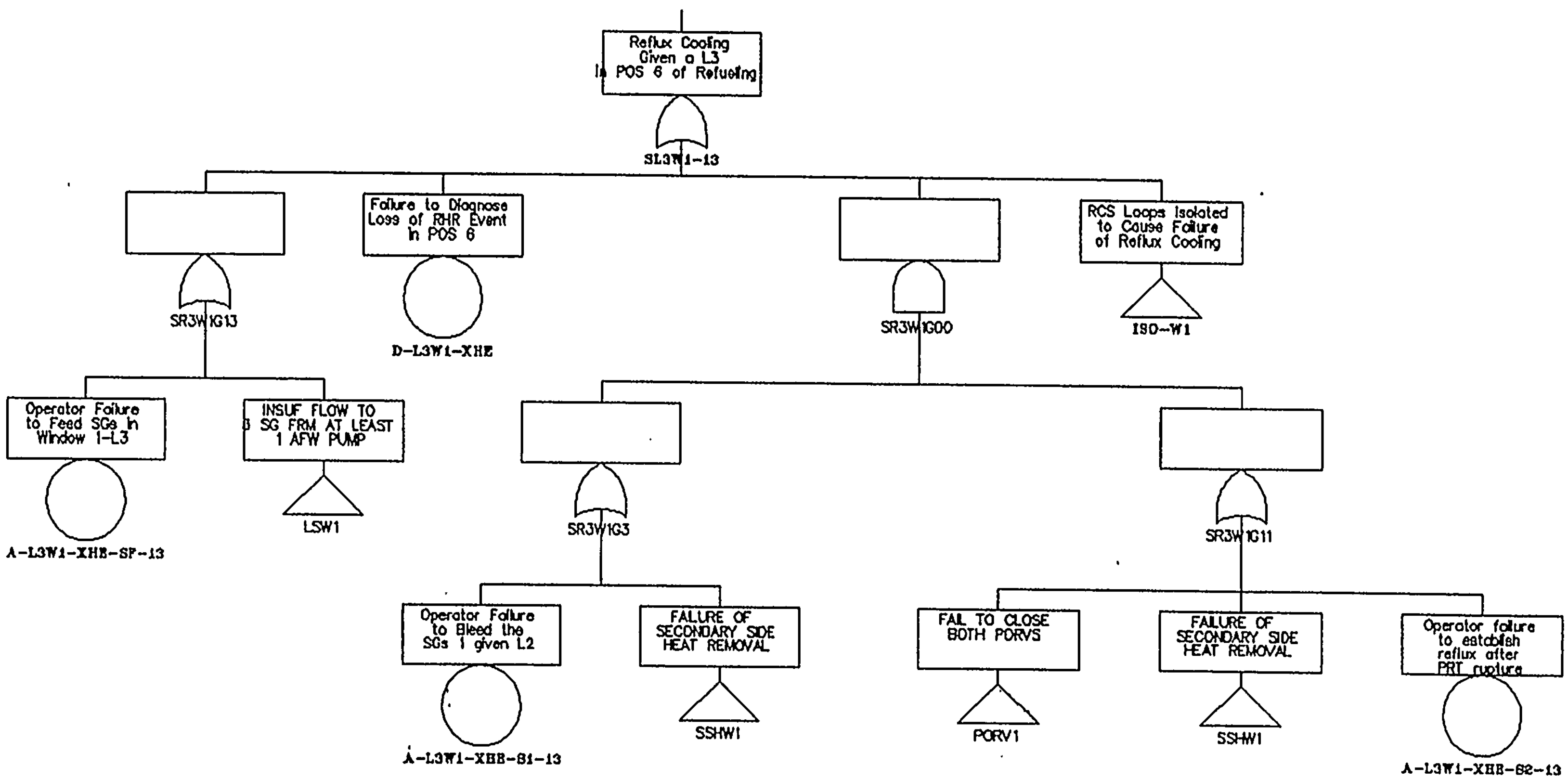
Restore RHR given L3 in POS 6 - Refueling



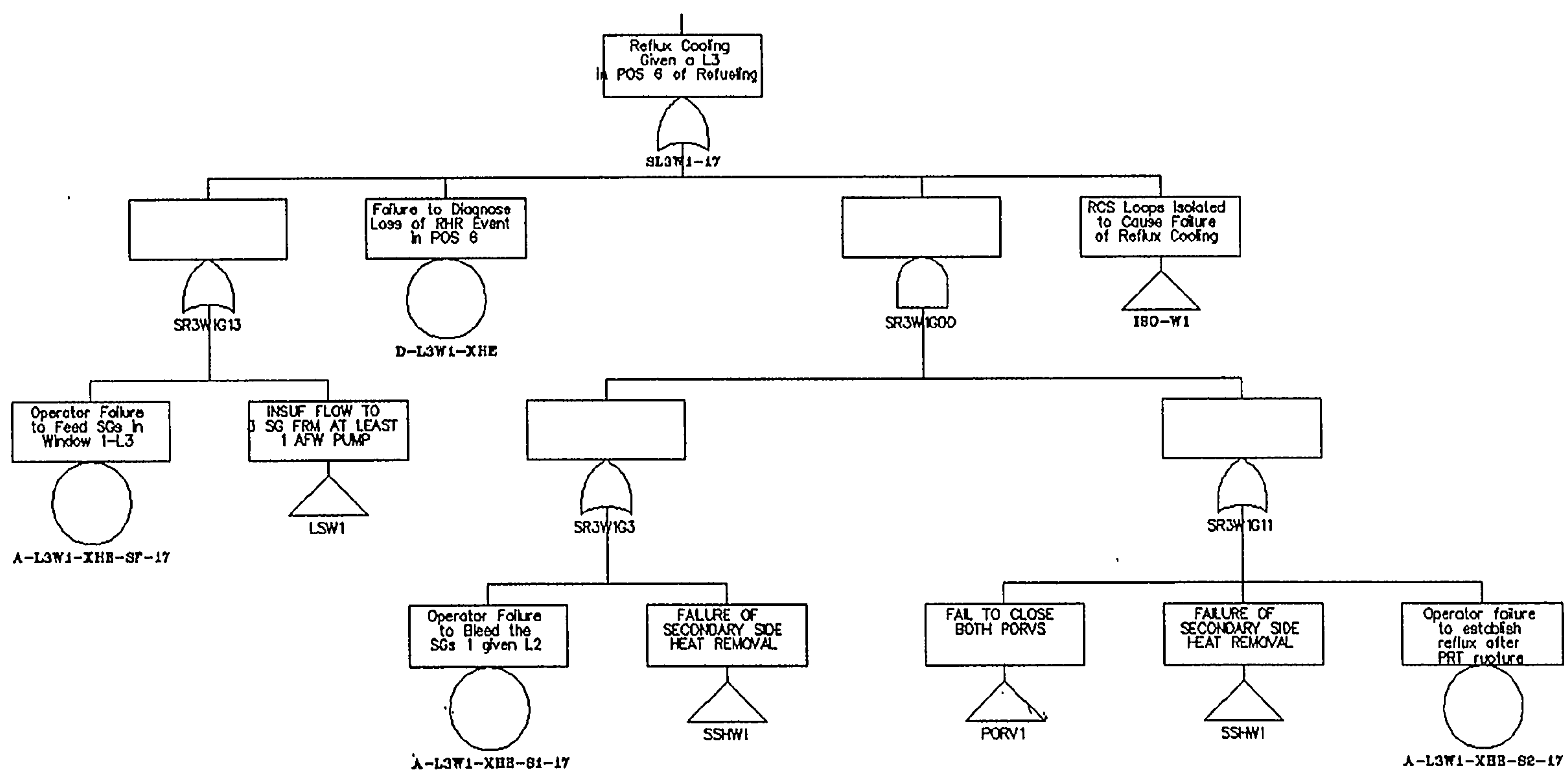
Non-Recovery of AC Power in 144 min. of LOOP



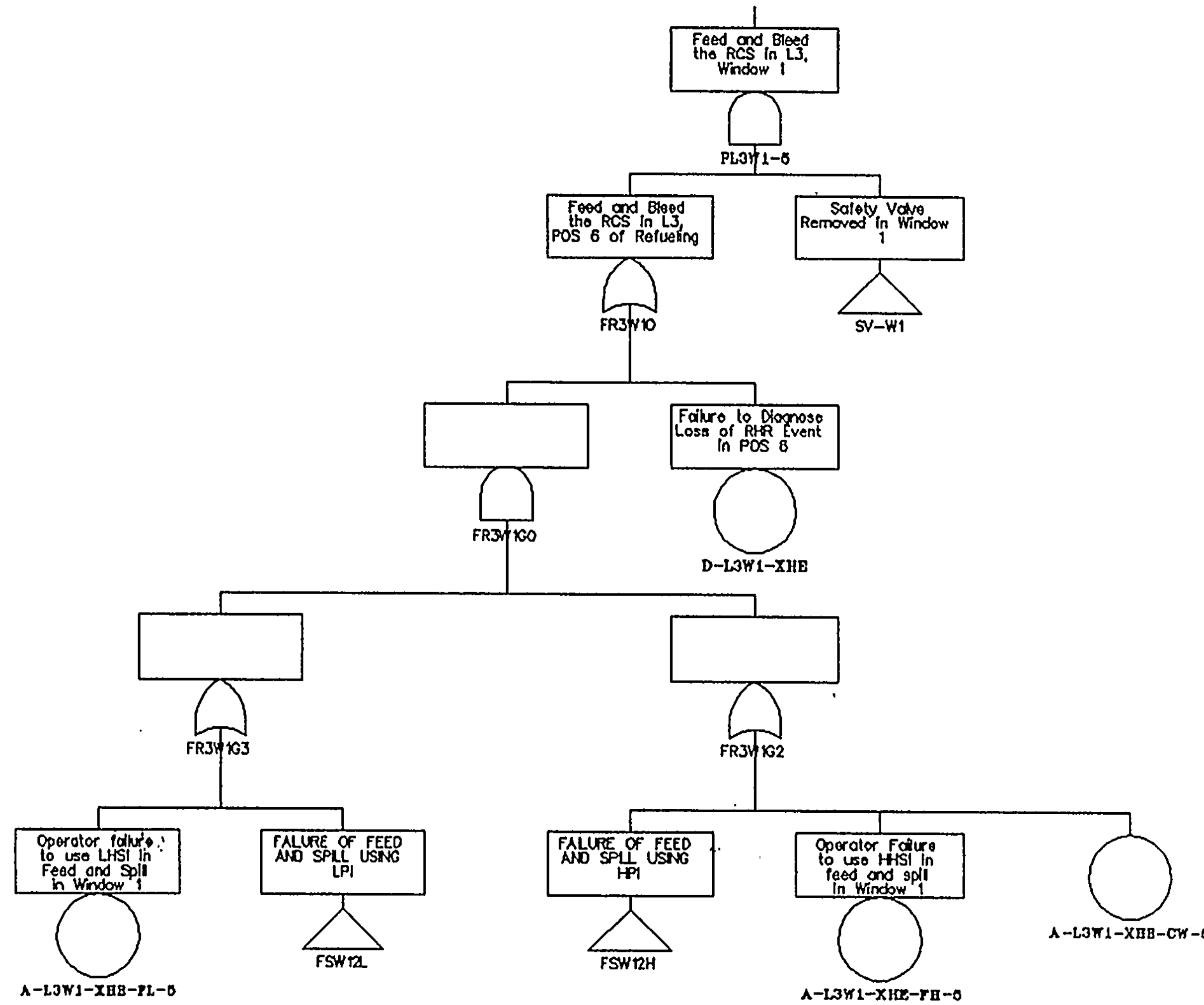
Reflux Cooling in window 1



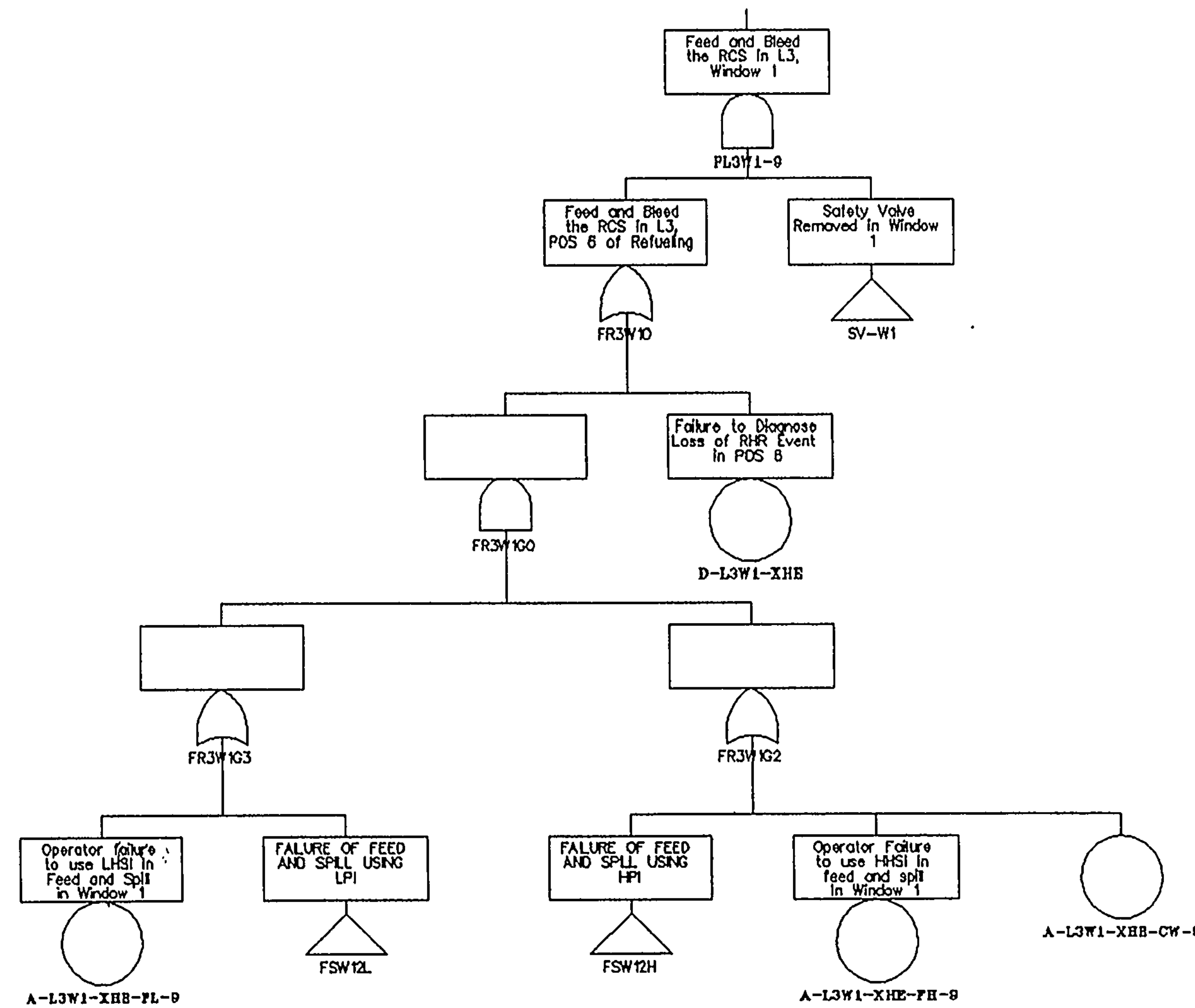
Reflux Cooling in window 1

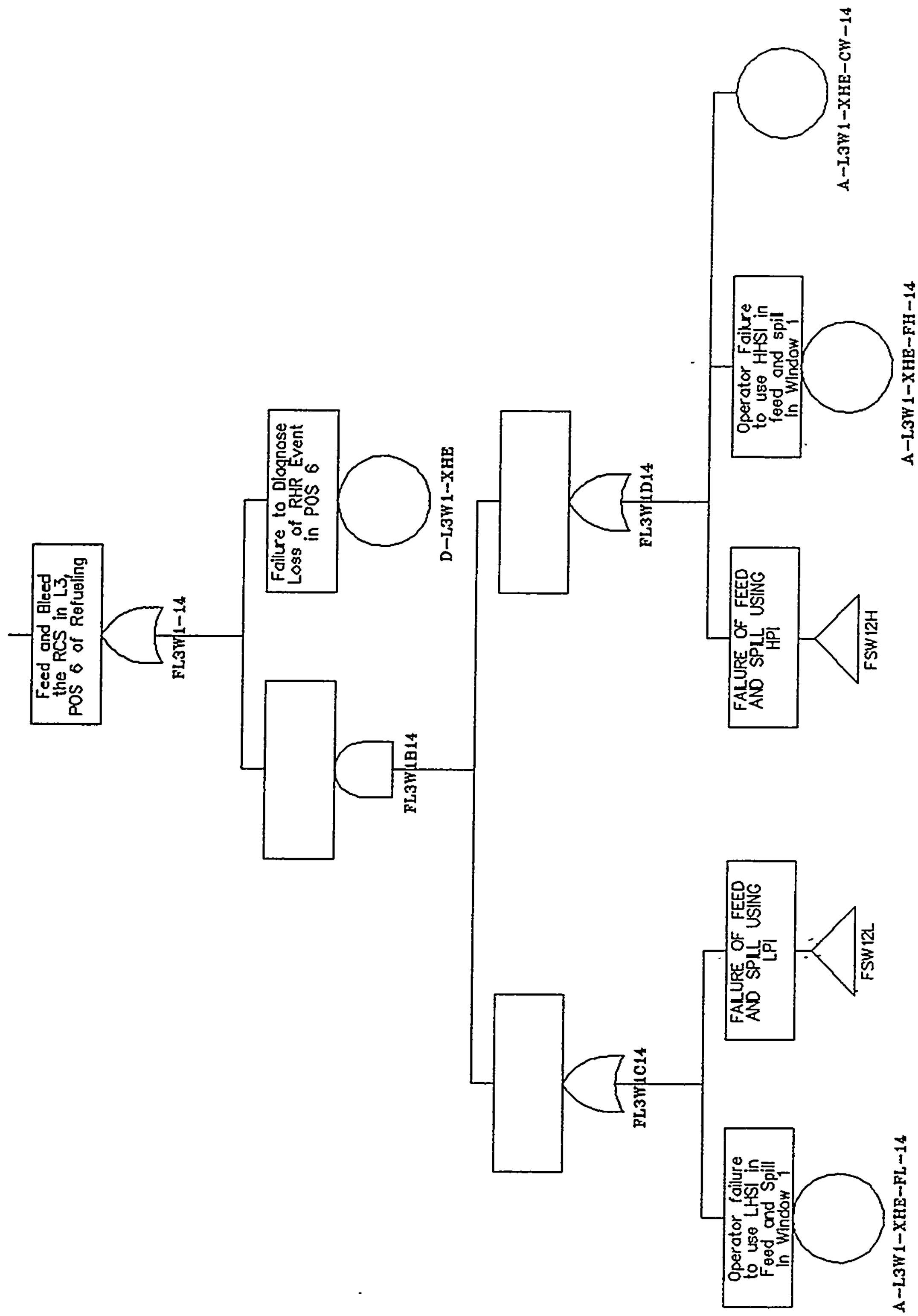


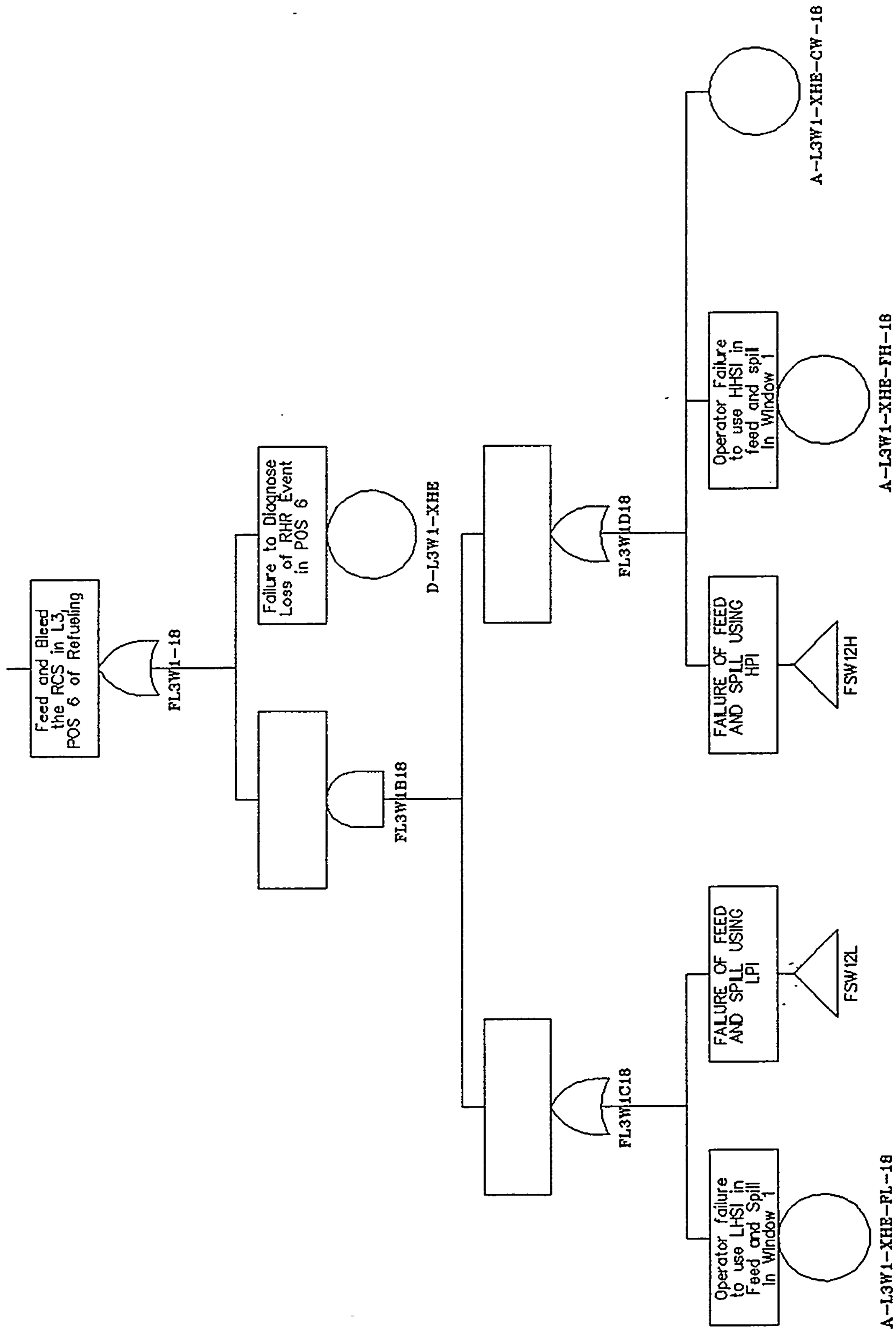
Feed and Bleed the RCS in L3, Window 1



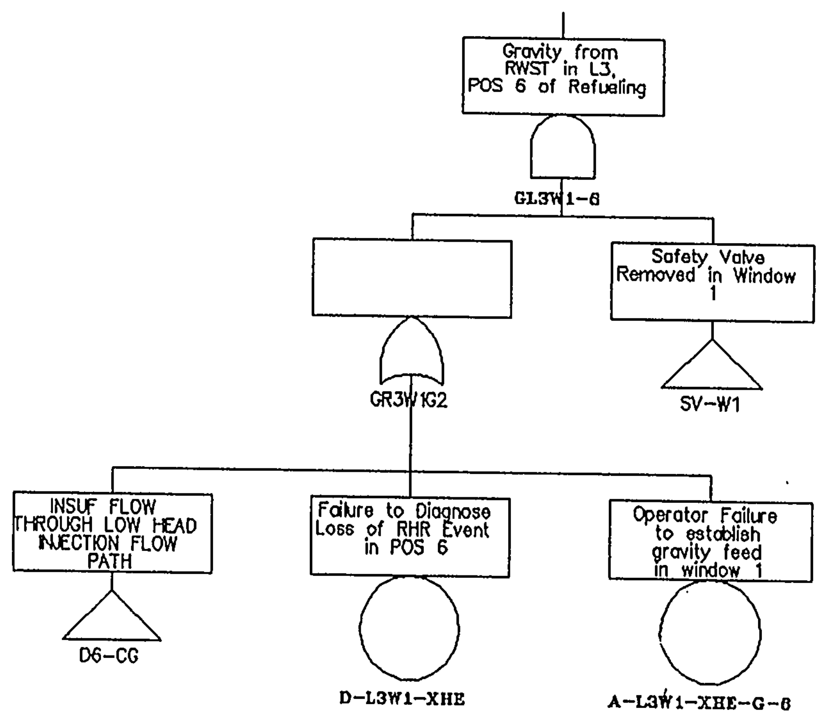
Feed and Bleed the RCS in L3, Window 1



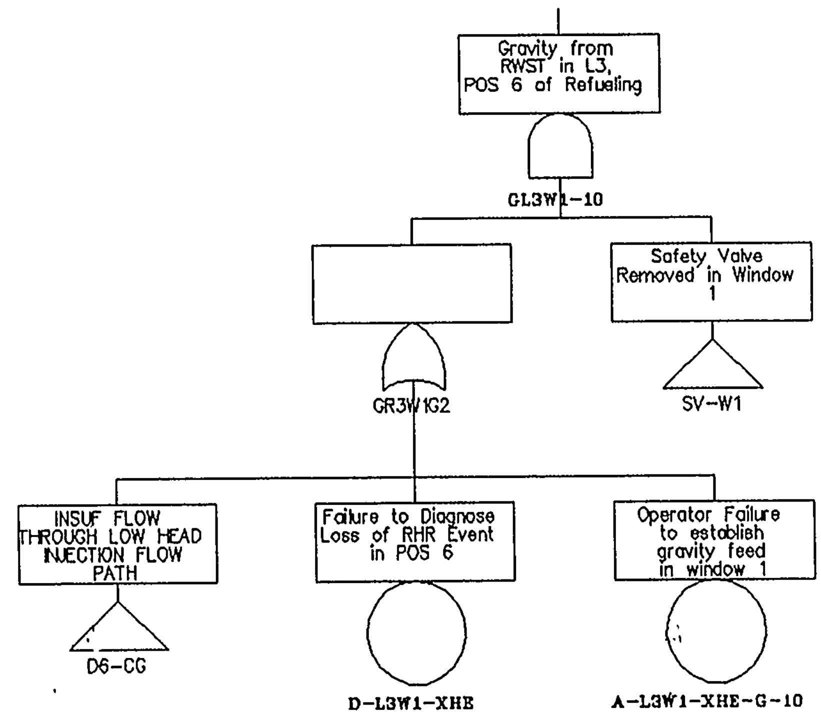

Feed and Bleed the RCS in L3, POS 6 of Refueling
FL3W1-14
Failure to Diagnose Loss of RHR Event in POS 6
D-L3W1-XHE
FL3W1B14
FL3W1D14
FAILURE OF FEED AND SPILL USING HPI
FSW12H
Operator Failure to use HHSI in feed and spill in Window 1
A-L3W1-XHE-FH-14
A-L3W1-XHE-CW-14
FL3W1C14
FAILURE OF FEED AND SPILL USING LPI
FSW12L
Operator failure to use LHSI in Feed and Spill in Window 1
A-L3W1-XHE-FL-14


Feed and Bleed the RCS in L3, POS 6 of Refueling
FL3W1-18
Failure to Diagnose Loss of RHR Event in POS 6
D-L3W1-XHE
FL3W1B18
FL3W1D18
FL3W1C18
FAILURE OF FEED AND SPILL USING HPI
FSW12H
Operator Failure to use HHSI in feed and spill In Window 1
A-L3W1-XHE-FH-18
A-L3W1-XHE-CW-18
FAILURE OF FEED AND SPILL USING LPI
FSW12L
Operator failure to use LHSI in Feed and Spill In Window 1
A-L3W1-XHE-FL-18

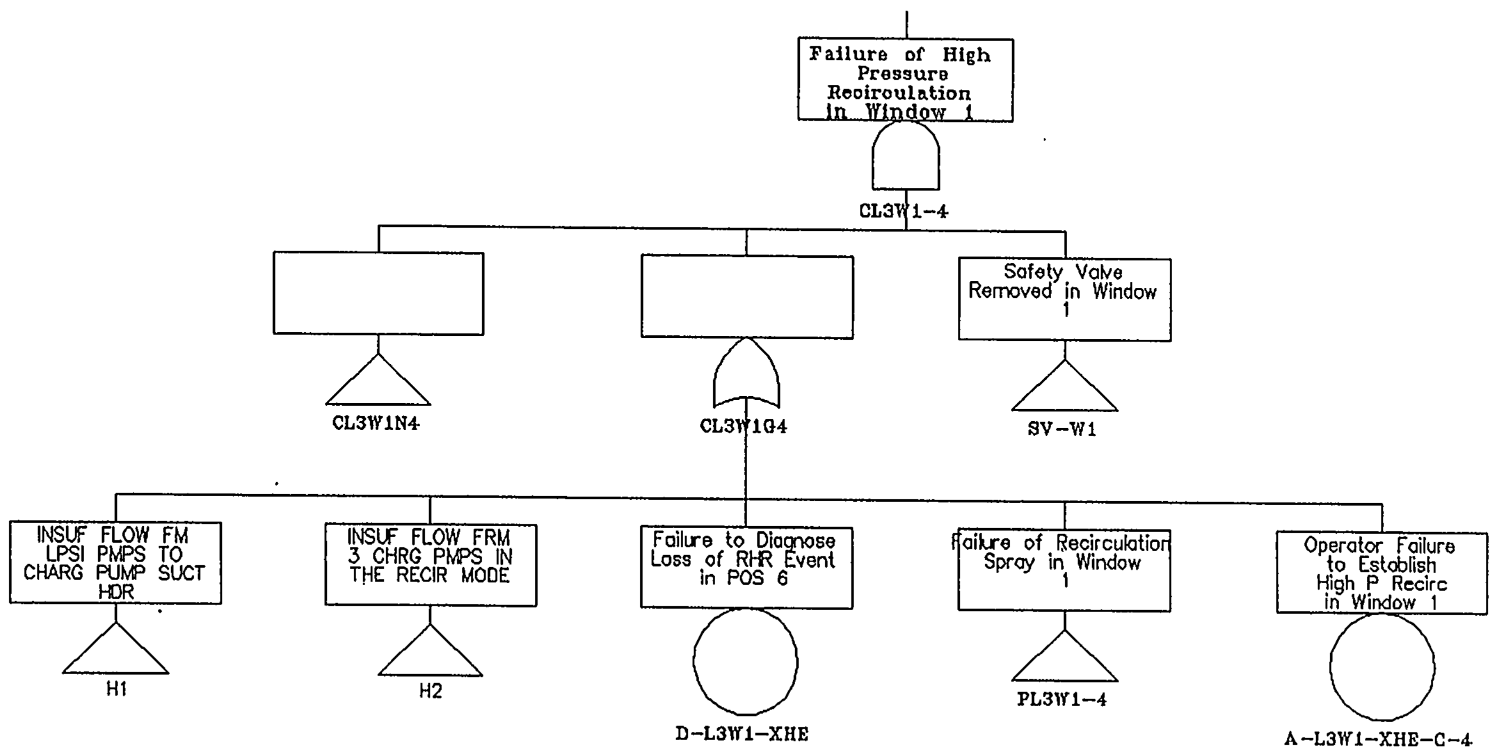
Gravity from RWST in L3, Window 1



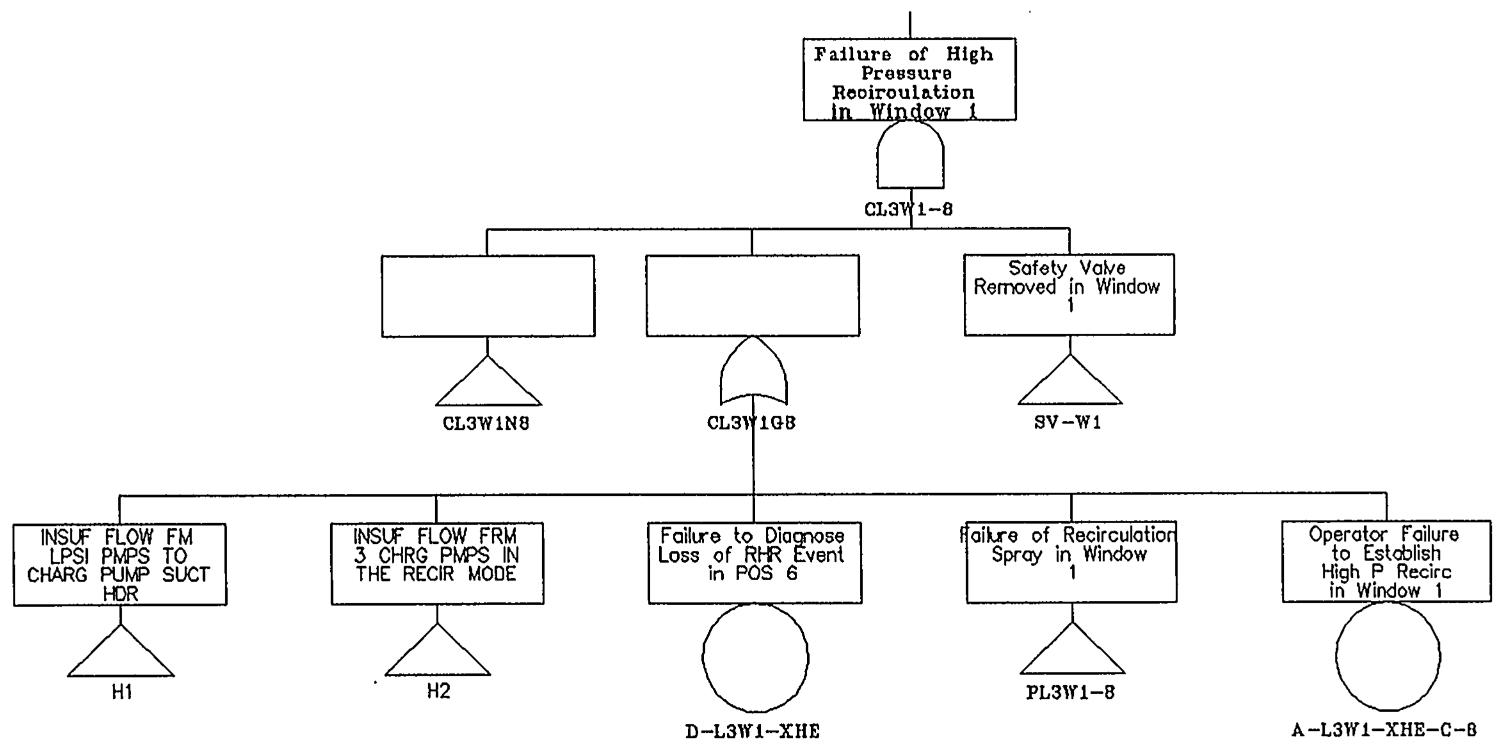
Gravity from RWST in L3, Window 1



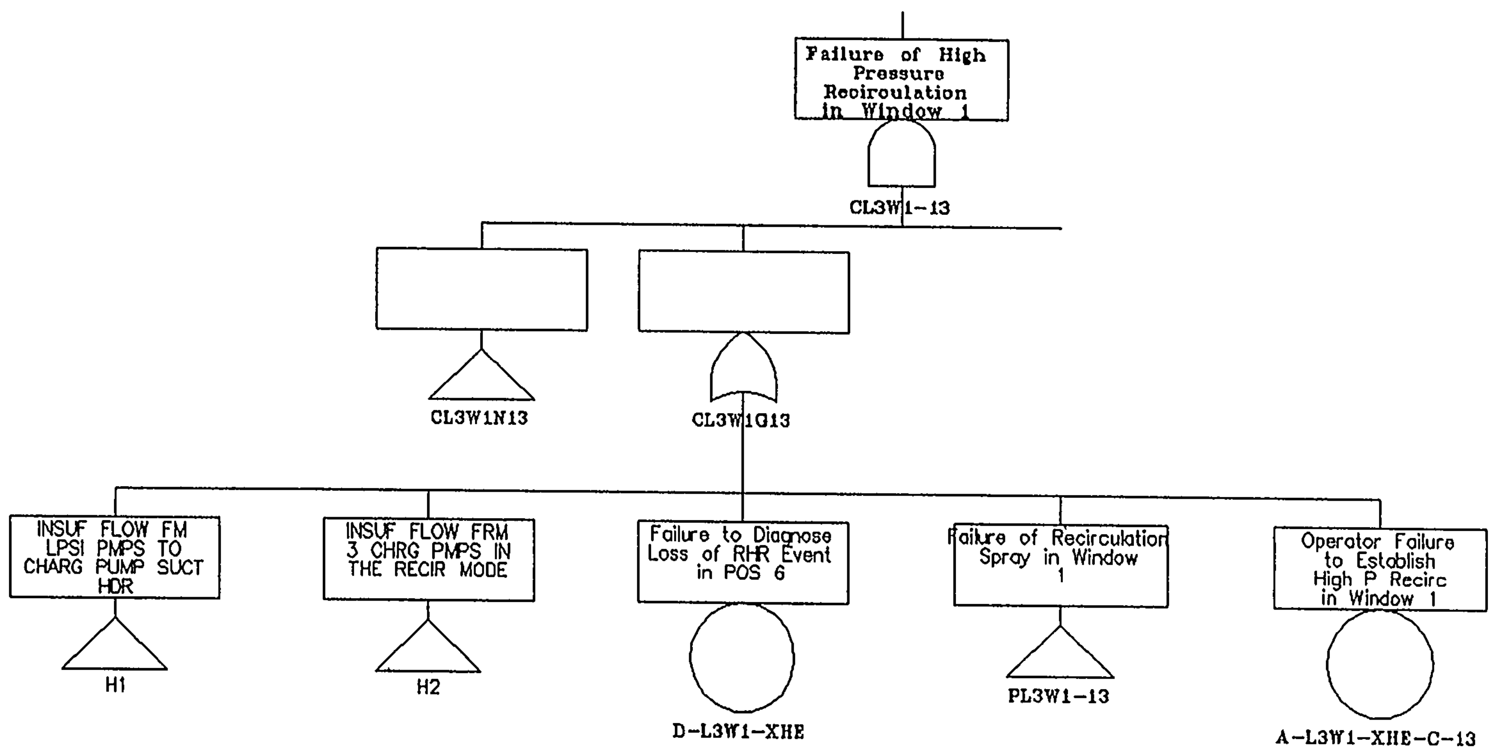
Failure of High Pressure Recirculation in Window 1



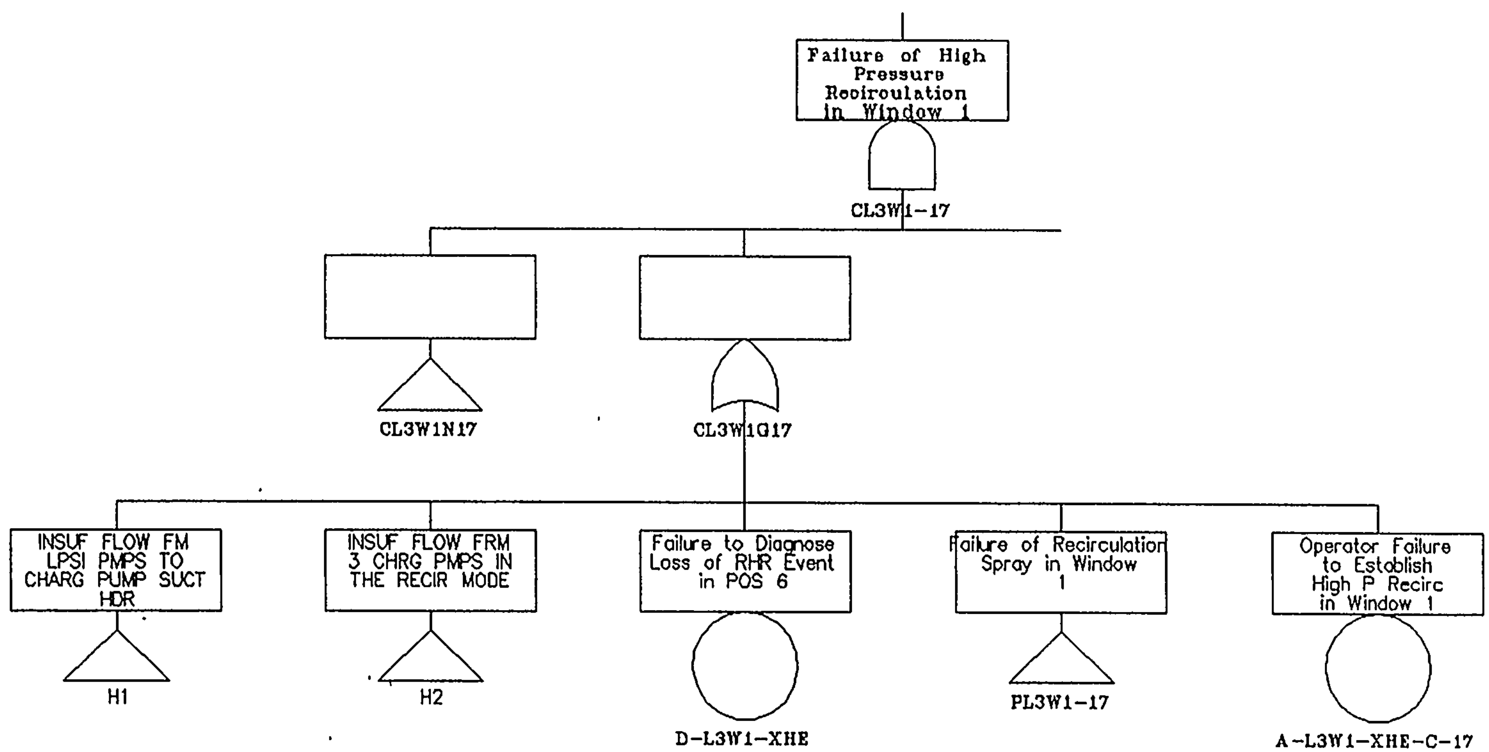
Failure of High Pressure Recirculation in Window 1

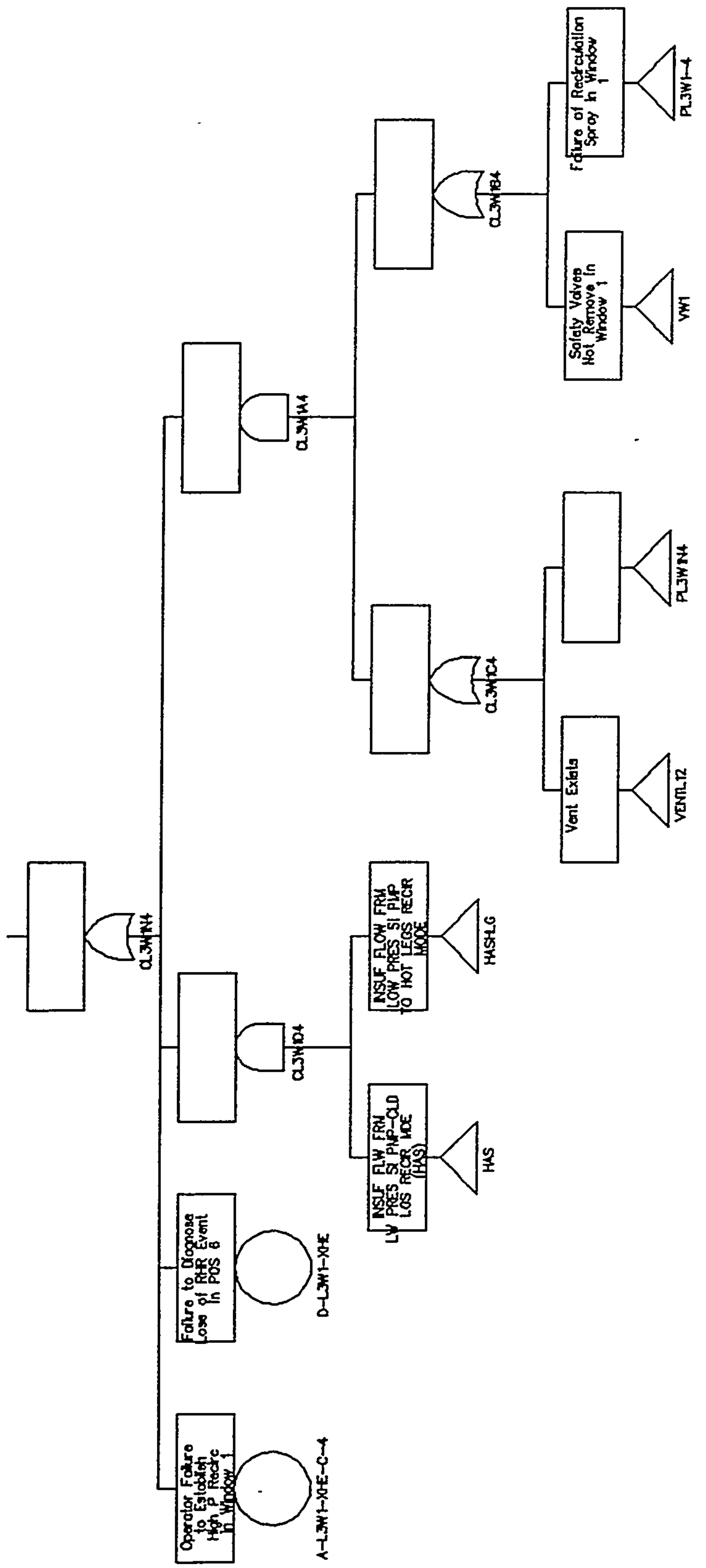


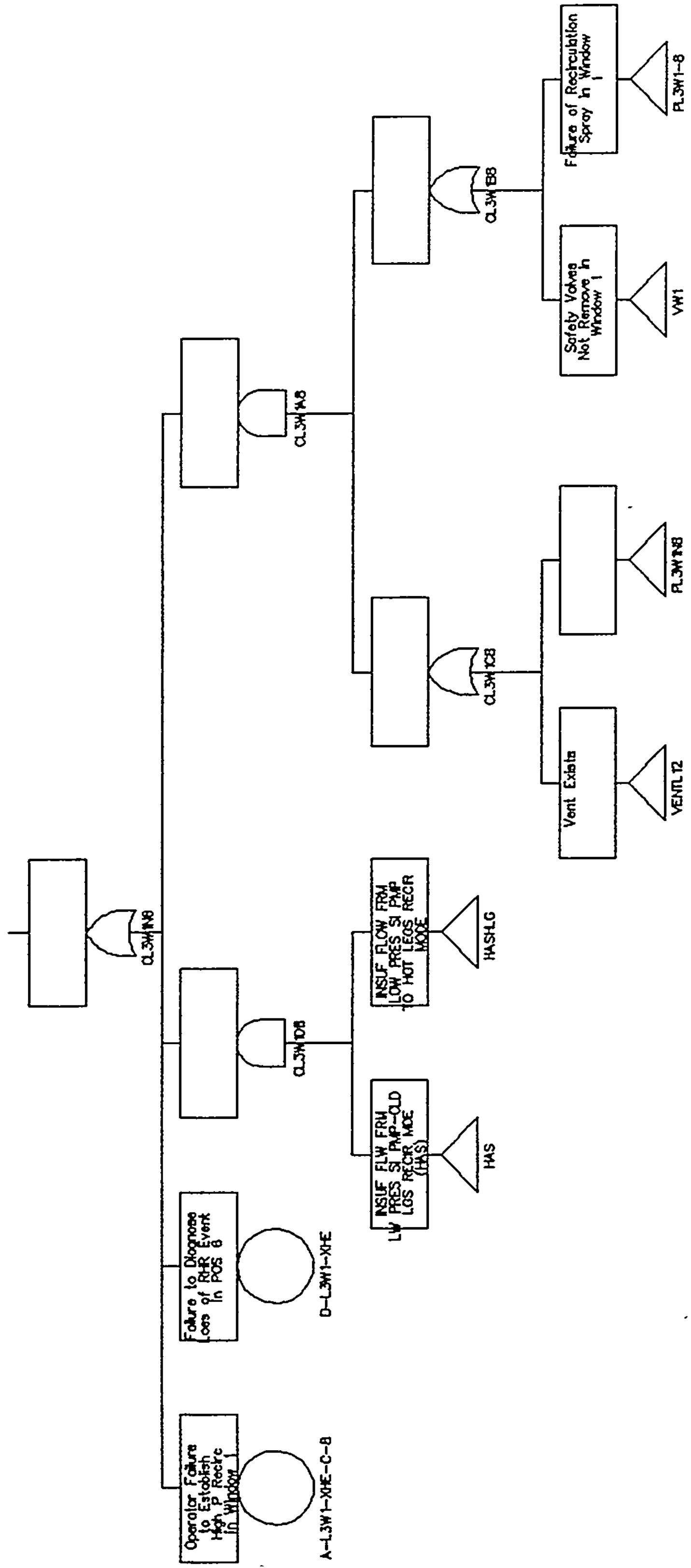
Failure of High Pressure Recirculation in Window 1

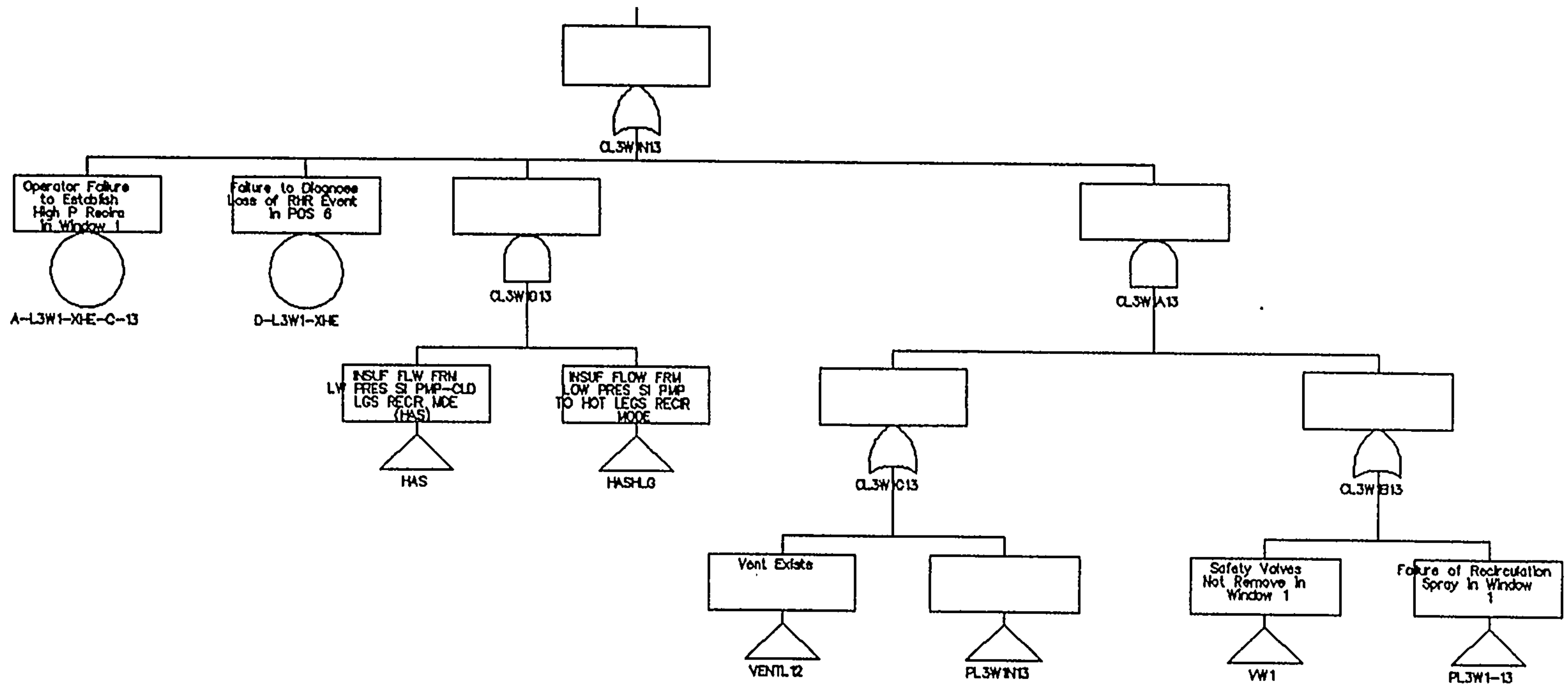


Failure of High Pressure Recirculation in Window 1

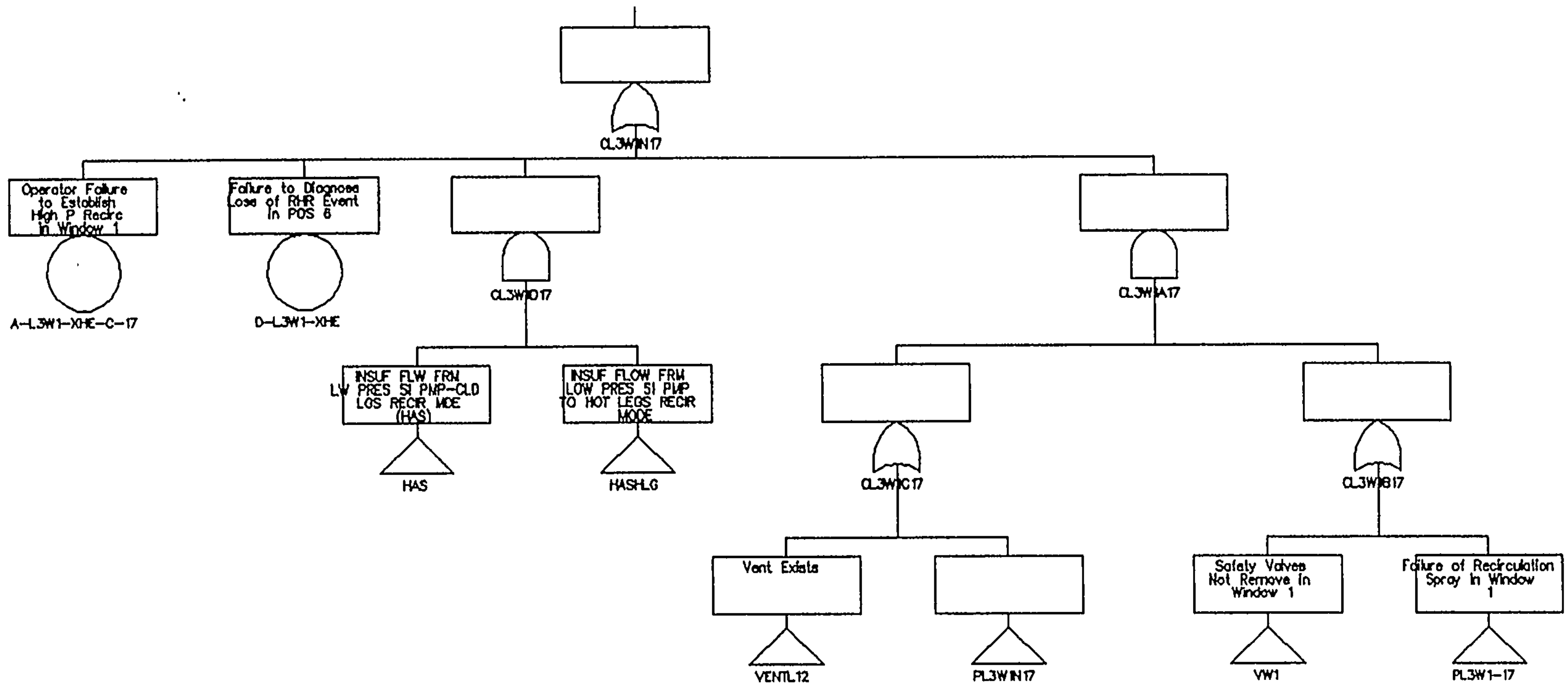


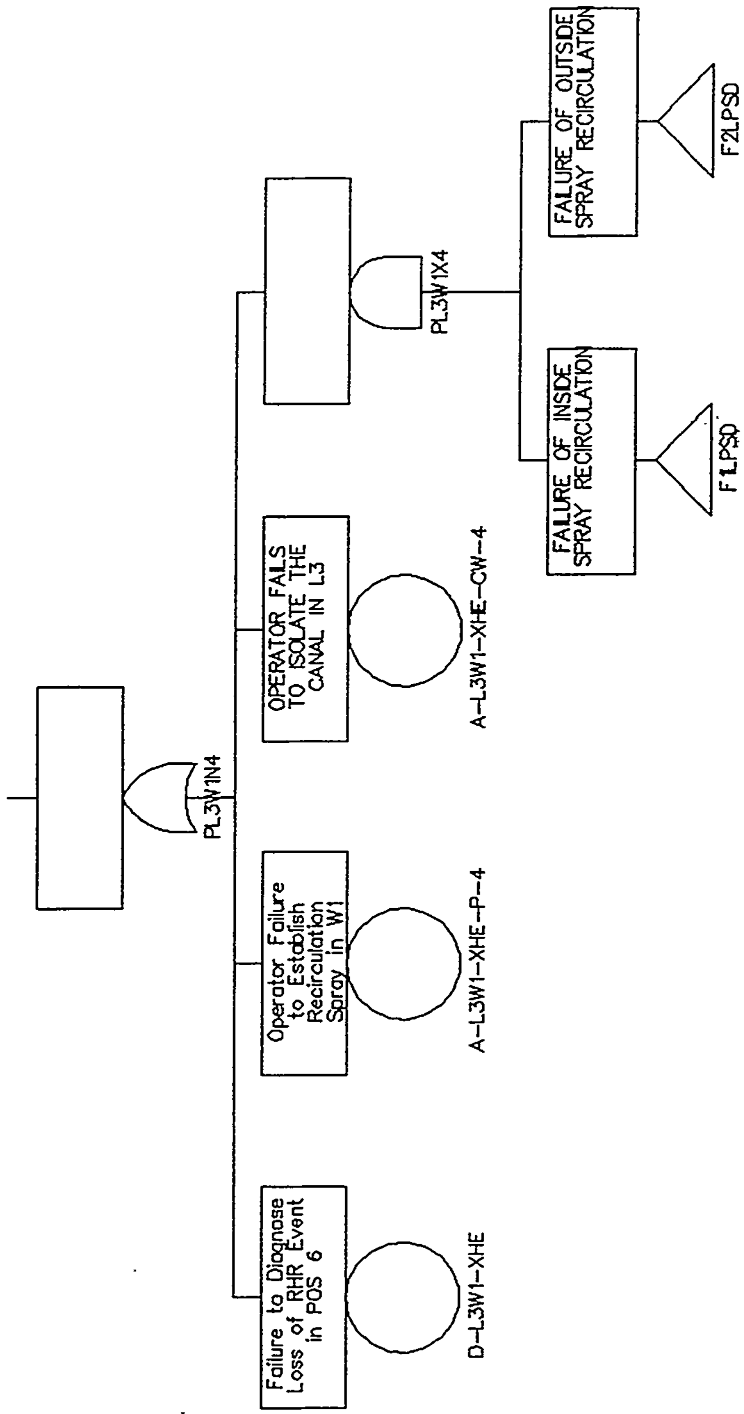

CL3W1N4
CL3W1A4
CL3W1B4
Failure of Recirculation Spray In Window 1
PL3W1-4
Safety Valves Not Remove In Window 1
VW1
CL3W1C4
PL3W1N4
Vent Exists
VENTL12
CL3W1D4
INSUF FLOW FRM LOW PRES SI PMP TO HOT LEGS RECIR MODE
HASHLG
INSUF FLW FRM LW PRES SI PMP-CLD LGS RECIR MDE (HAS)
HAS
Failure to Diagnose Loss of RHR Event In POS 6
D-L3W1-XHE
Operator Failure to Establish High P Recirc In Window 1
A-L3W1-XHE-C-4

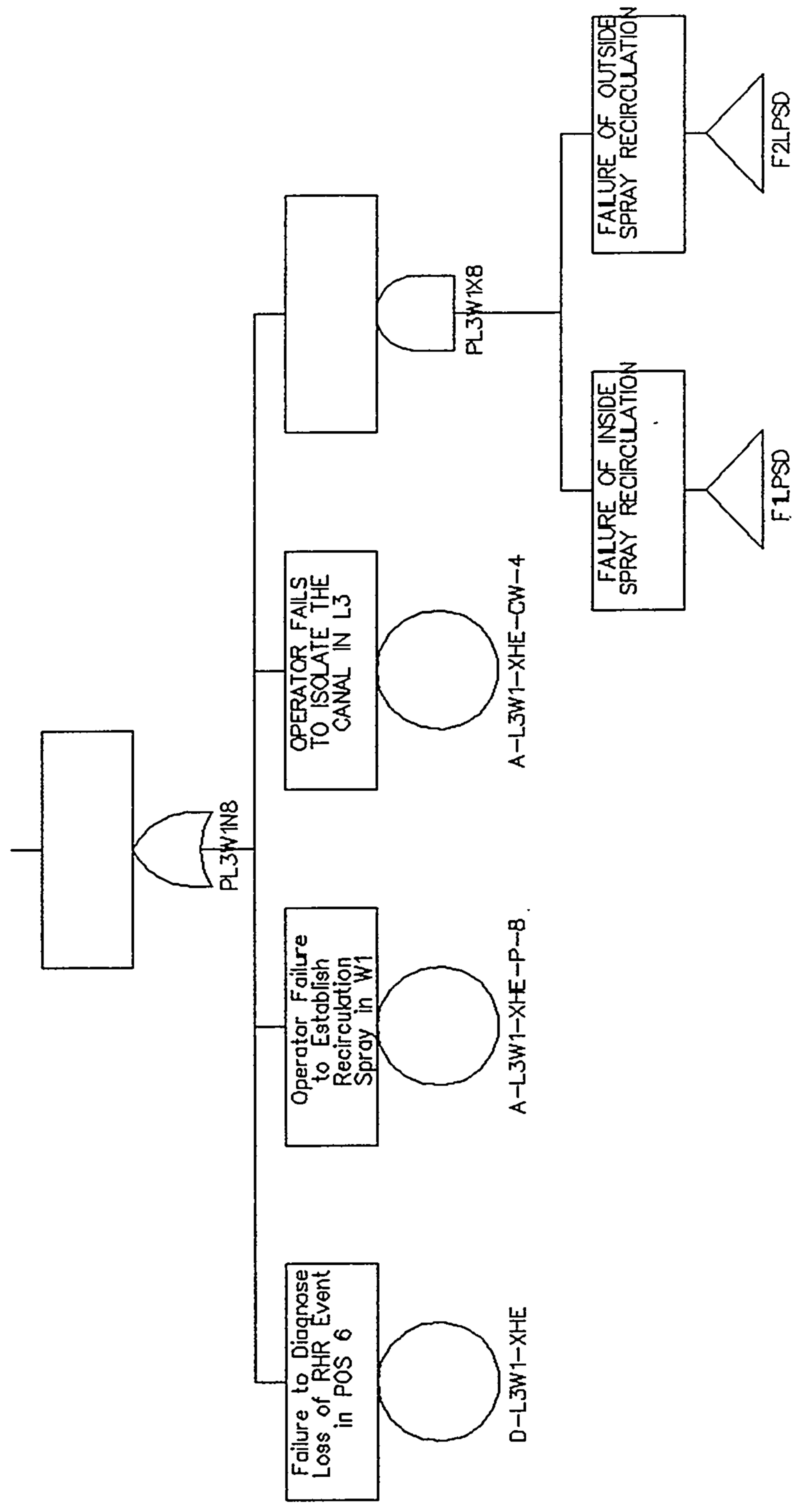

CL3W1N8
CL3W1A8
CL3W1B8
Failure of Recirculation Spray In Window 1
PL3W1-8
Safety Valves Not Remove In Window 1
VW1
CL3W1C8
PL3W1N8
Vent Exists
VENTL12
CL3W1D8
INSUF FLOW FRM LOW PRES SI PMP TO HOT LEGS RECIR MODE
HASHLG
INSUF FLW FRM LW PRES SI PMP-CLD LGS RECIR MDE (HAS)
HAS
Failure to Diagnose Loss of RHR Event In POS 8
D-L3W1-XHE
Operator Failure to Establish High P Recirc In Window 1
A-L3W1-XHE-C-8



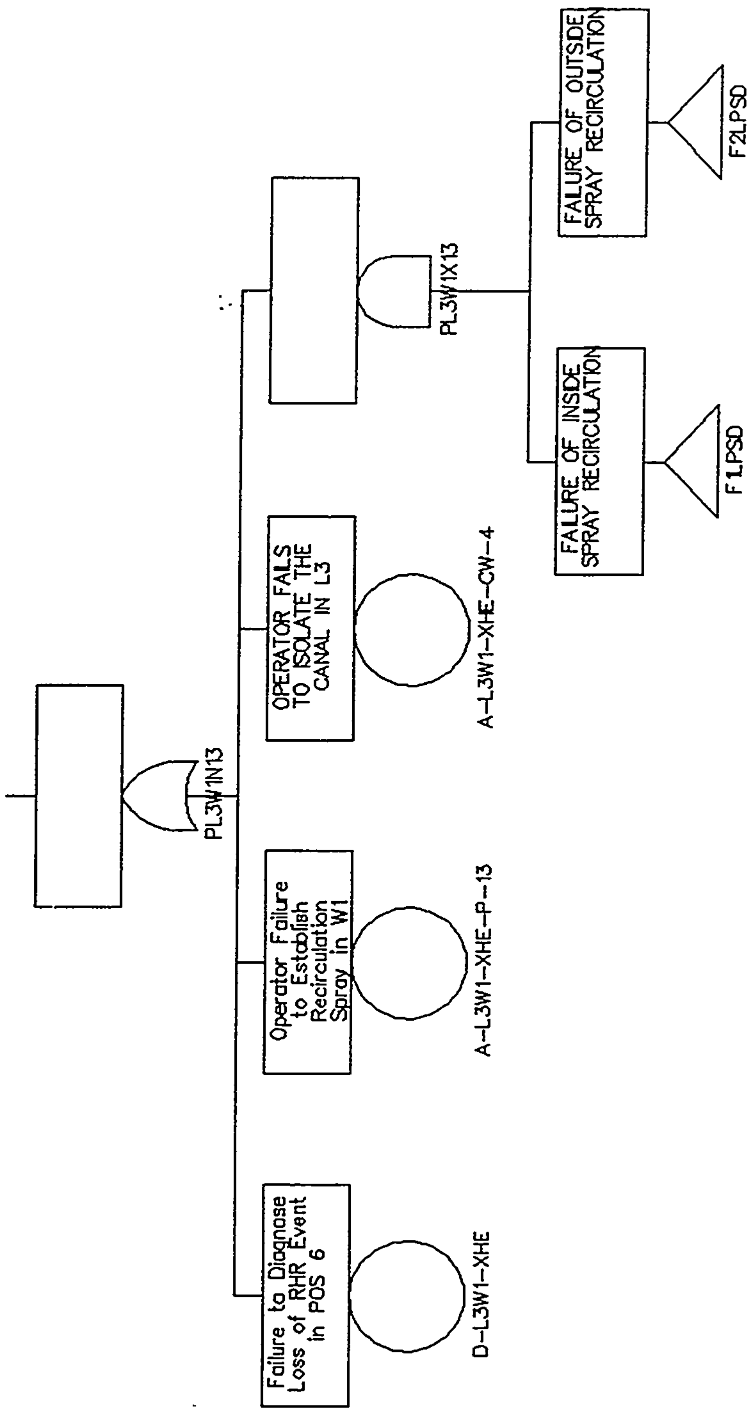
CL3WIN13
Operator Failure to Establish High P Recirc In Window 1
A-L3W1-XHE-C-13
Failure to Diagnose Loss of RHR Event In POS 6
D-L3W1-XHE
CL3WID13
INSUF FLW FRM LW PRES SI PMP-CLD LGS RECR MDE (HAS)
HAS
INSUF FLOW FRM LOW PRES SI PMP TO HOT LEGS RECIR MODE
HASHLG
CL3WIA13
CL3WIC13
Vent Exists
VENTL12
PL3WIN13
CL3WIB13
Safety Valves Not Remove In Window 1
VW1
Failure of Recirculation Spray In Window 1
PL3W1-13

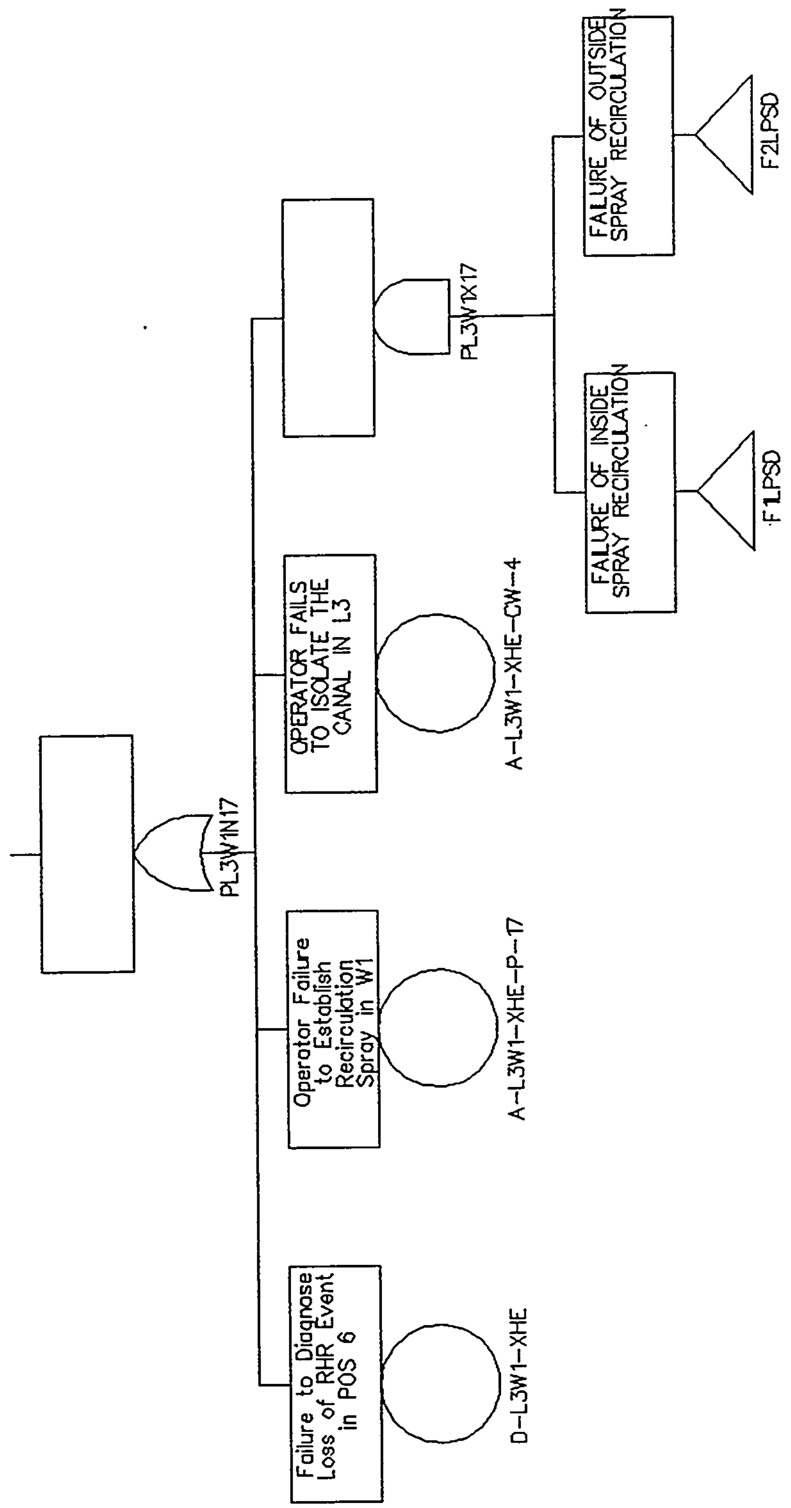

CL3WIN17
Operator Failure to Establish High P Recirc In Window 1
A-L3W1-XHE-C-17
Failure to Diagnose Loss of RHR Event In POS 6
D-L3W1-XHE
CL3WID17
INSUF FLW FRM LW PRES SI PMP-CLD LGS RECIR MDE (HAS)
HAS
INSUF FLOW FRM LOW PRES SI PMP TO HOT LEGS RECIR MODE
HASHLG
CL3WIA17
CL3WIC17
Vent Exists
VENTL12
PL3WIN17
CL3WIB17
Safety Valves Not Remove In Window 1
VW1
Failure of Recirculation Spray In Window 1
PL3W1-17

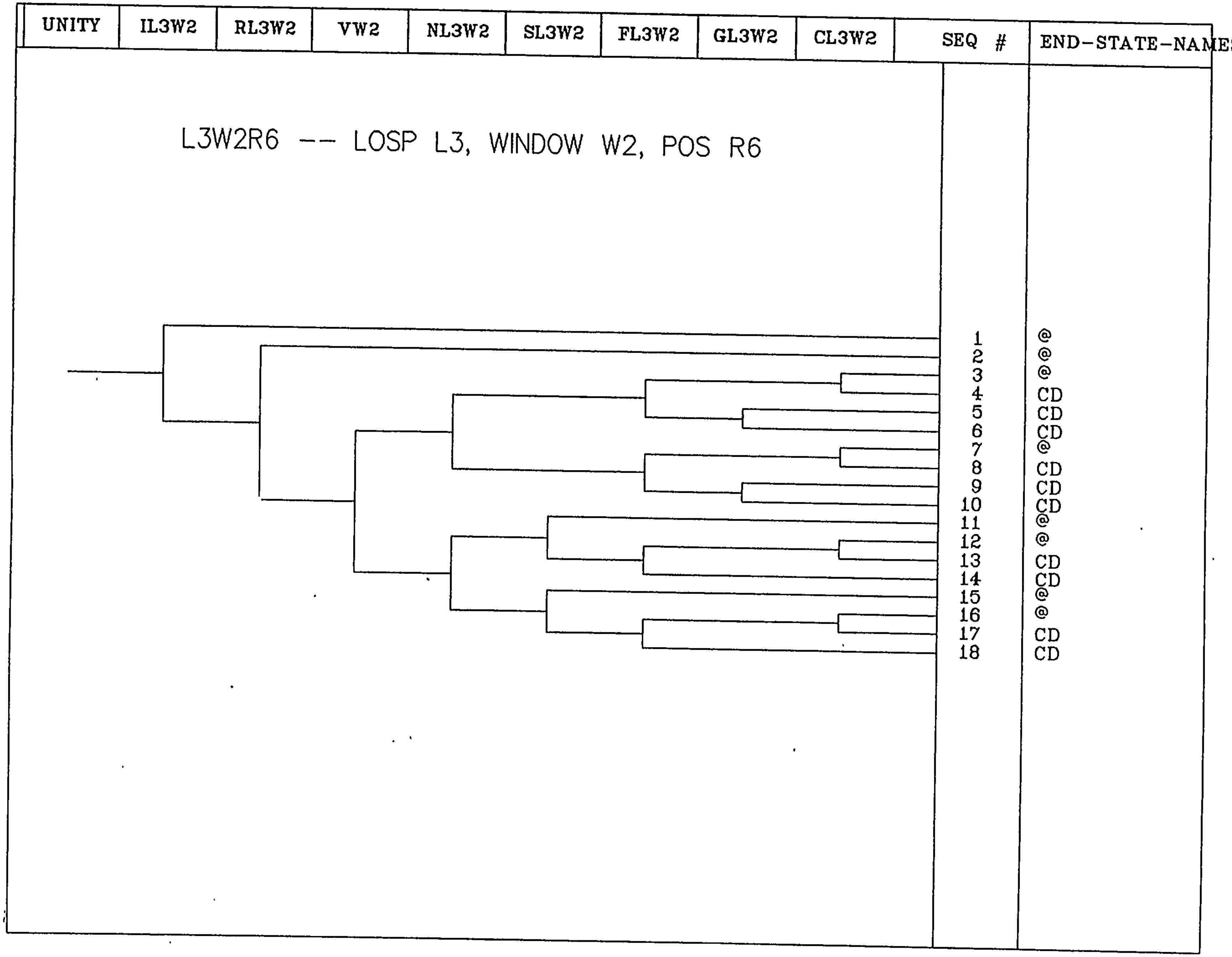

PL3W1N4
Failure to Diagnose Loss of RHR Event in POS 6
D-L3W1-XHE
Operator Failure to Establish Recirculation Spray in W1
A-L3W1-XHE-P-4
OPERATOR FAILS TO ISOLATE THE CANAL IN L3
A-L3W1-XHE-CW-4
PL3W1X4
FAILURE OF INSDE SPRAY RECIRCULATION
F1LPSD
FAILURE OF OUTSIDE SPRAY RECIRCULATION
F2LPSD

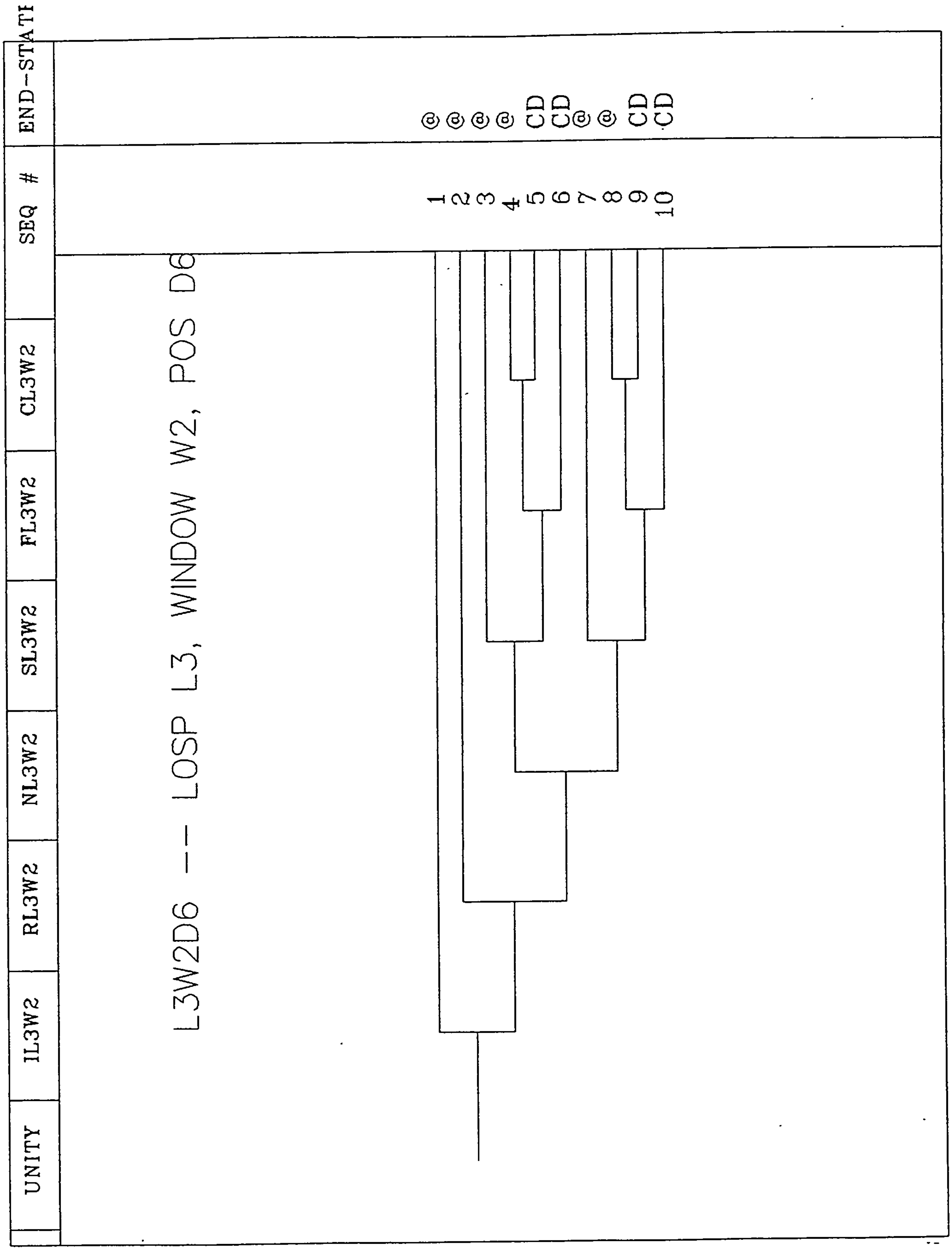


PL3W1N8
Failure to Diagnose Loss of RHR Event in POS 6
D-L3W1-XHE
Operator Failure to Establish Recirculation Spray in W1
A-L3W1-XHE-P-B
OPERATOR FAILS TO ISOLATE THE CANAL IN L3
A-L3W1-XHE-CW-4
PL3W1X8
FAILURE OF INSIDE SPRAY RECIRCULATION
F1LPSD
FAILURE OF OUTSIDE SPRAY RECIRCULATION
F2LPSD

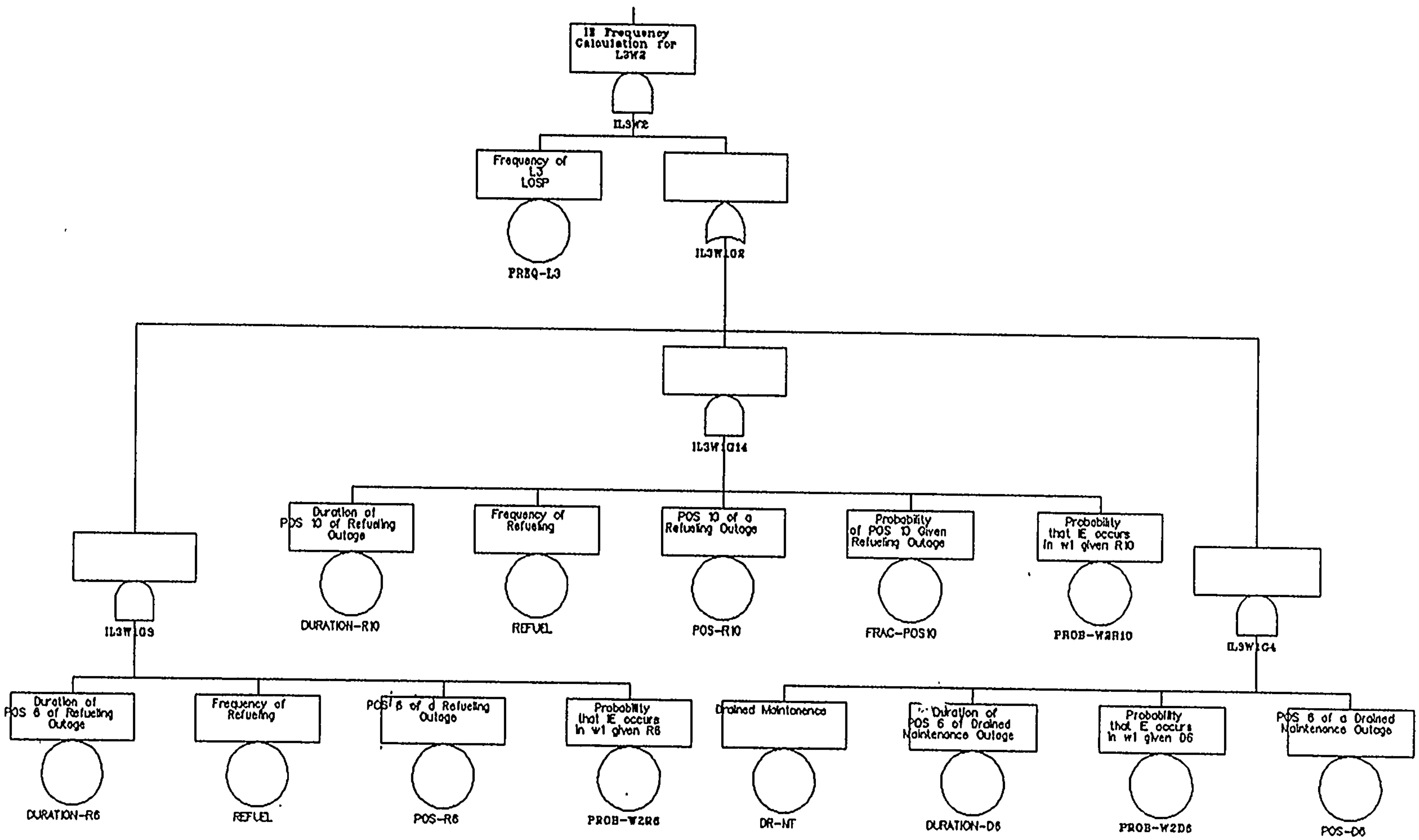

PL3W1N13
Failure to Diagnose Loss of RHR Event in POS 6
D-L3W1-XHE
Operator Failure to Establish Recirculation Spray in W1
A-L3W1-XHE-P--13
OPERATOR FAILS TO ISOLATE THE CANAL IN L3
A-L3W1-XHE-CW-4
PL3W1X13
FAILURE OF INSIDE SPRAY RECIRCULATION
F1LPSD
FAILURE OF OUTSIDE SPRAY RECIRCULATION
F2LPSD


Failure to Diagnose Loss of RHR Event in POS 6
D-L3W1-XHE
Operator Failure to Establish Recirculation Spray in W1
A-L3W1-XHE-P-17
PL3W1N17
OPERATOR FAILS TO ISOLATE THE CANAL IN L3
A-L3W1-XHE-CW-4
PL3W1X17
FALURE OF INSIDE SPRAY RECIRCULATION
F1LPSD
FALURE OF OUTSIDE SPRAY RECIRCULATION
F2LPSD

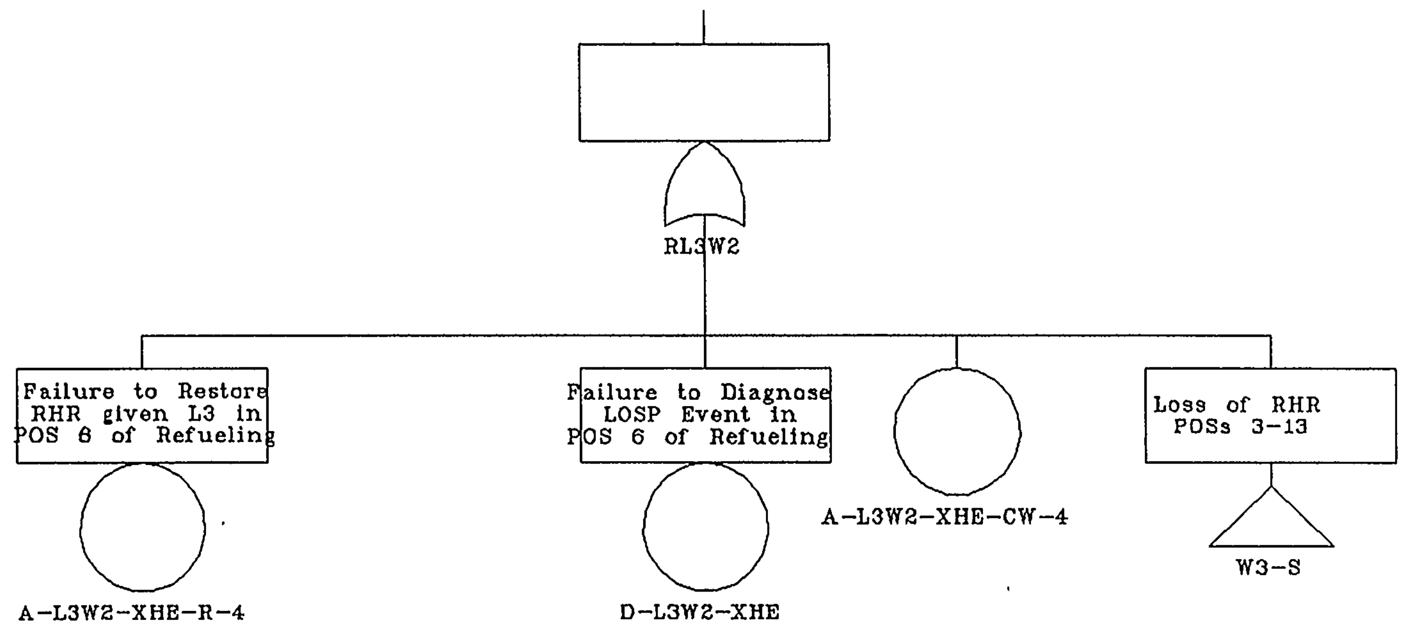

UNITY
IL3W2
RL3W2
VW2
NL3W2
SL3W2
FL3W2
GL3W2
CL3W2
SEQ #
END-STATE-NAMES
L3W2R6 -- LOSP L3, WINDOW W2, POS R6
1 @
2 @
3 @
4 CD
5 CD
6 CD
7 @
8 CD
9 CD
10 CD
11 @
12 @
13 CD
14 CD
15 @
16 @
17 CD
18 CD


L3W2D6 -- LOSP L3, WINDOW W2, POS D6
UNITY
IL3W2
RL3W2
NL3W2
SL3W2
FL3W2
CL3W2
SEQ #
END-STATI
1 @
2 @
3 @
4 @
5 CD
6 CD
7 @
8 @
9 CD
10 CD

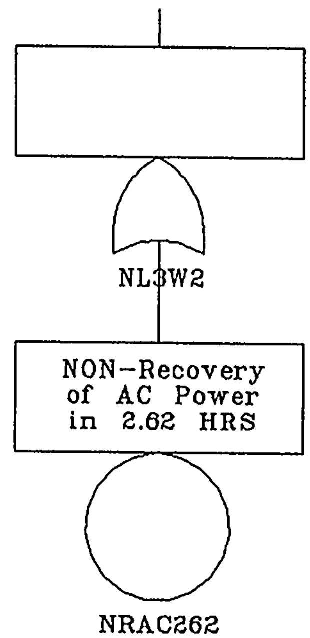
I top event for L3 LOSP – L3 in window 2



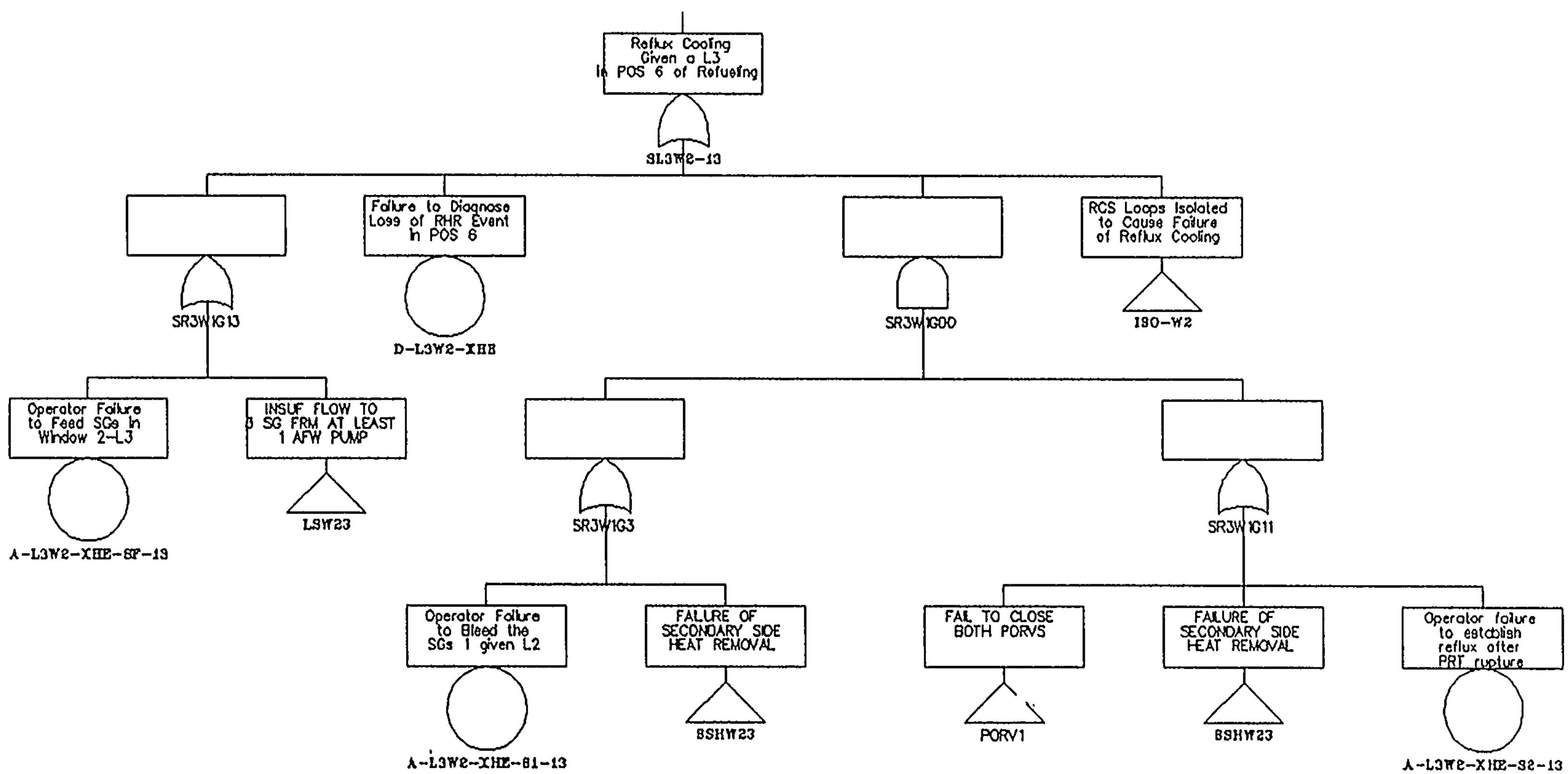
Restore RHR given L3 in POS 6 - Refueling



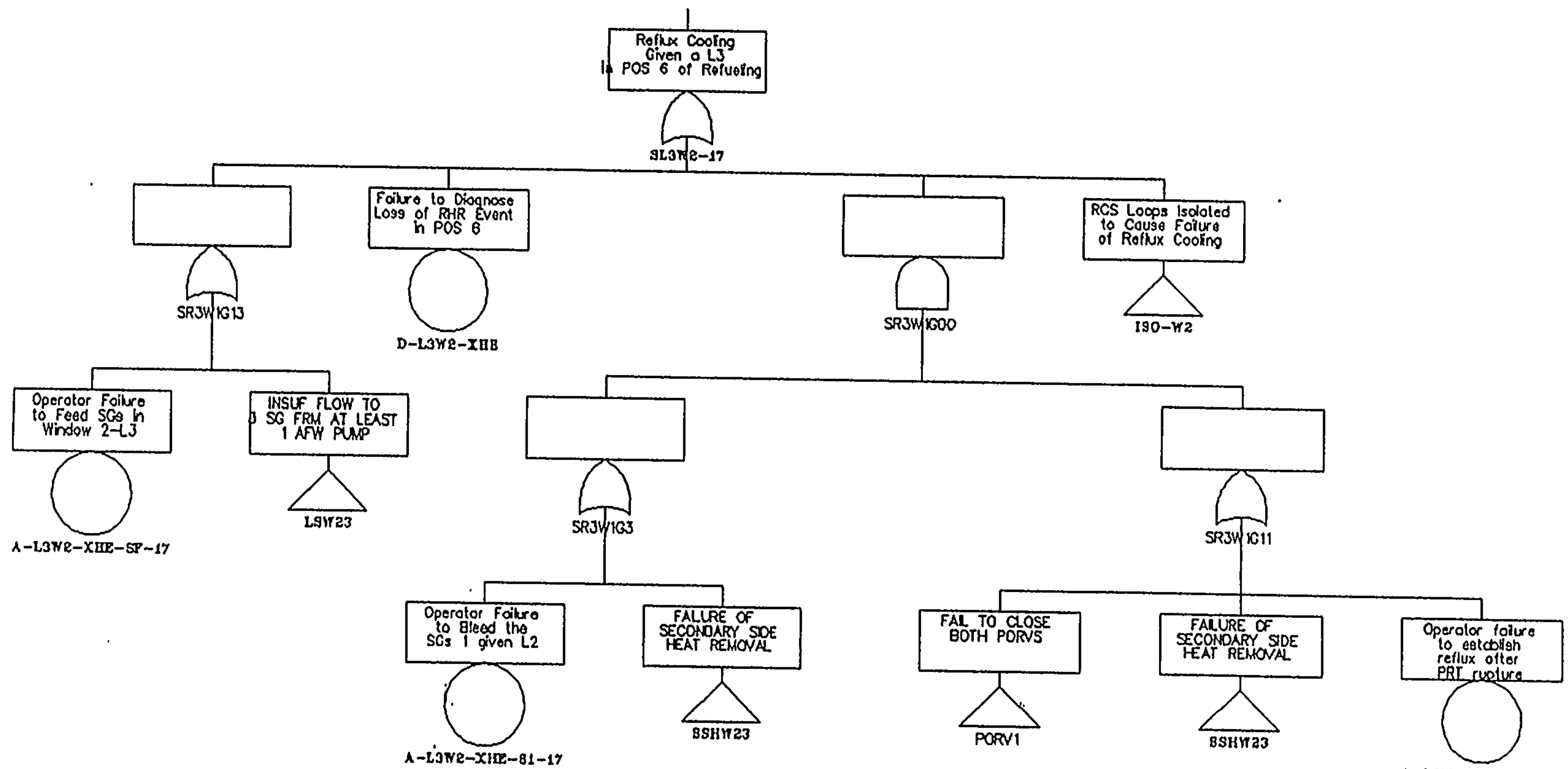
Non-Recovery of AC Power in W2



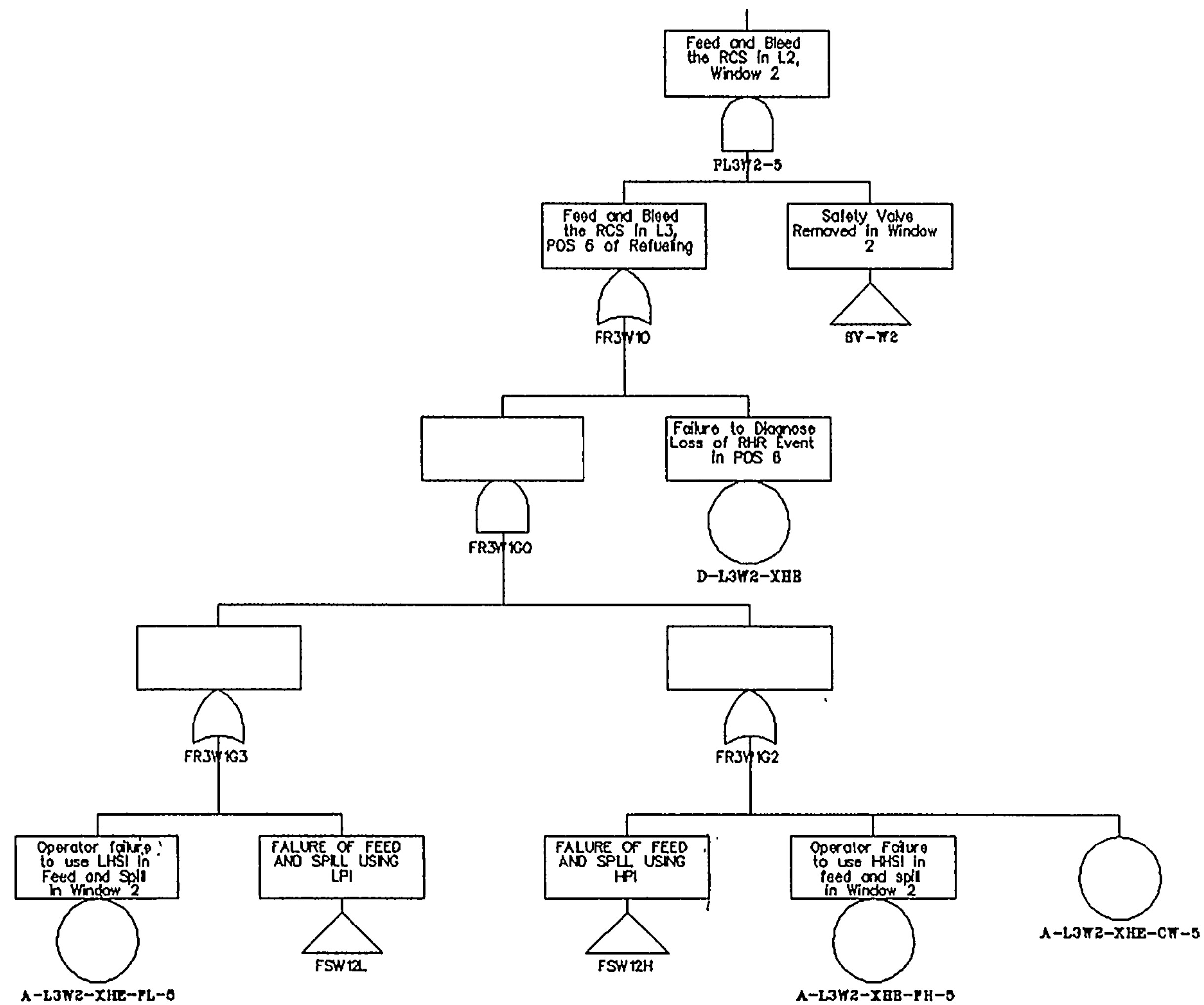
Reflux Cooling in window 2



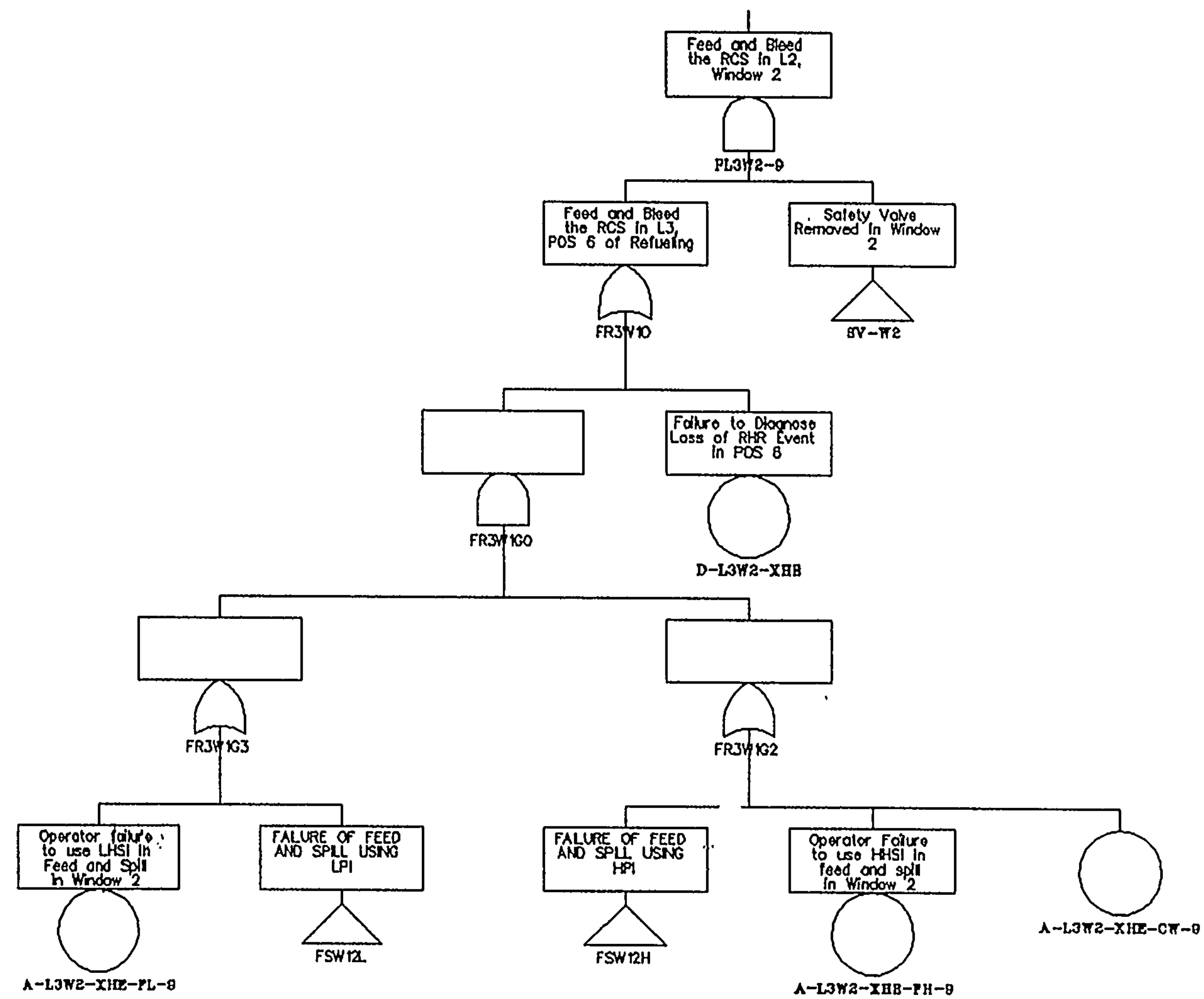
Reflux Cooling in window 2

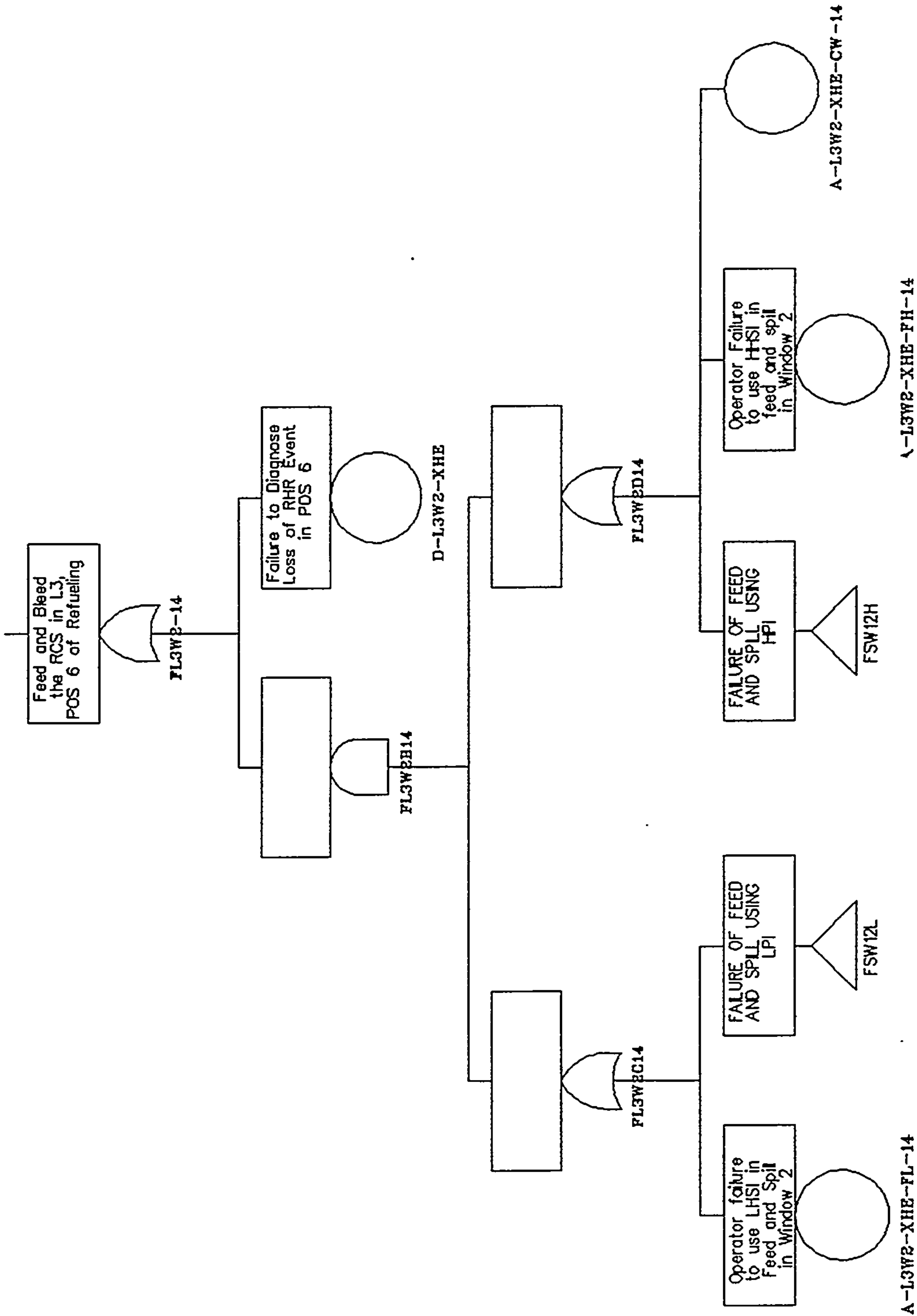


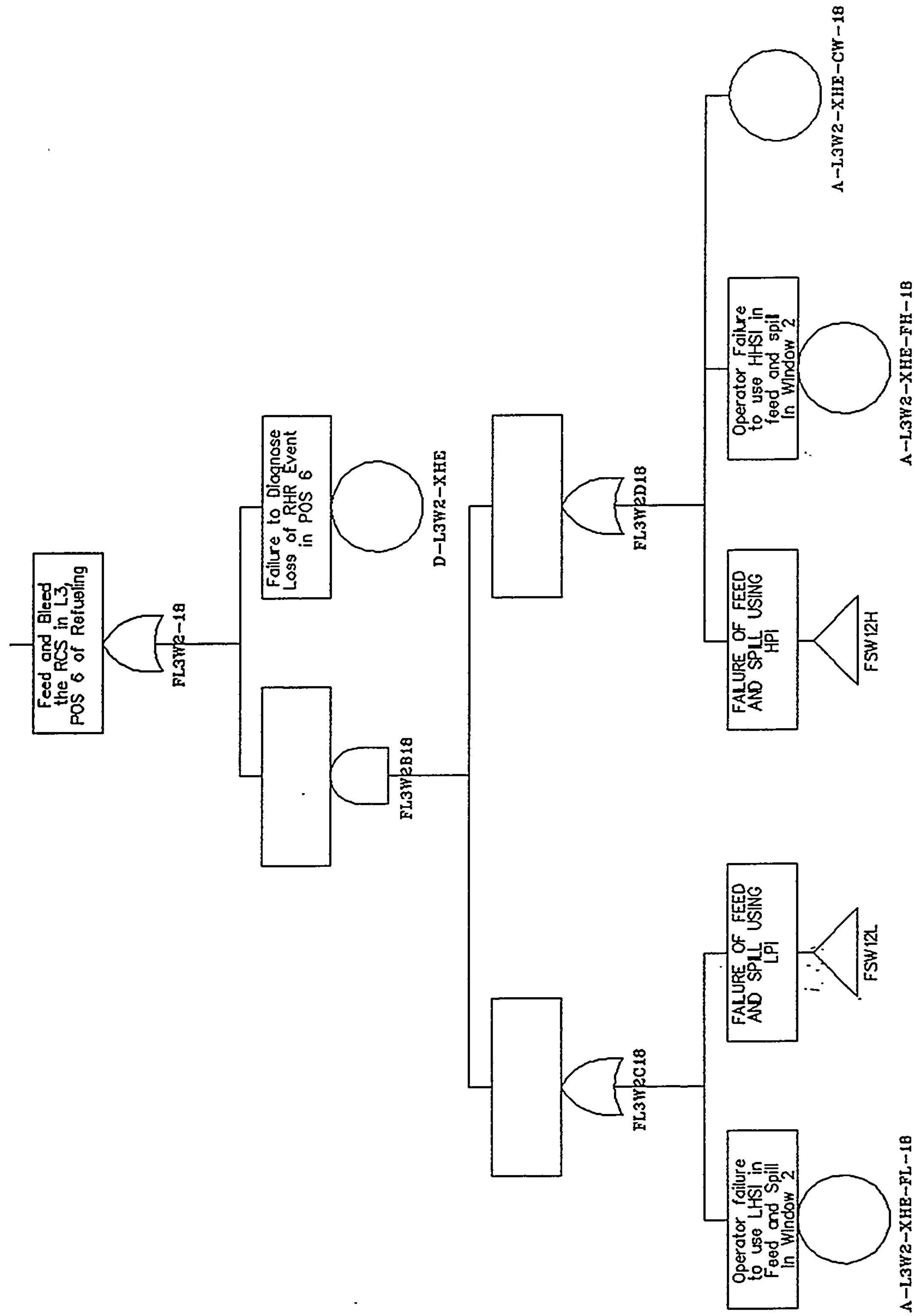
Feed and Bleed the RCS in L3, Window 2



Feed and Bleed the RCS in L3, Window 2

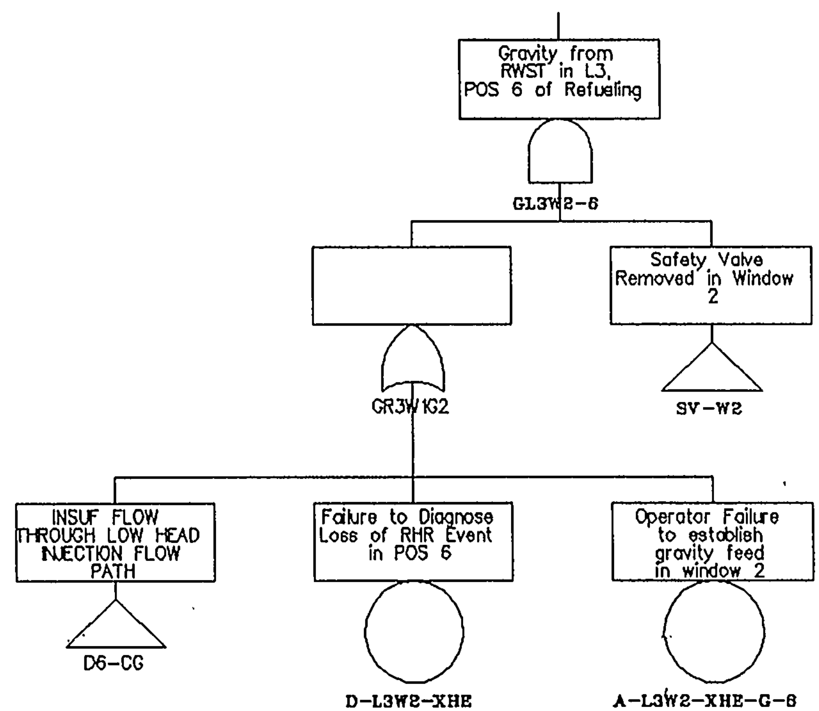



Feed and Bleed the RCS in L3, POS 6 of Refueling
FL3W2-14
Failure to Diagnose Loss of RHR Event in POS 6
D-L3W2-XHE
FL3W2B14
FL3W2D14
FAILURE OF FEED AND SPILL USING HPI
FSW12H
Operator Failure to use HHSI in feed and spill in Window 2
A-L3W2-XHE-FH-14
A-L3W2-XHE-CW-14
FL3W2C14
FAILURE OF FEED AND SPILL USING LPI
FSW12L
Operator failure to use LHSI in Feed and Spill in Window 2
A-L3W2-XHE-FL-14

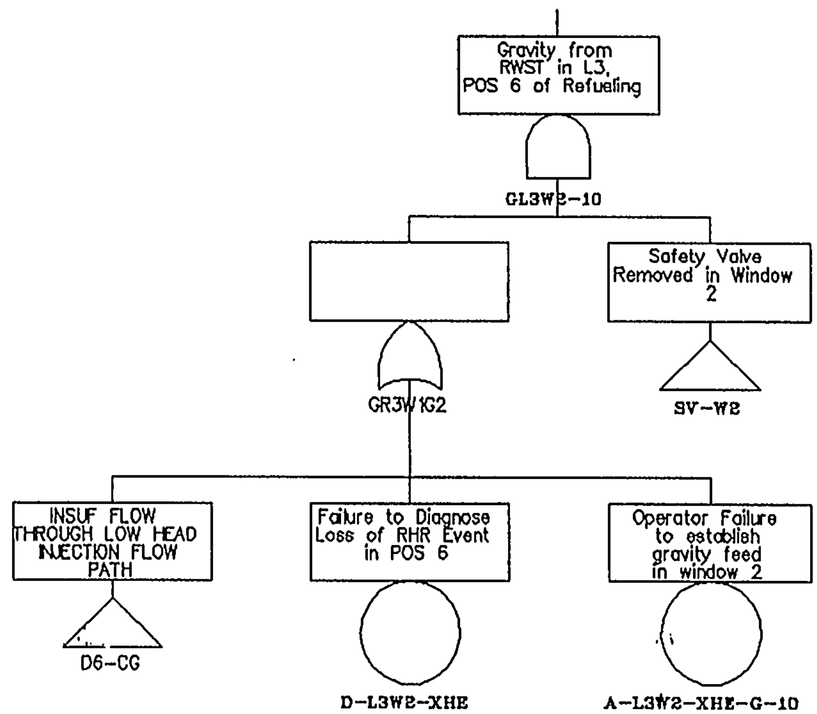


Feed and Bleed the RCS in L3, POS 6 of Refueling
FL3W2-18
Failure to Diagnose Loss of RHR Event in POS 6
D-L3W2-XHE
FL3W2B18
FL3W2D18
FL3W2C18
FAILURE OF FEED AND SPILL USING HPI
FSW12H
Operator Failure to use HHSI in feed and spill In Window 2
A-L3W2-XHE-FH-18
A-L3W2-XHE-CW-18
FAILURE OF FEED AND SPILL USING LPI
FSW12L
Operator failure to use LHSI in Feed and Spill In Window 2
A-L3W2-XHE-FL-18

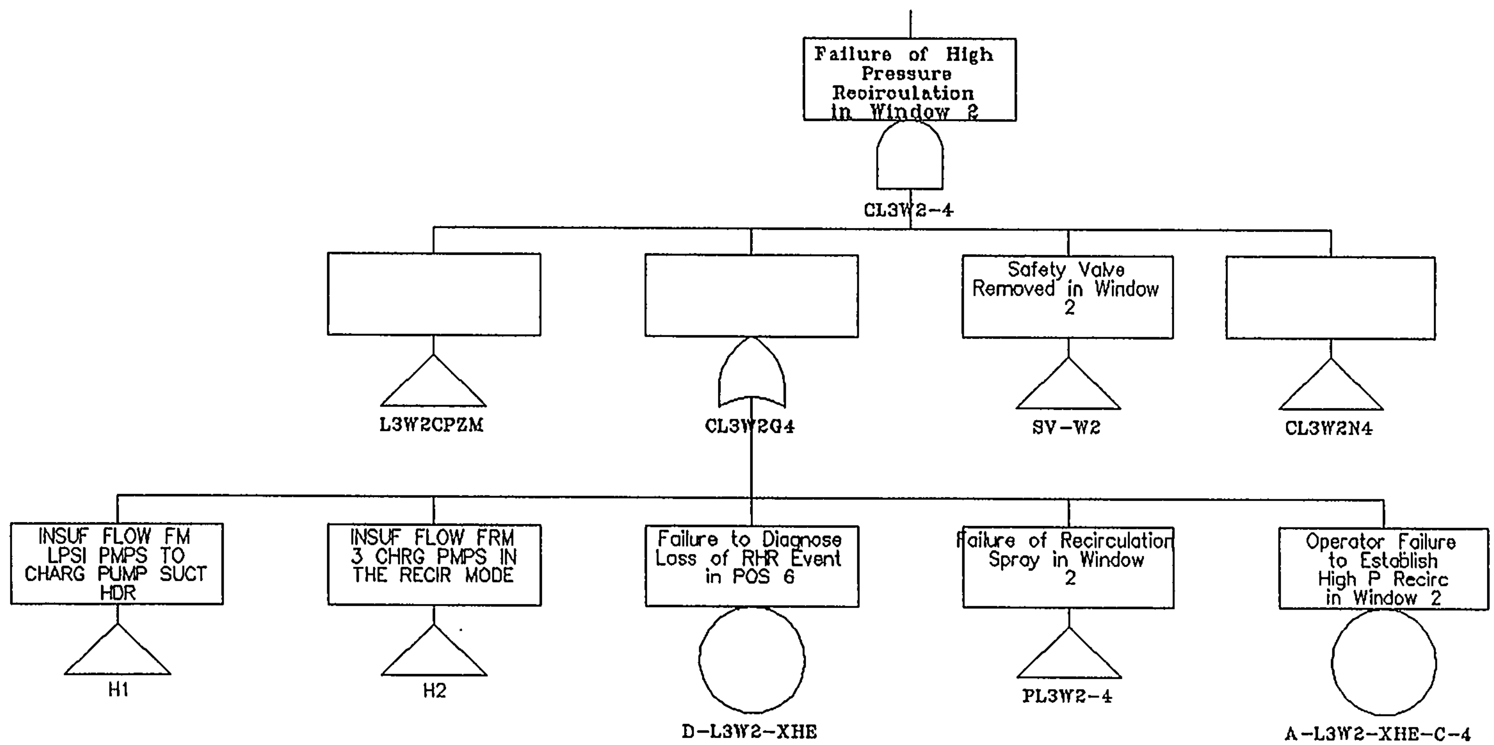
Gravity from RWST in L3, Window 2



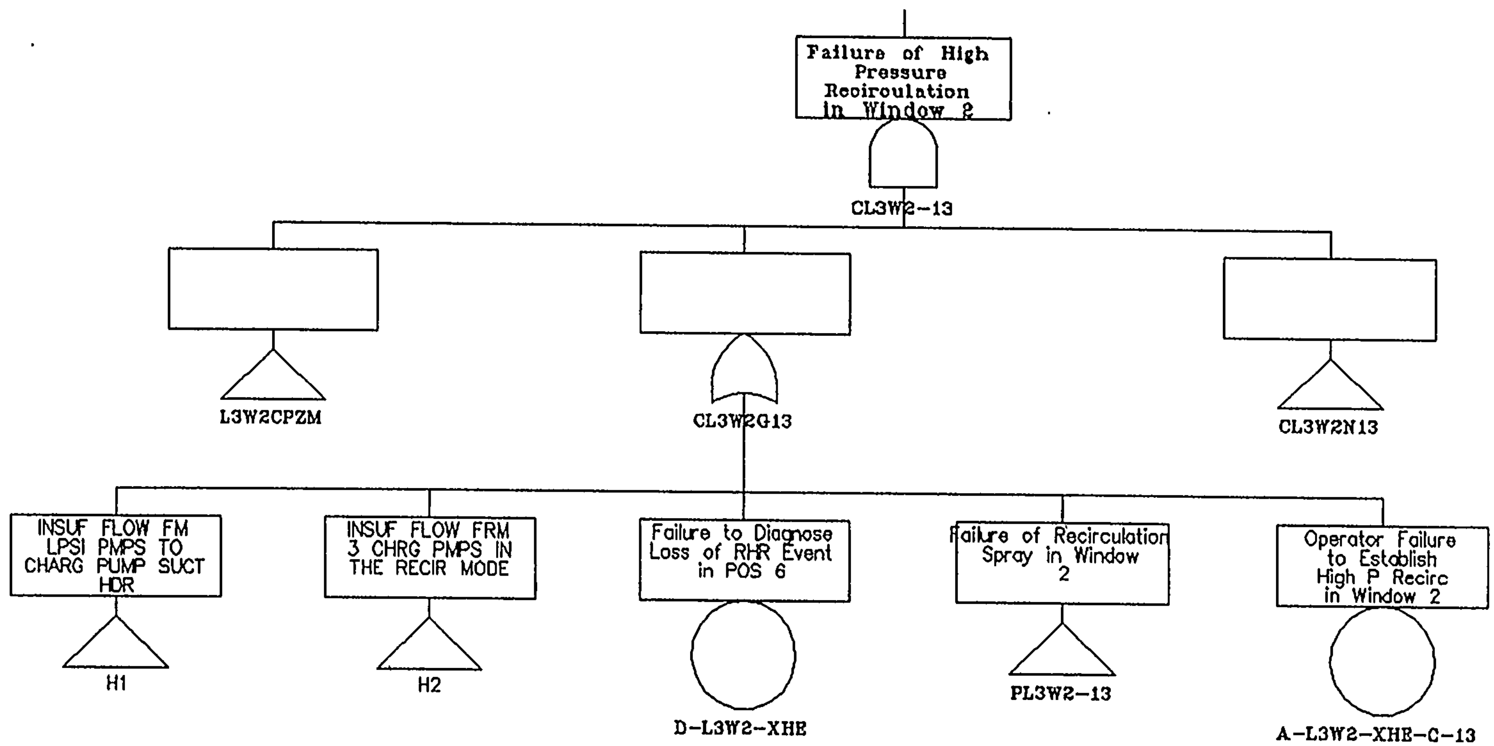
Gravity from RWST in L3, Window 2



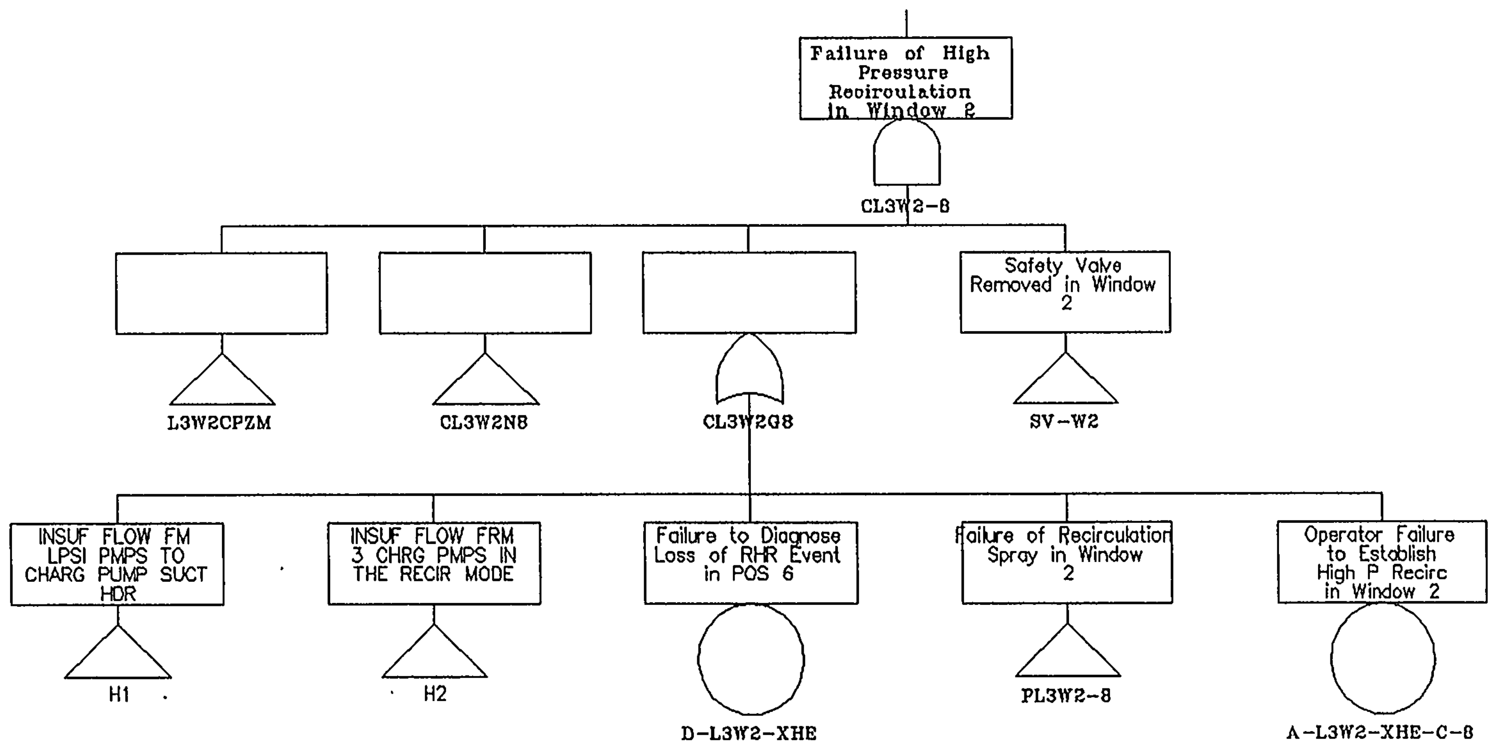
Failure of High Pressure Recirculation in Window 2



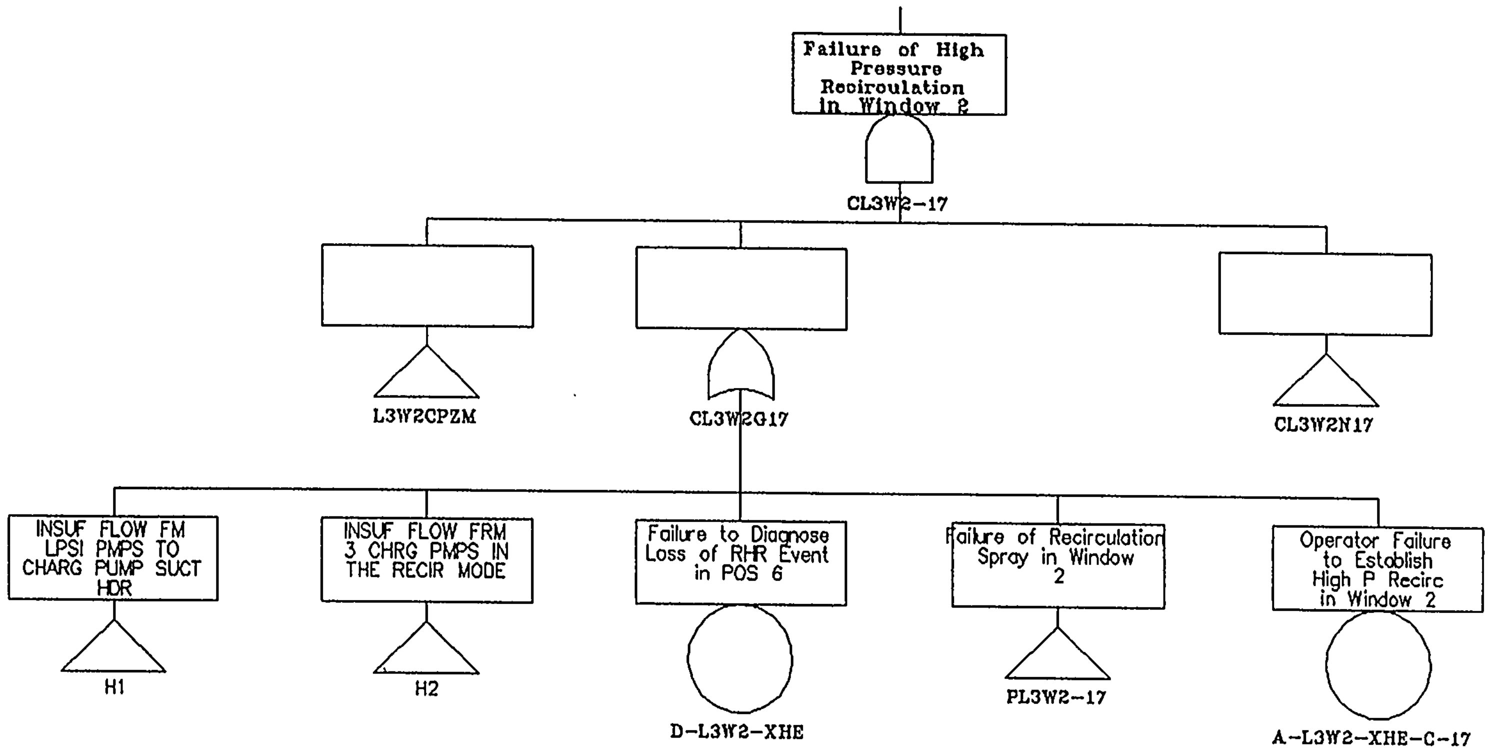
Failure of High Pressure Recirculation in Window 2



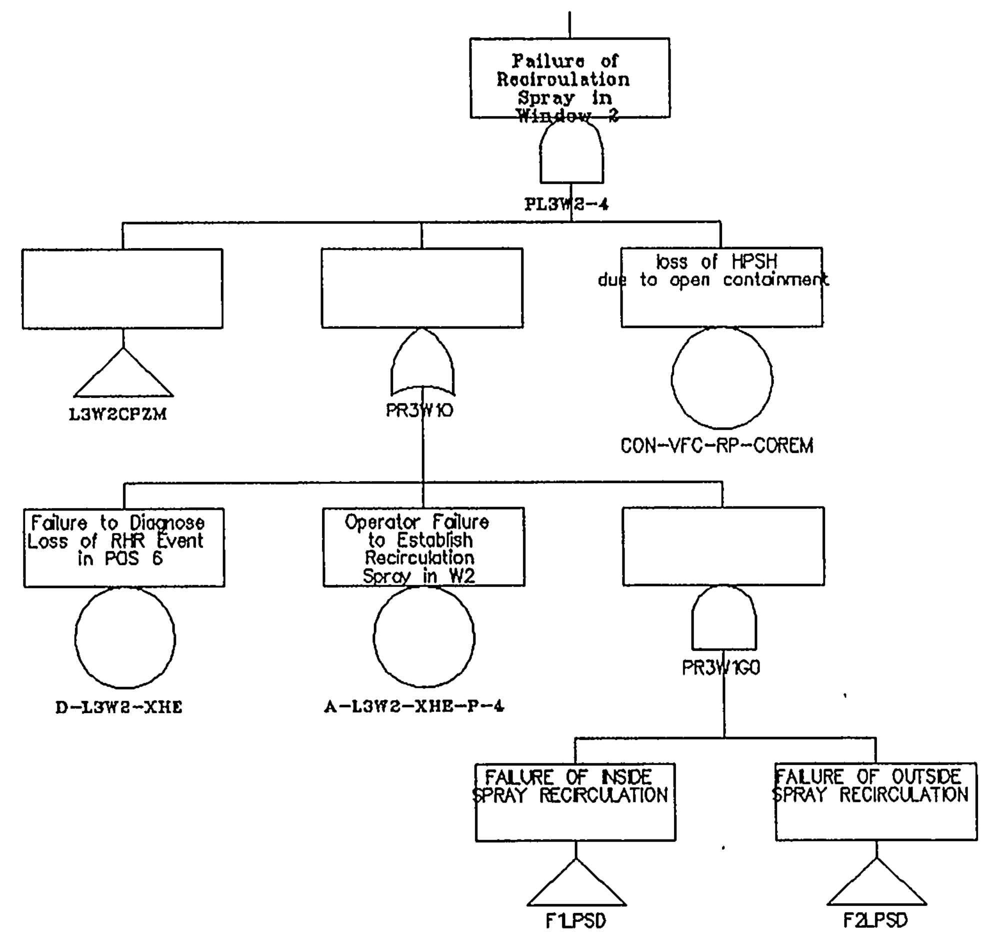
Failure of High Pressure Recirculation in Window 2



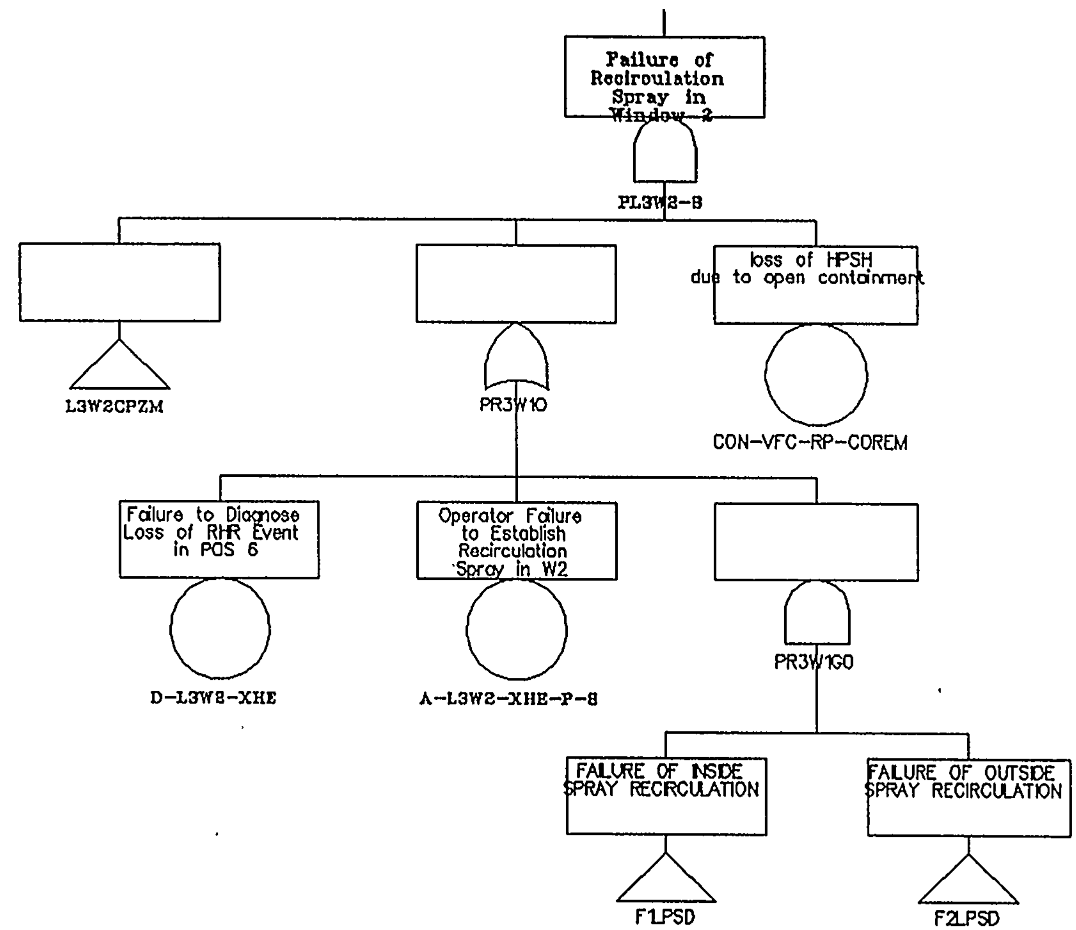
Failure of High Pressure Recirculation in Window 2



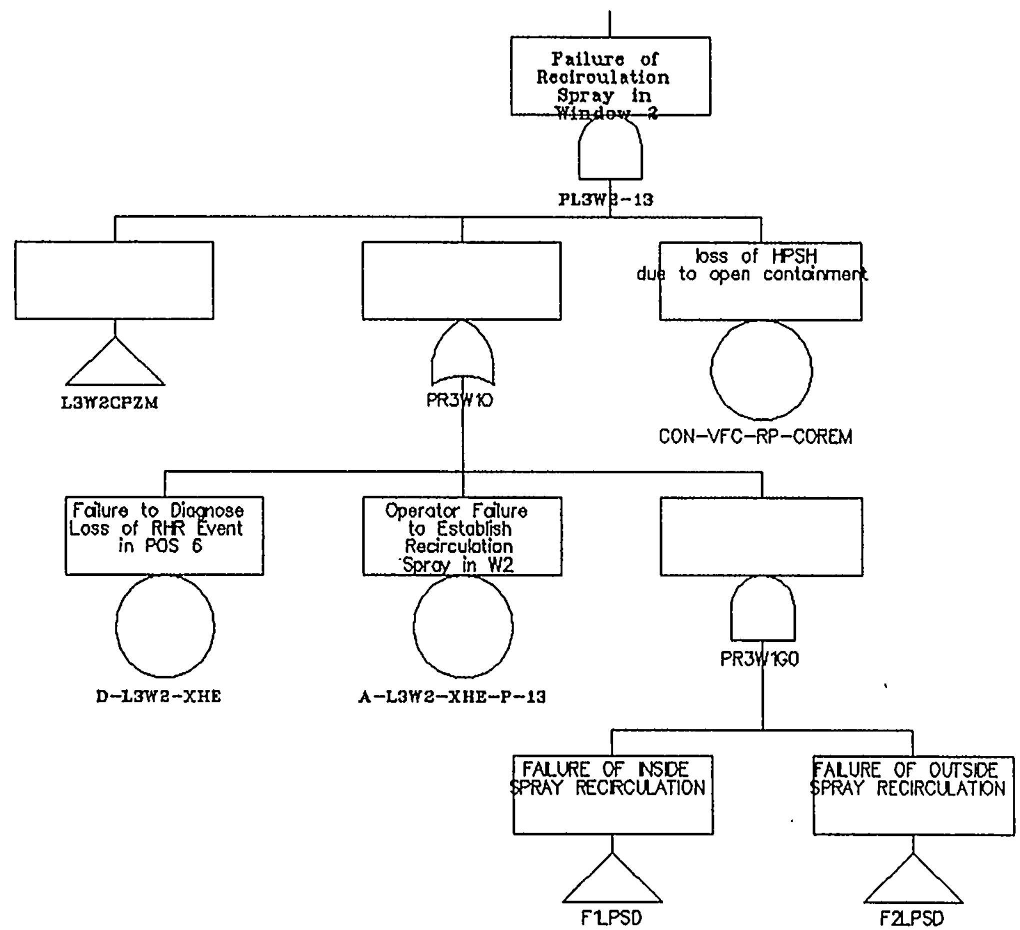
Failure of Recirculation Spray in Window 2–cause HPR failure



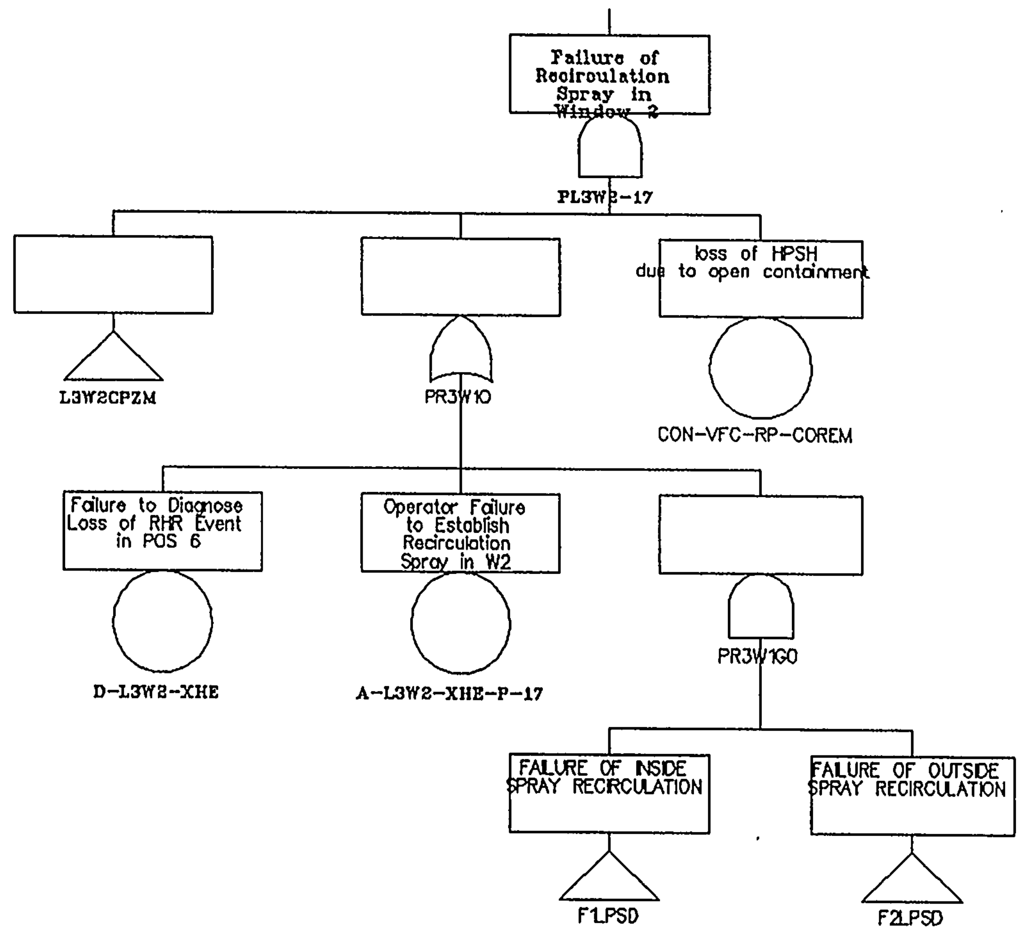
Failure of Recirculation Spray in Window 2-cause HPR failure

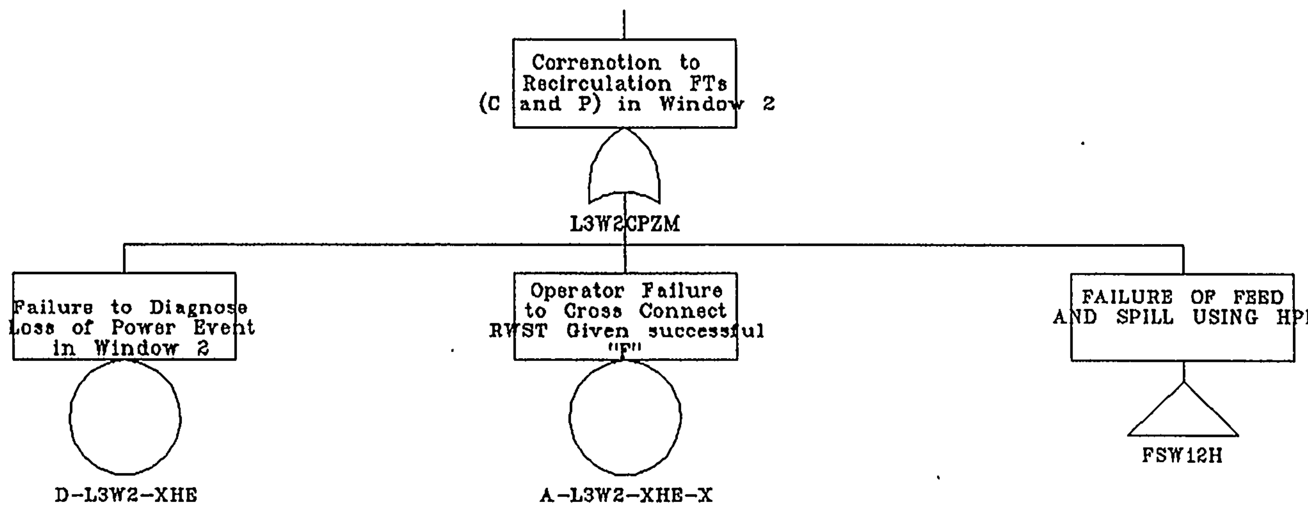


Failure of Recirculation Spray in Window 2-cause HPR failure

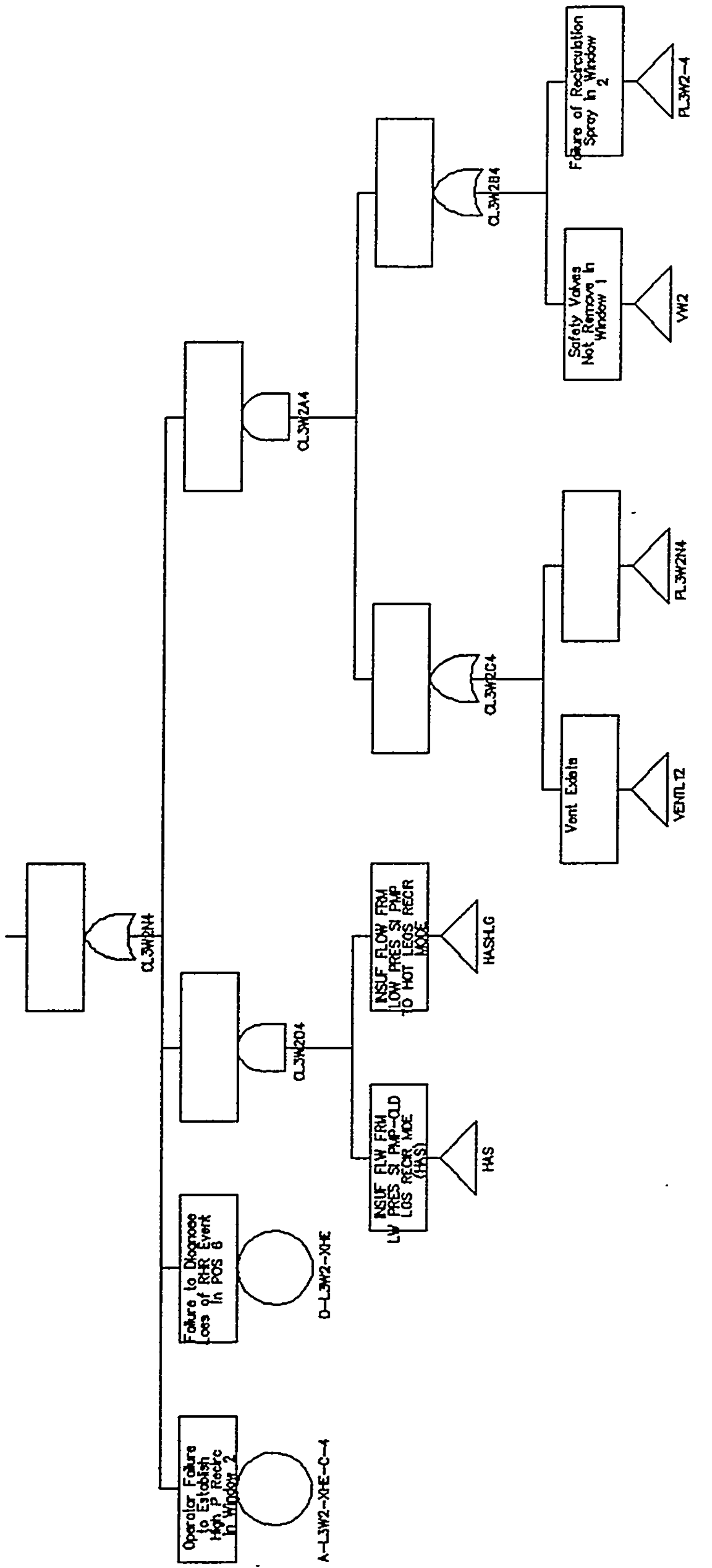


Failure of Recirculation Spray in Window 2-cause HPR failure

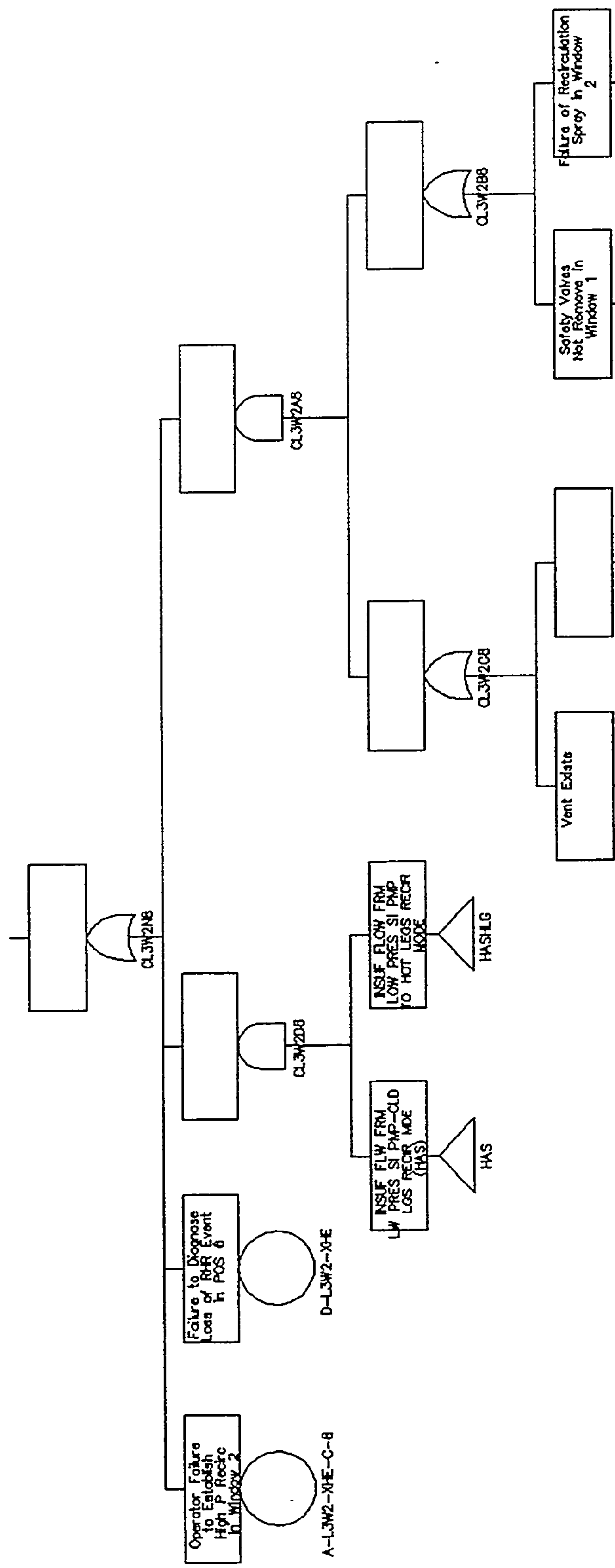




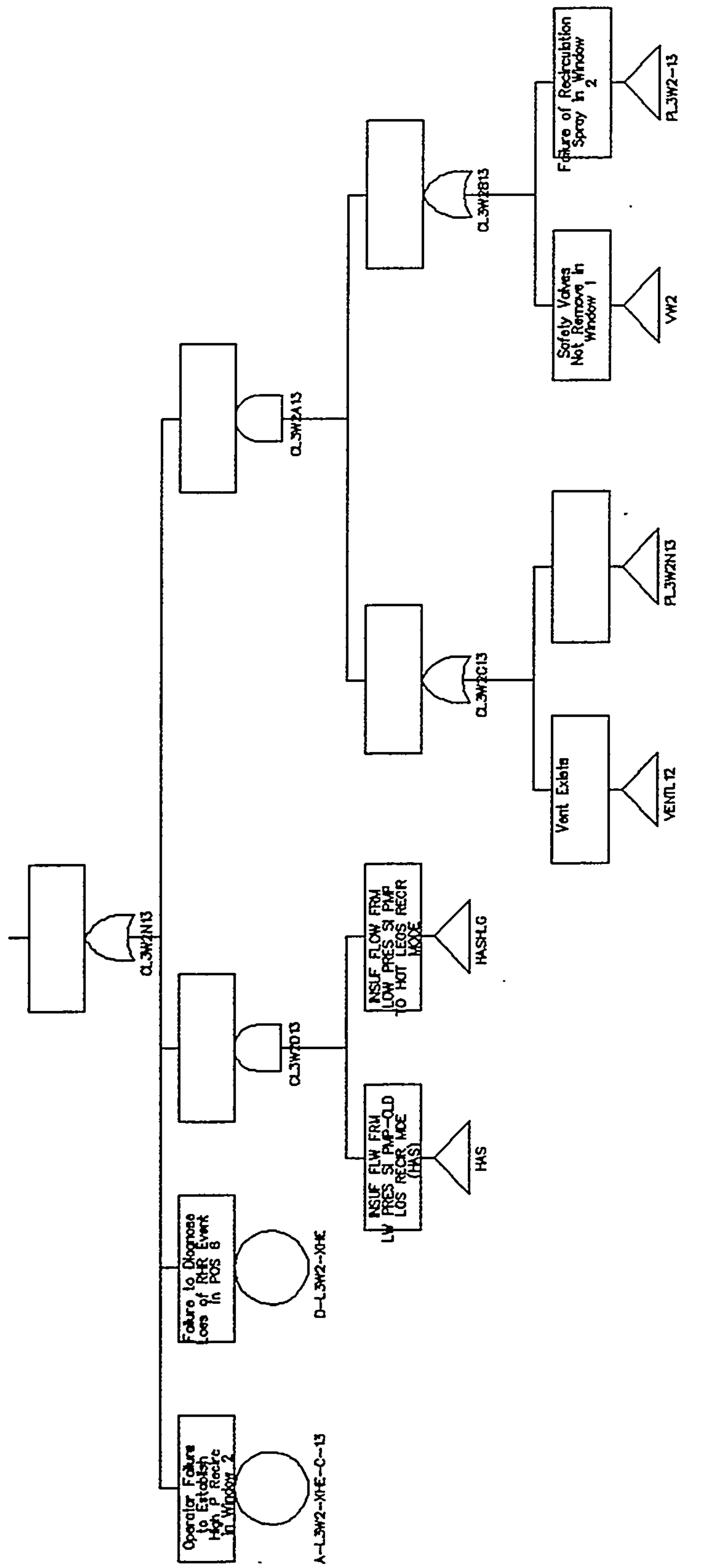
Correnotion to Recirculation FTs (C and P) in Window 2
L3W2CPZM
Failure to Diagnose Loss of Power Event in Window 2
D-L3W2-XHE
Operator Failure to Cross Connect RWST Given successful "F"
A-L3W2-XHE-X
FAILURE OF FEED AND SPILL USING HPI
FSW12H

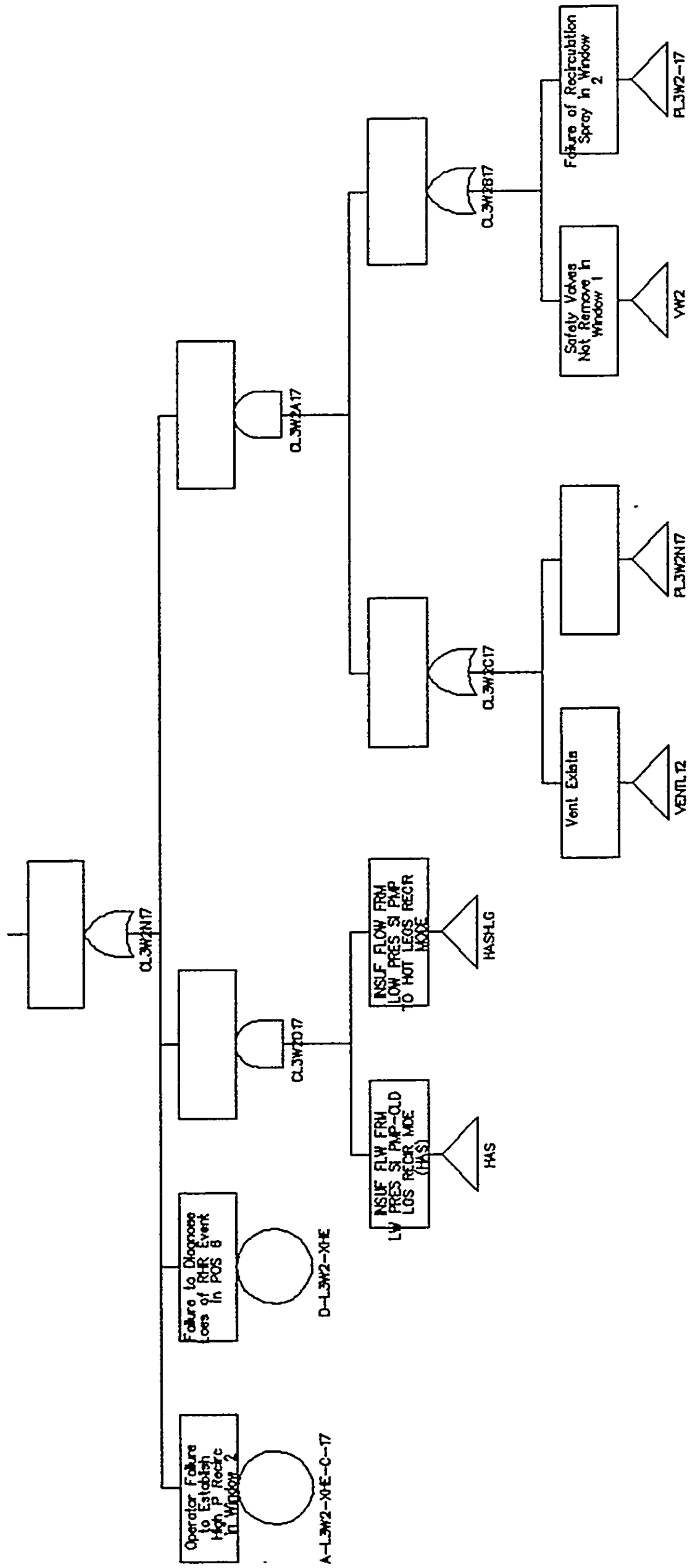


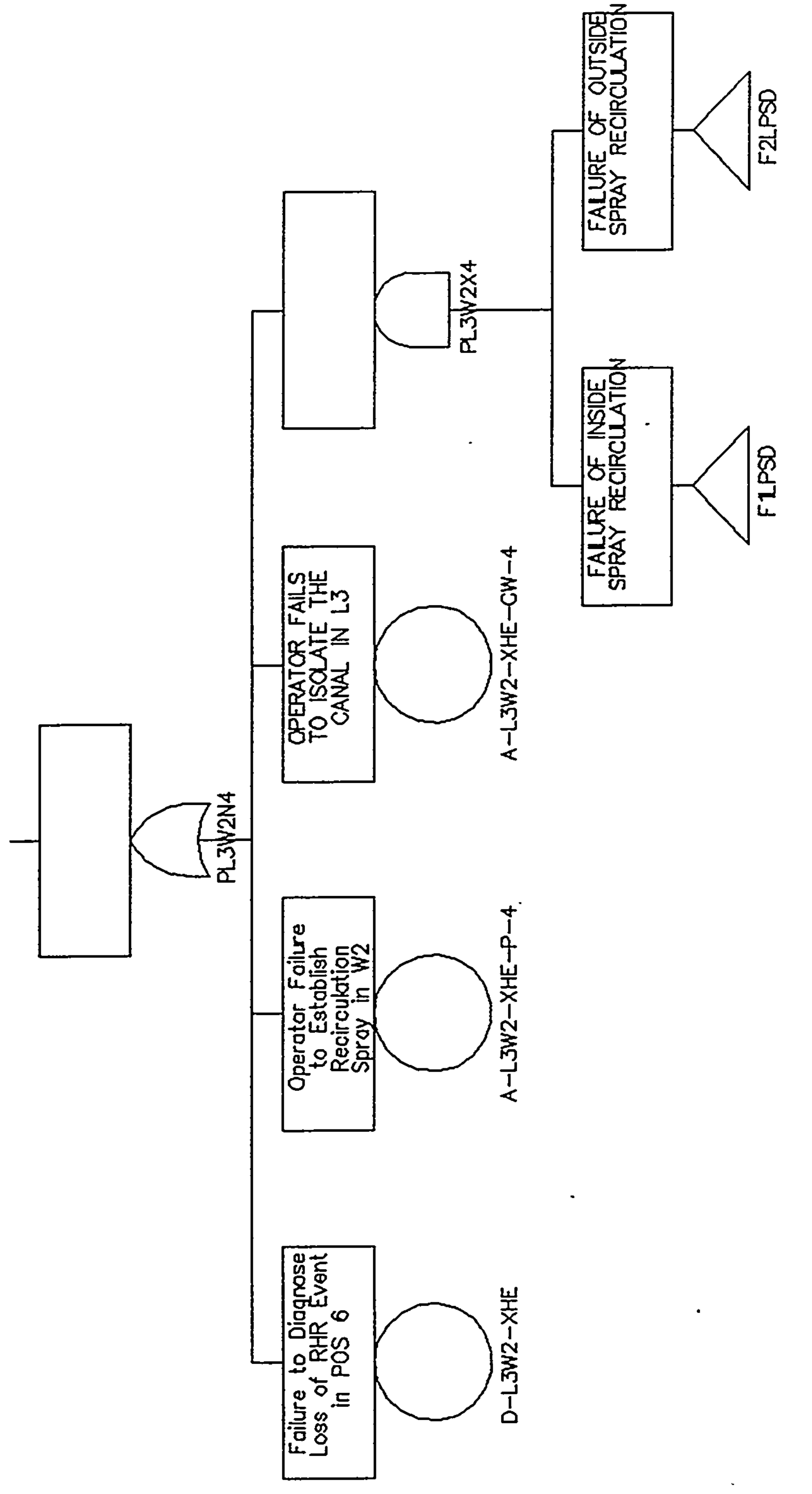
CL3W2N4
CL3W2A4
CL3W2B4
Failure of Recirculation Spray in Window 2
PL3W2-4
Safety Valves Not Remove In Window 1
VW2
CL3W2C4
PL3W2N4
Vent Exists
VENTL12
CL3W2D4
INSUF FLOW FRM LOW PRES SI PMP TO HOT LEGS RECIR MODE
HASHLG
INSUF FLW FRM LW PRES SI PMP-CLD LOS RECIR MDE (HAS)
HAS
Failure to Diagnose Loss of RHR Event In POS 6
D-L3W2-XHE
Operator Failure to Establish High P Recirc In Window 2
A-L3W2-XHE-C-4



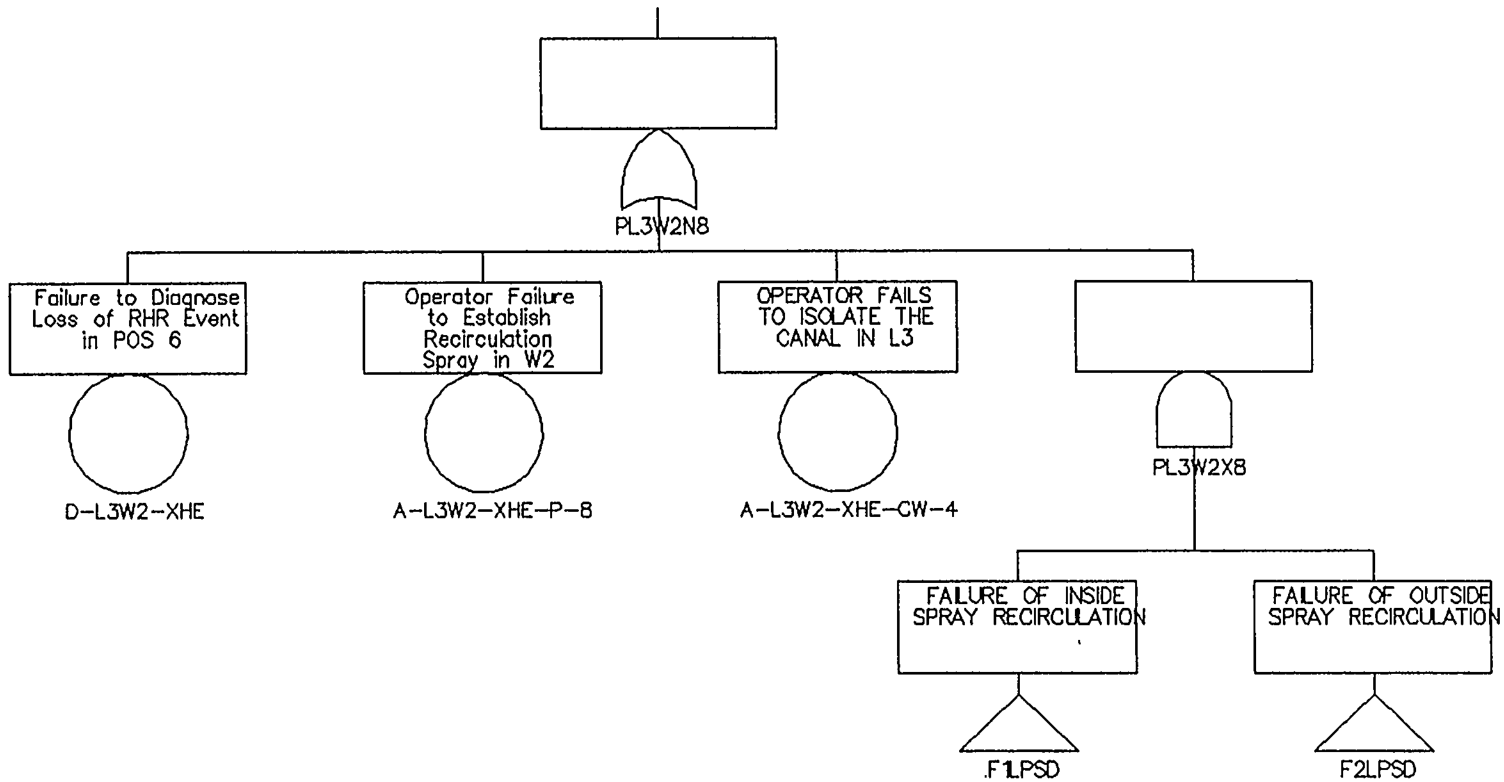
CL3W2N8
CL3W2A8
CL3W2B8
CL3W2C8
CL3W2D8
Failure of Recirculation Spray in Window 2
PL3W2-8
Safety Valves Not Remove in Window 1
VW2
PL3W2N8
Vent Exists
VENTL12
INSUF FLOW FRM LOW PRES SI PMP TO HOT LEGS RECIR MODE
HASHLG
INSUF FLW FRM LW PRES SI PMP-CLD LGS RECIR MDE (HAS)
HAS
Failure to Diagnose Loss of RHR Event in POS 8
D-L3W2-XHE
Operator Failure to Establish High P Recirc in Window 2
A-L3W2-XHE-C-8

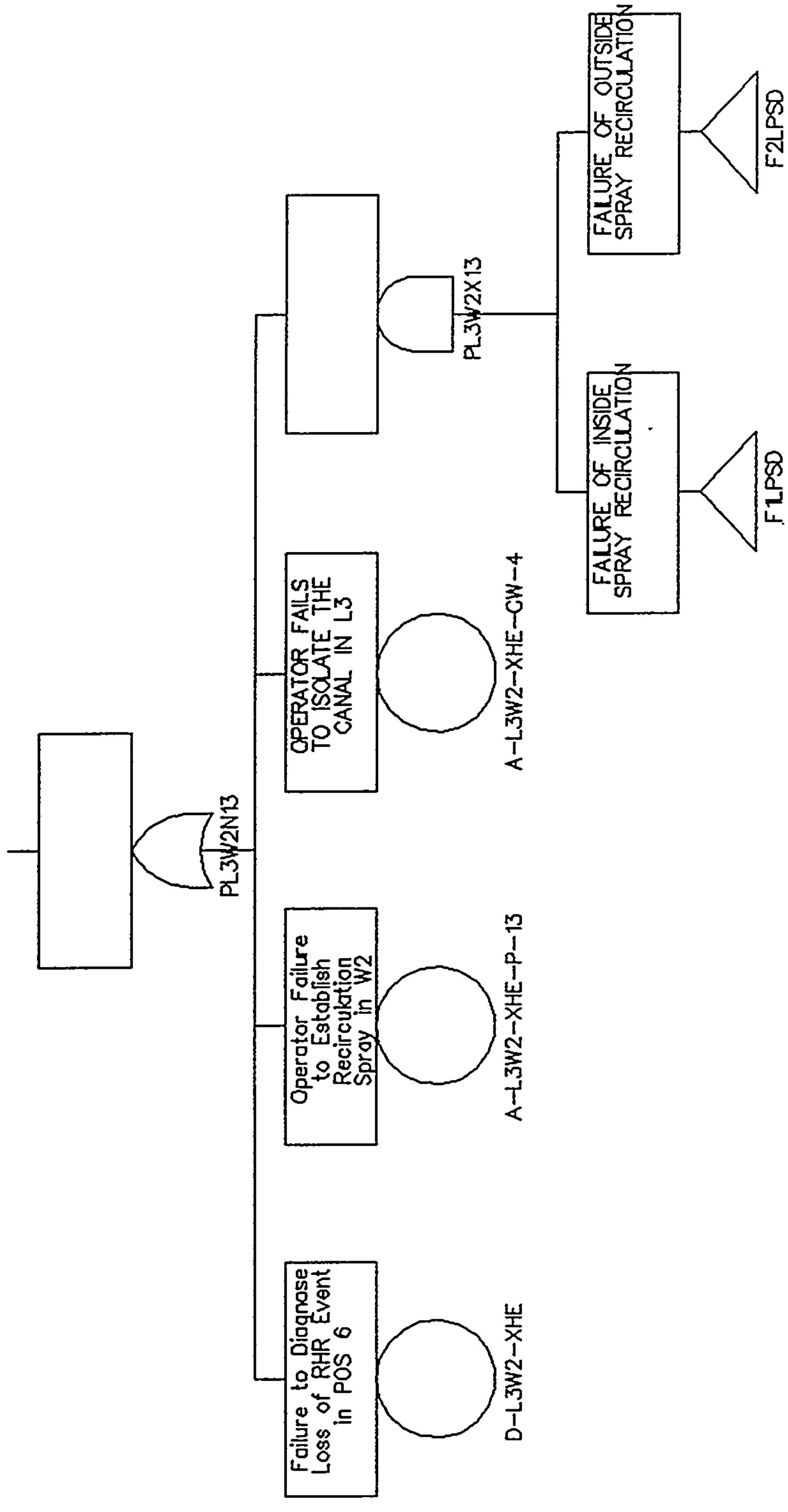

CL3W2N13
CL3W2A13
CL3W2B13
CL3W2C13
CL3W2D13
Failure of Recirculation Spray in Window 2
PL3W2-13
Safety Valves Not Remove in Window 1
VW2
PL3W2N13
Vent Exists
VENTL12
INSUF FLOW FRM LOW PRES SI PMP TO HOT LEGS RECIR MODE
HASHLG
INSUF FLW FRM LW PRES SI PMP-CLD LGS RECIR MDE (HAS)
HAS
Failure to Diagnose Loss of RHR Event In POS 8
D-L3W2-XHE
Operator Failure to Establish High P Recirc in Window 2
A-L3W2-XHE-C-13

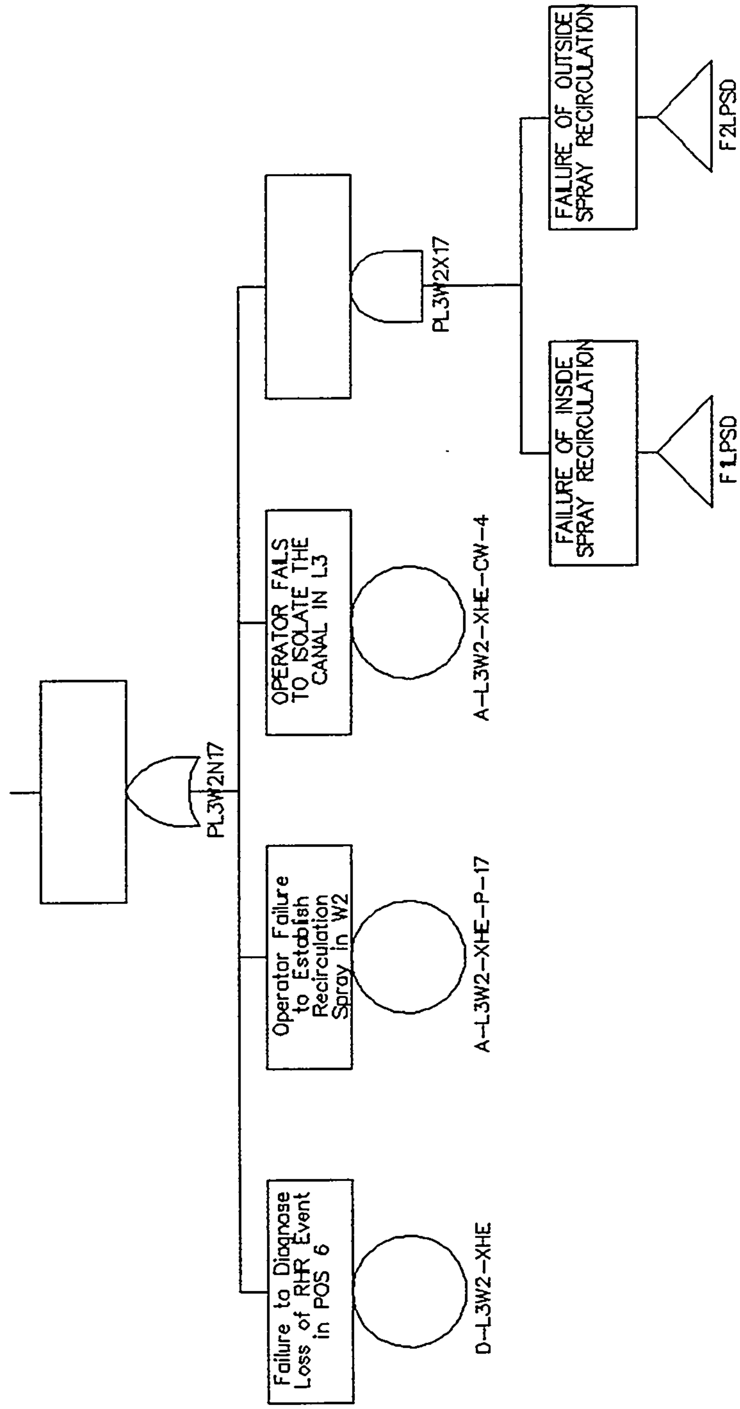

CL3W2N17
CL3W2A17
CL3W2B17
Safety Valves Not Remove In Window 1
VW2
Failure of Recirculation Spray In Window 2
PL3W2-17
CL3W2C17
Vent Exists
VENTL12
PL3W2N17
CL3W2D17
INSUF FLW FRM LW PRES SI PMP-CLD LGS RECR MDE (HAS)
HAS
INSUF FLOW FRM LOW PRES SI PMP TO HOT LEGS RECR MODE
HAS-LG
Failure to Diagnose Loss of RHR Event In POS 8
D-L3W2-XHE
Operator Failure to Establish High P Recirc In Window 2
A-L3W2-XHE-C-17

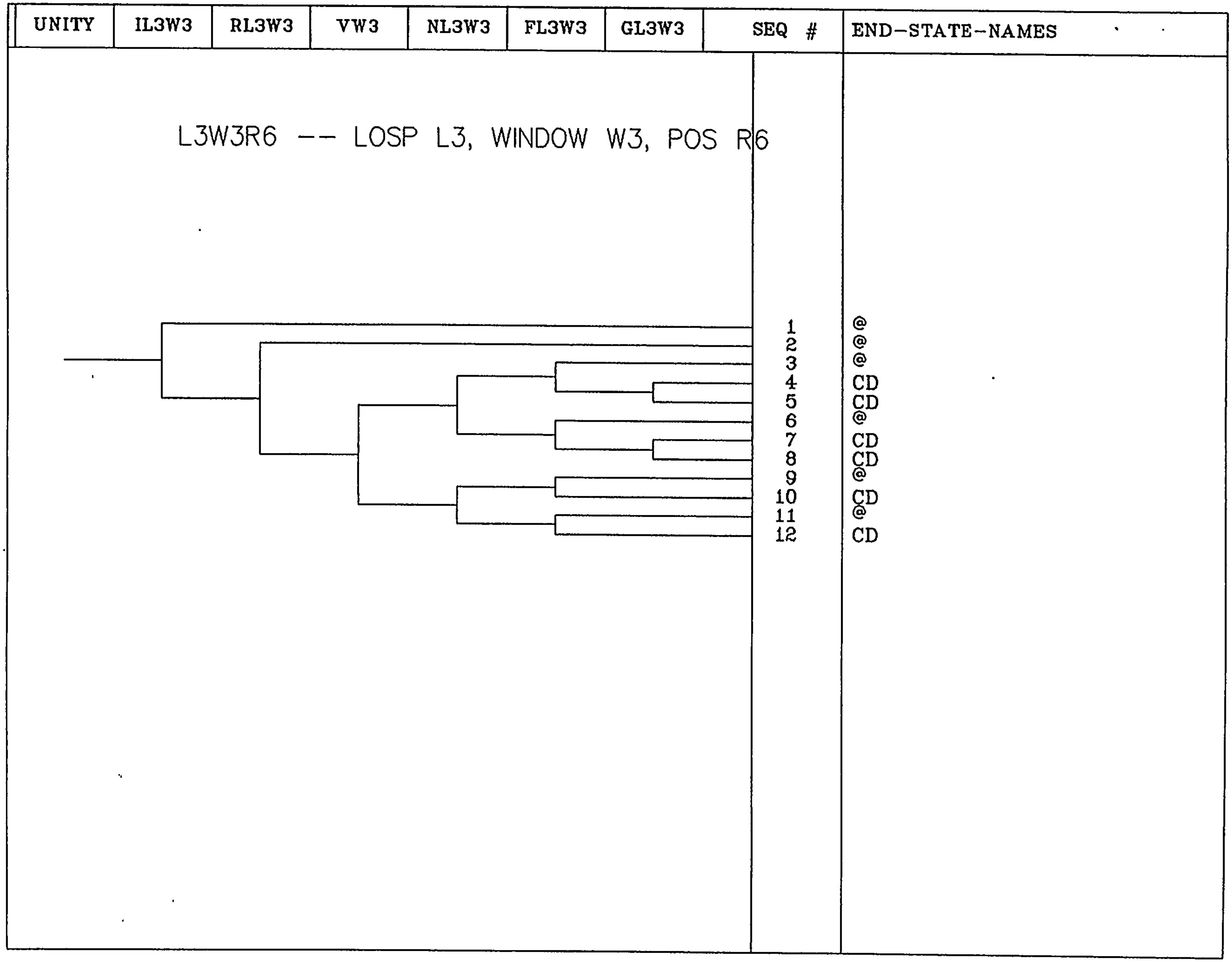


PL3W2N4
Failure to Diagnose Loss of RHR Event in POS 6
D-L3W2-XHE
Operator Failure to Establish Recirculation Spray in W2
A-L3W2-XHE-P-4
OPERATOR FAILS TO ISOLATE THE CANAL IN L3
A-L3W2-XHE-CW-4
PL3W2X4
FAILURE OF INSIDE SPRAY RECIRCULATION
F1LPSD
FAILURE OF OUTSIDE SPRAY RECIRCULATION
F2LPSD

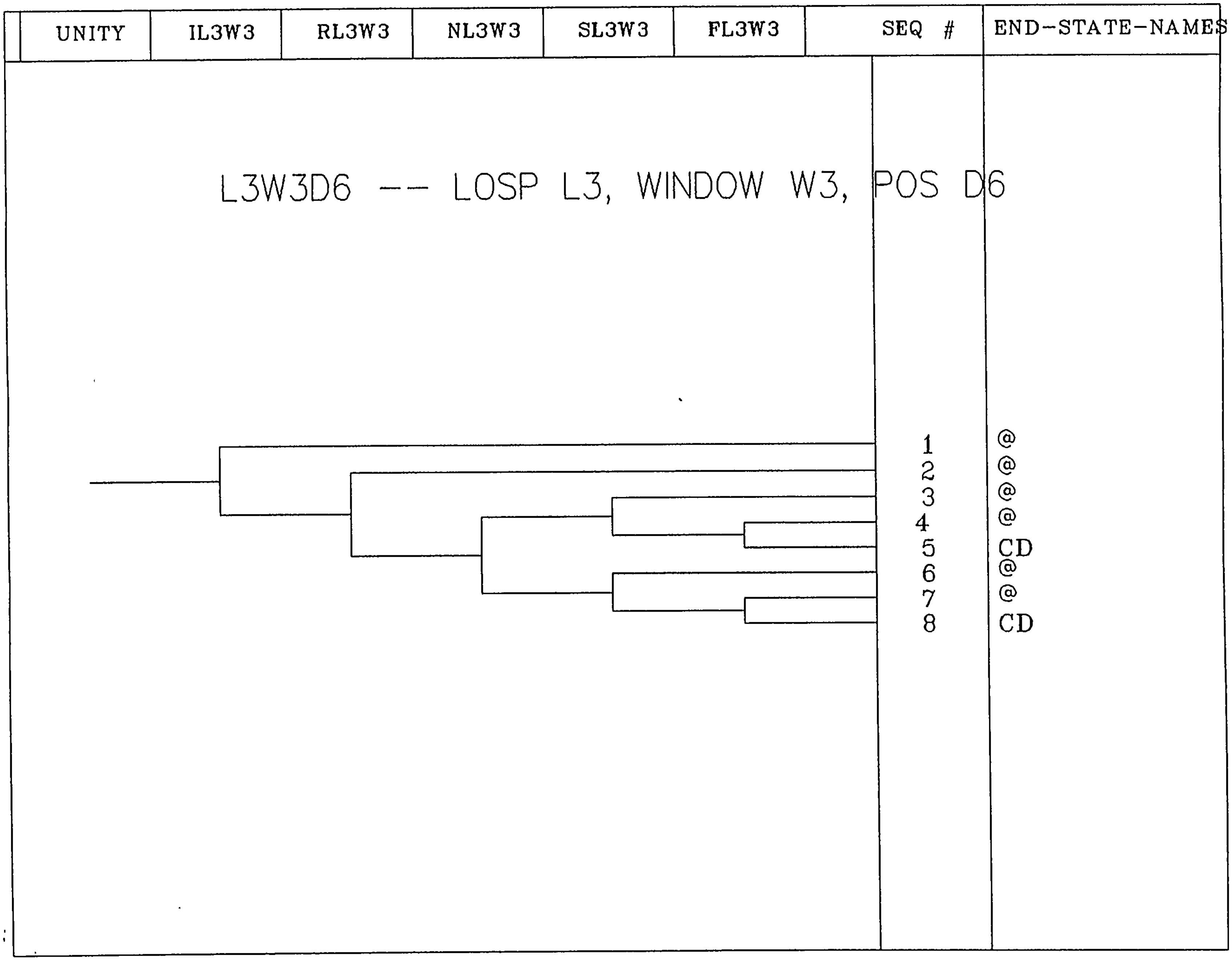

PL3W2N8
Failure to Diagnose Loss of RHR Event in POS 6
D-L3W2-XHE
Operator Failure to Establish Recirculation Spray in W2
A-L3W2-XHE-P-8
OPERATOR FAILS TO ISOLATE THE CANAL IN L3
A-L3W2-XHE-CW-4
PL3W2X8
FAILURE OF INSIDE SPRAY RECIRCULATION
F1LPSD
FAILURE OF OUTSIDE SPRAY RECIRCULATION
F2LPSD

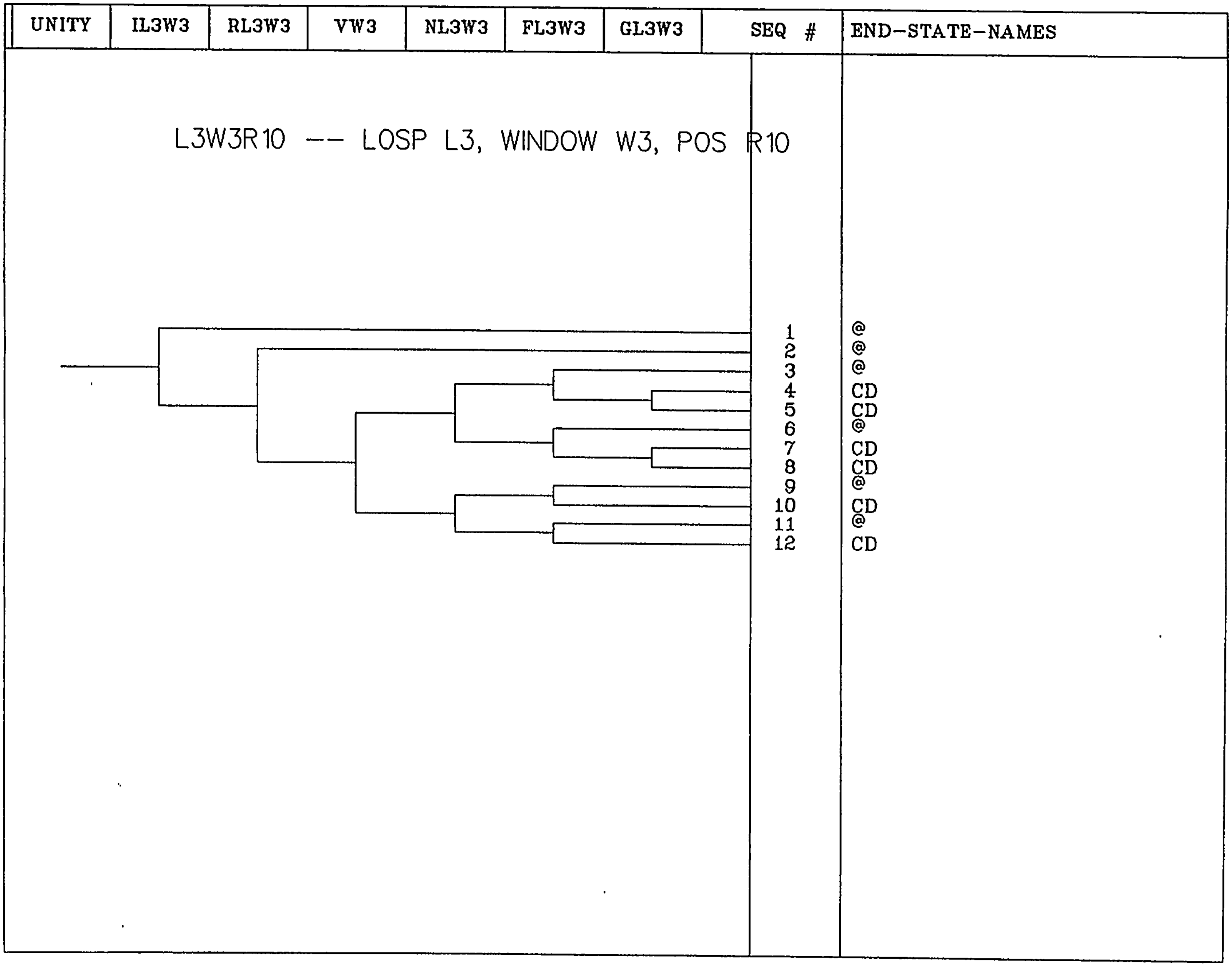

PL3W2N13
Failure to Diagnose Loss of RHR Event in POS 6
D-L3W2-XHE
Operator Failure to Establish Recirculation Spray in W2
A-L3W2-XHE-P-13
OPERATOR FAILS TO ISOLATE THE CANAL IN L3
A-L3W2-XHE-CW-4
PL3W2X13
FAILURE OF INSIDE SPRAY RECIRCULATION
F1LPSD
FAILURE OF OUTSIDE SPRAY RECIRCULATION
F2LPSD


PL3W2N17
Failure to Diagnose Loss of RHR Event in POS 6
D-L3W2-XHE
Operator Failure to Establish Recirculation Spray in W2
A-L3W2-XHE-P-17
OPERATOR FAILS TO ISOLATE THE CANAL IN L3
A-L3W2-XHE-CW-4
PL3W2X17
FAILURE OF INSIDE SPRAY RECIRCULATION
F1LPSD
FAILURE OF OUTSIDE SPRAY RECIRCULATION
F2LPSD



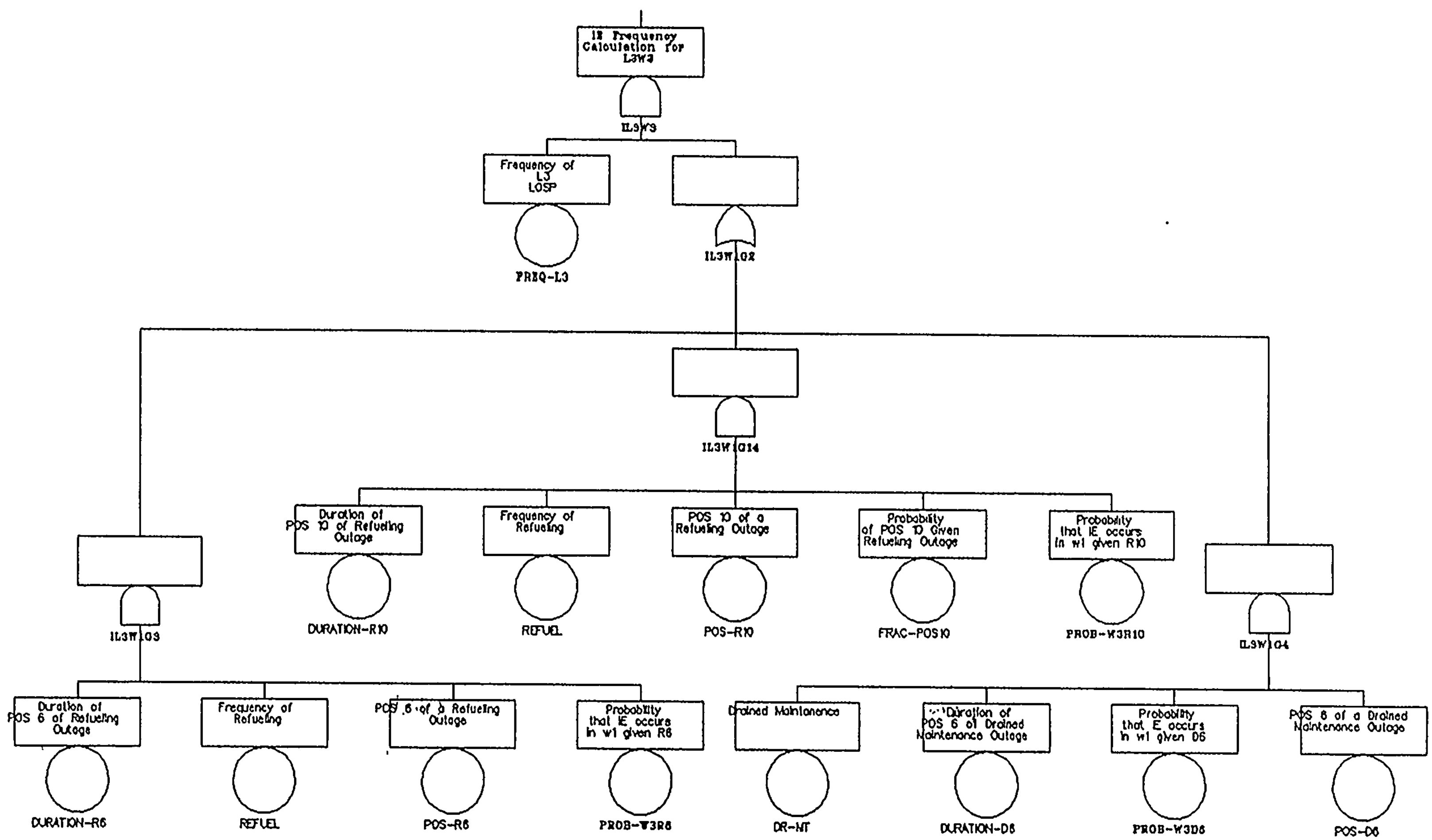
UNITY
IL3W3
RL3W3
VW3
NL3W3
FL3W3
GL3W3
SEQ #
END-STATE-NAMES
L3W3R6 -- LOSP L3, WINDOW W3, POS R6
1 @
2 @
3 @
4 CD
5 CD
6 @
7 CD
8 CD
9 @
10 CD
11 @
12 CD


UNITY
IL3W3
RL3W3
NL3W3
SL3W3
FL3W3
SEQ #
END-STATE-NAMES
L3W3D6 -- LOSP L3, WINDOW W3, POS D6
1 @
2 @
3 @
4 @
5 CD
6 @
7 @
8 CD

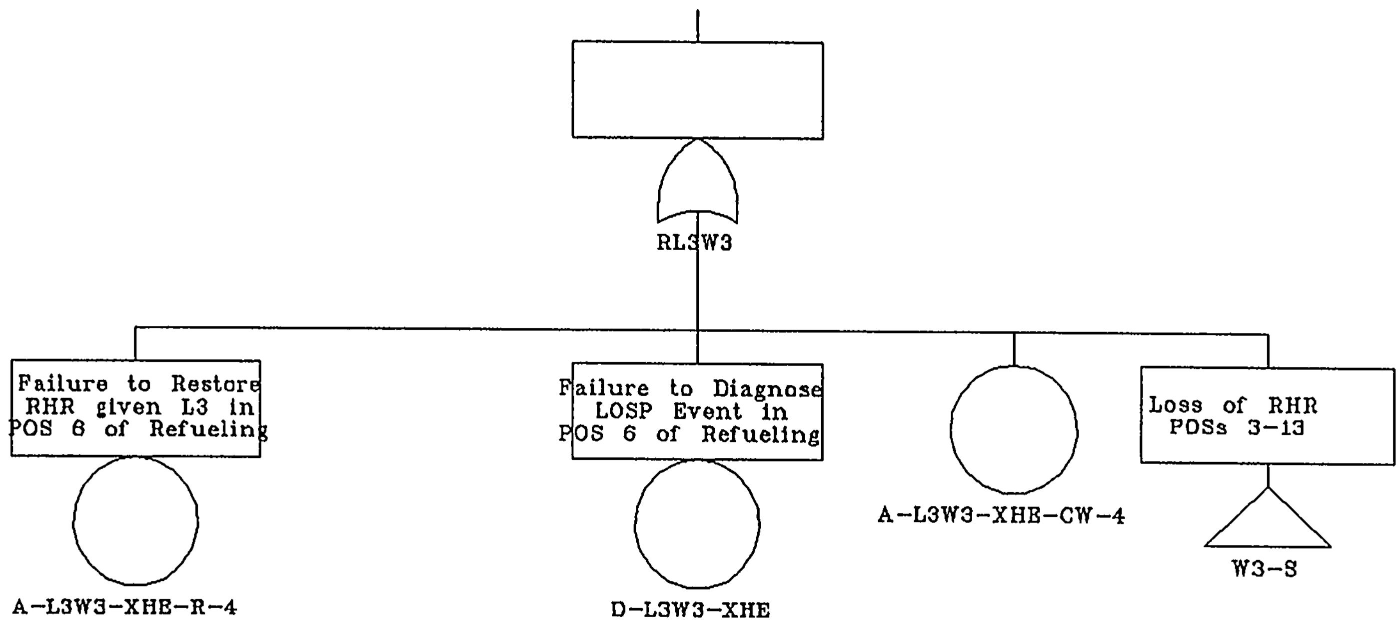


UNITY
IL3W3
RL3W3
VW3
NL3W3
FL3W3
GL3W3
SEQ #
END-STATE-NAMES
L3W3R10 -- LOSP L3, WINDOW W3, POS R10
1 @
2 @
3 @
4 CD
5 CD
6 @
7 CD
8 CD
9 @
10 CD
11 @
12 CD

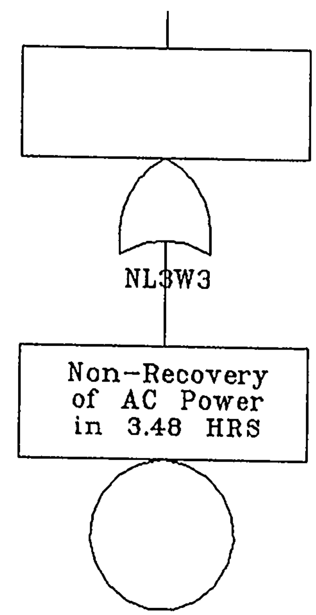
I top event for L3 LOSP – L3 in window 3



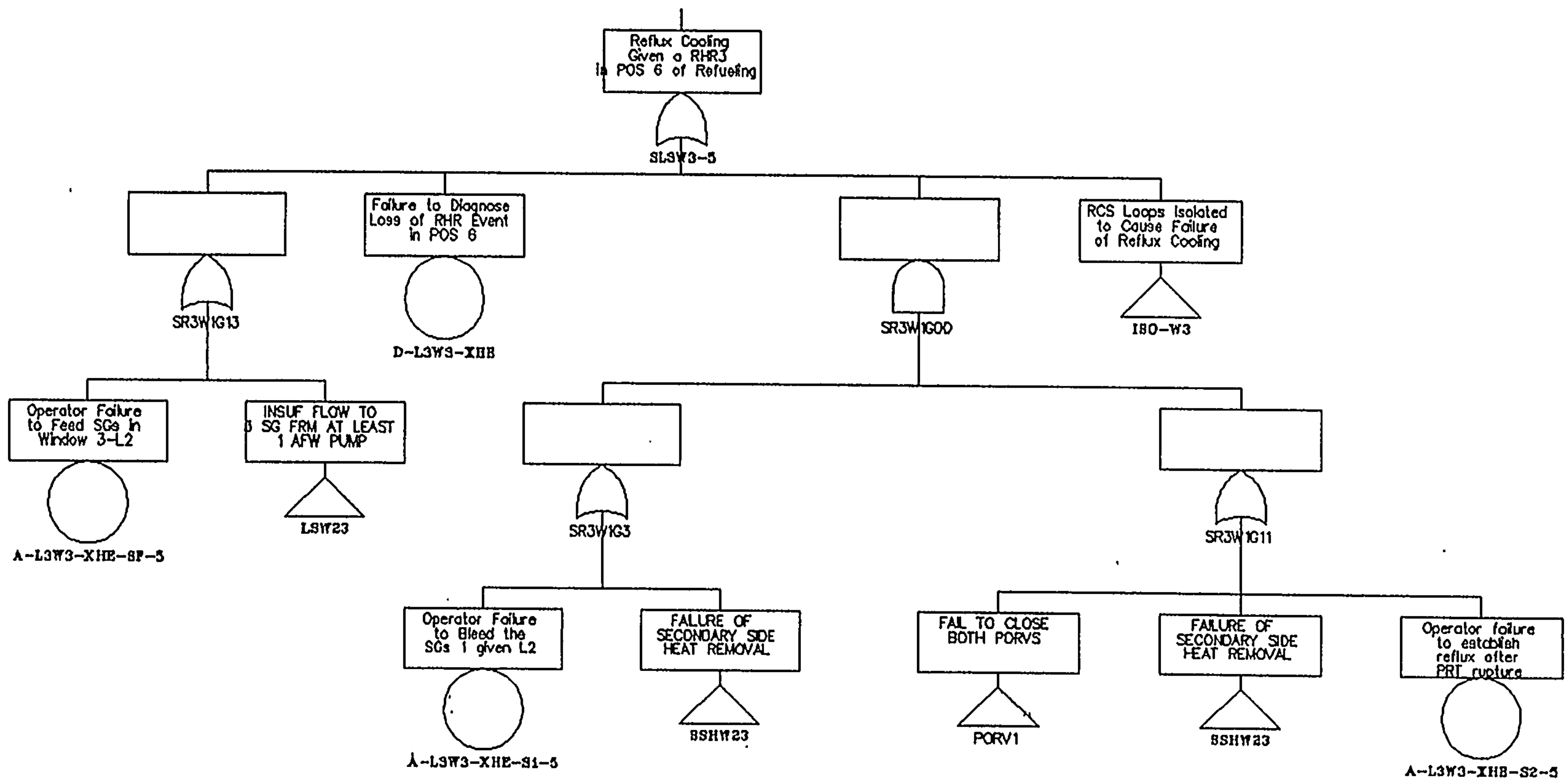
Restore RHR given L3 in POS 6 - Refueling



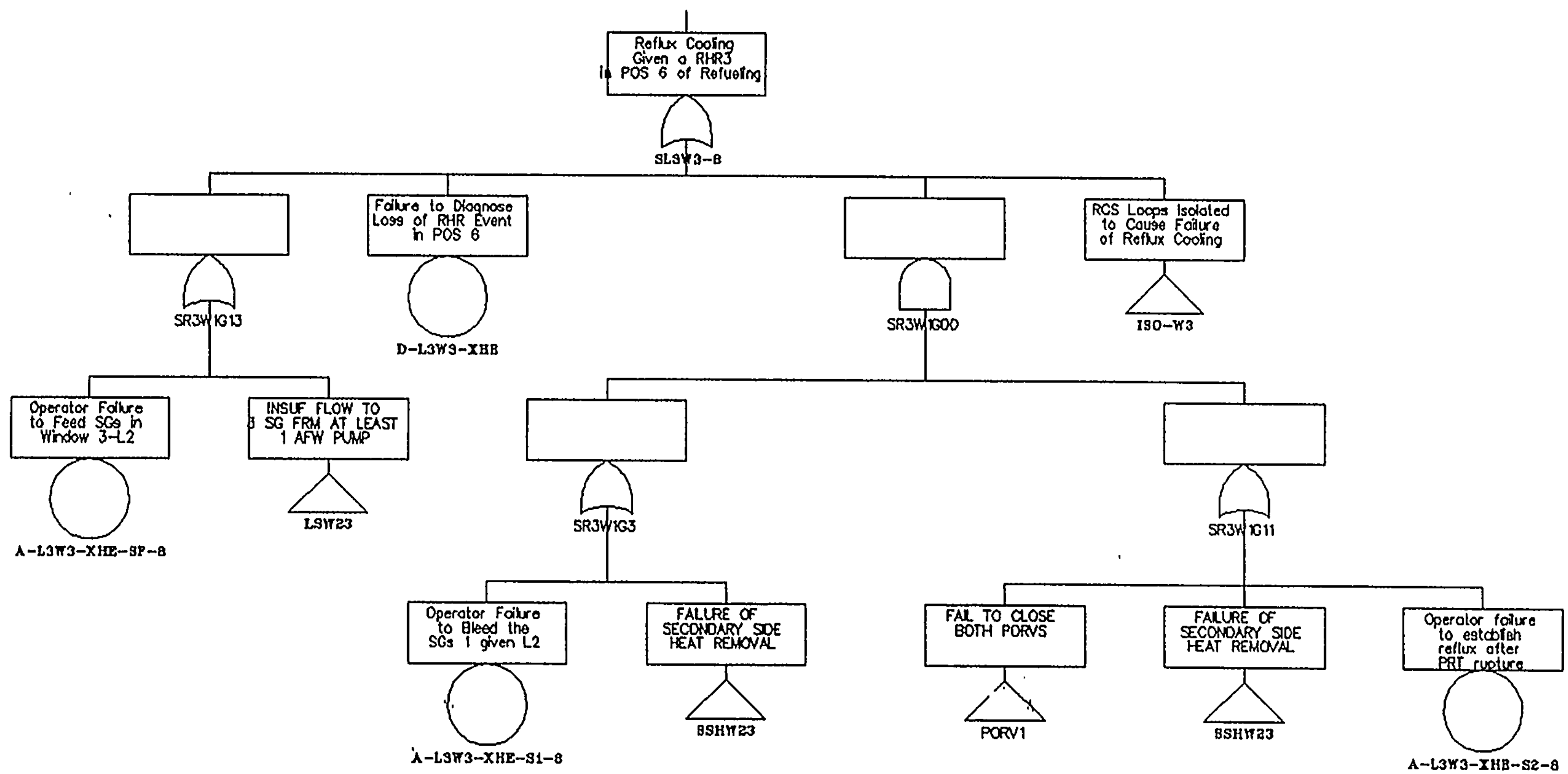
Non-Recovery of AC Power



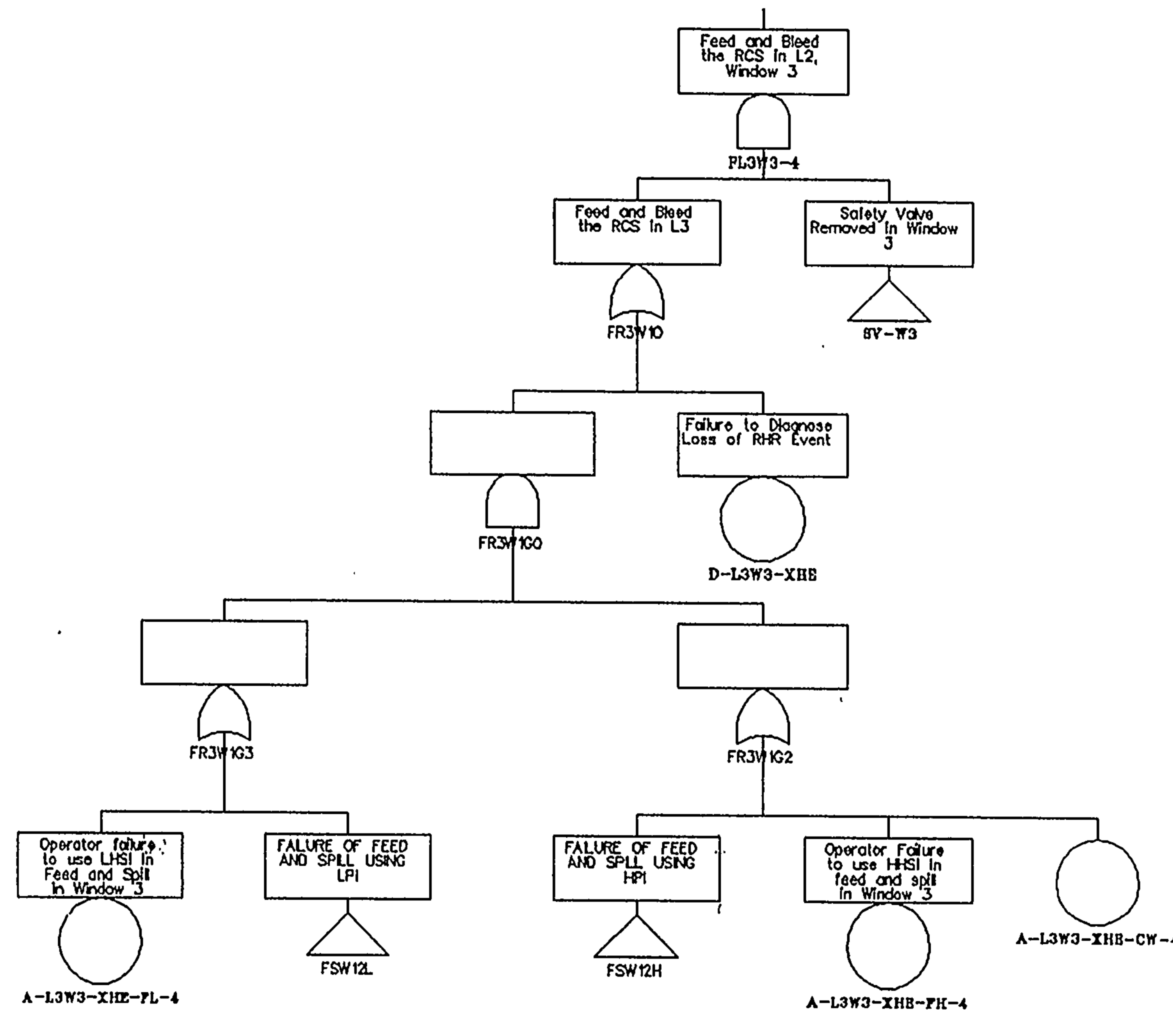
Reflux Cooling in window 3



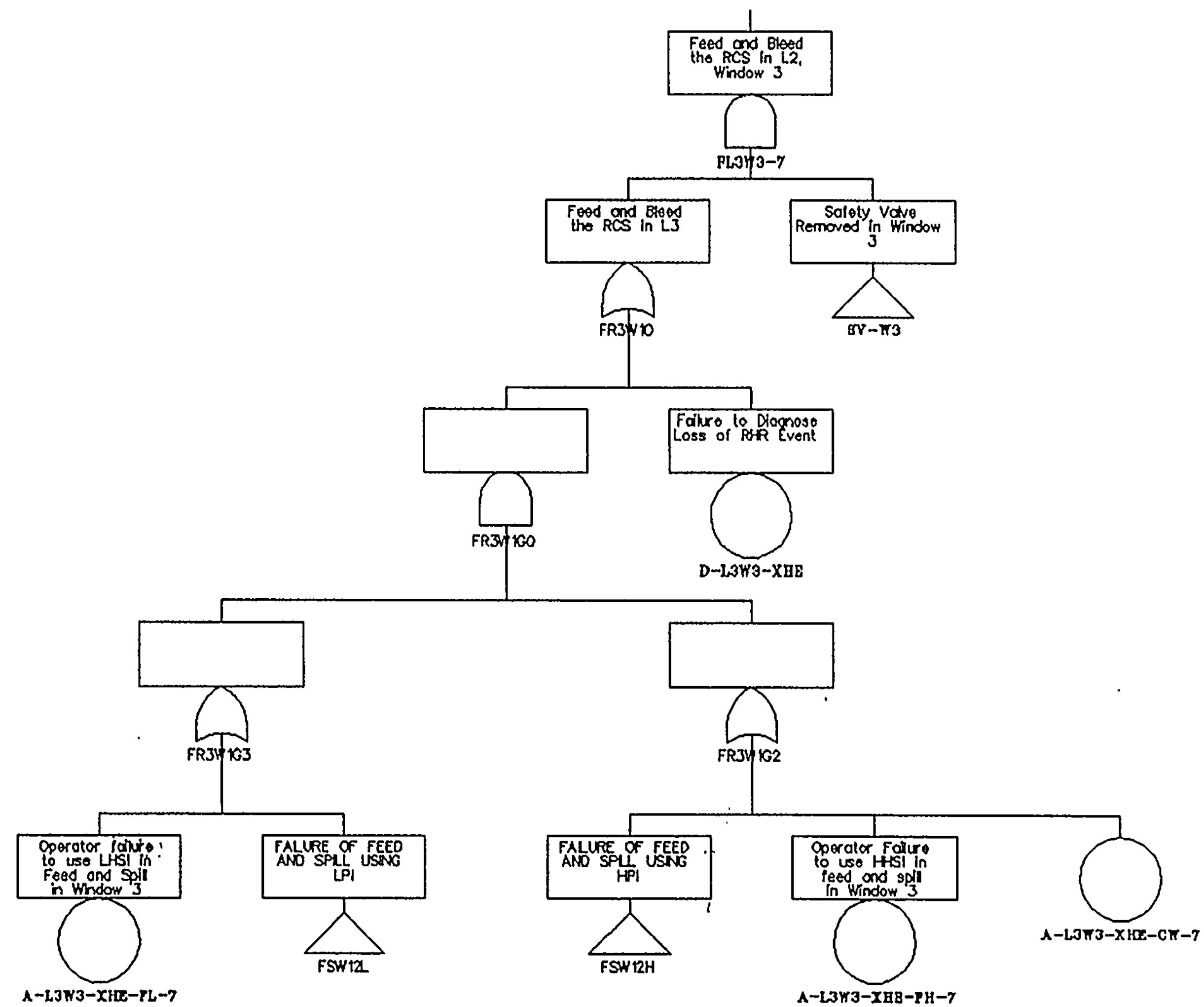
Reflux Cooling in window 3



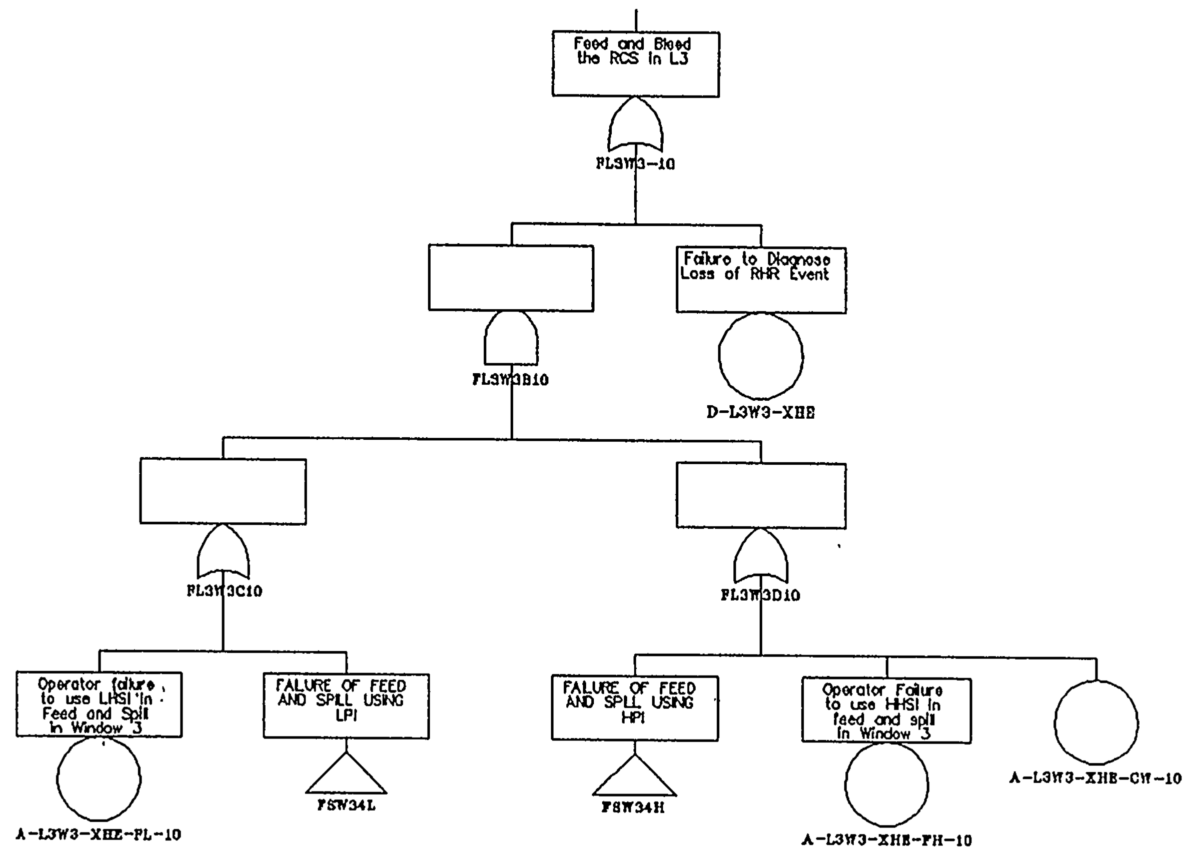
Feed and Bleed the RCS in L3, Window 3



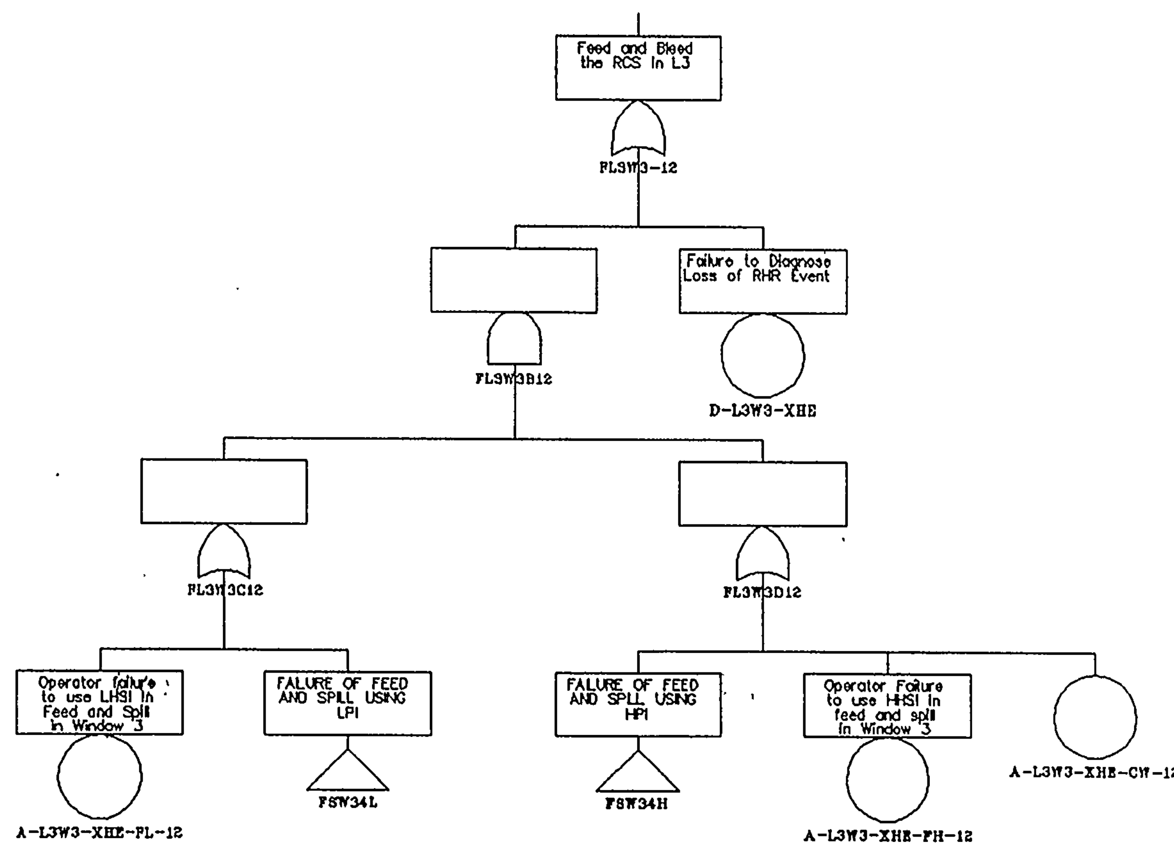
Feed and Bleed the RCS in L3, Window 3



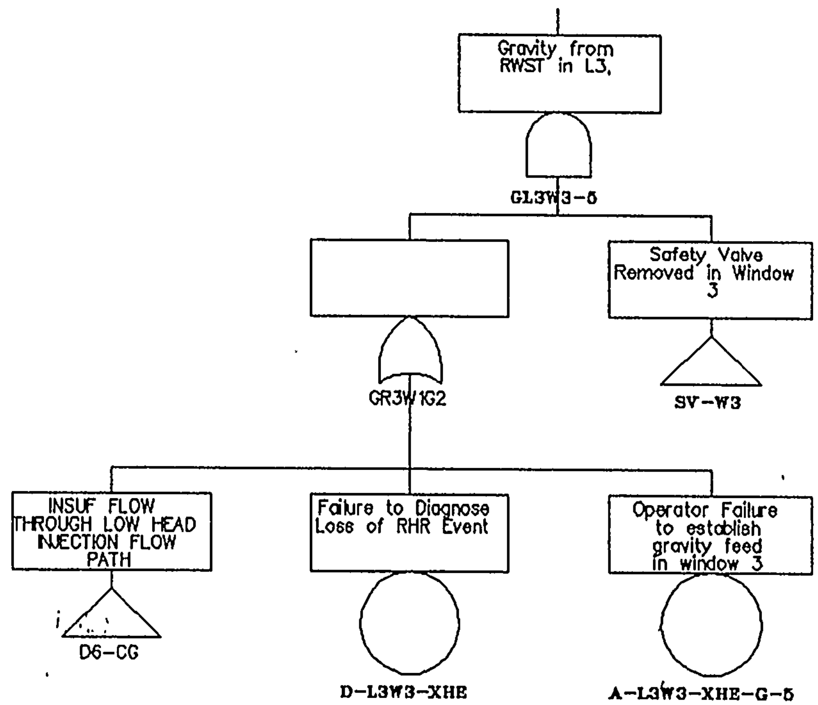
Feed and Bleed the RCS in L3, Window 3



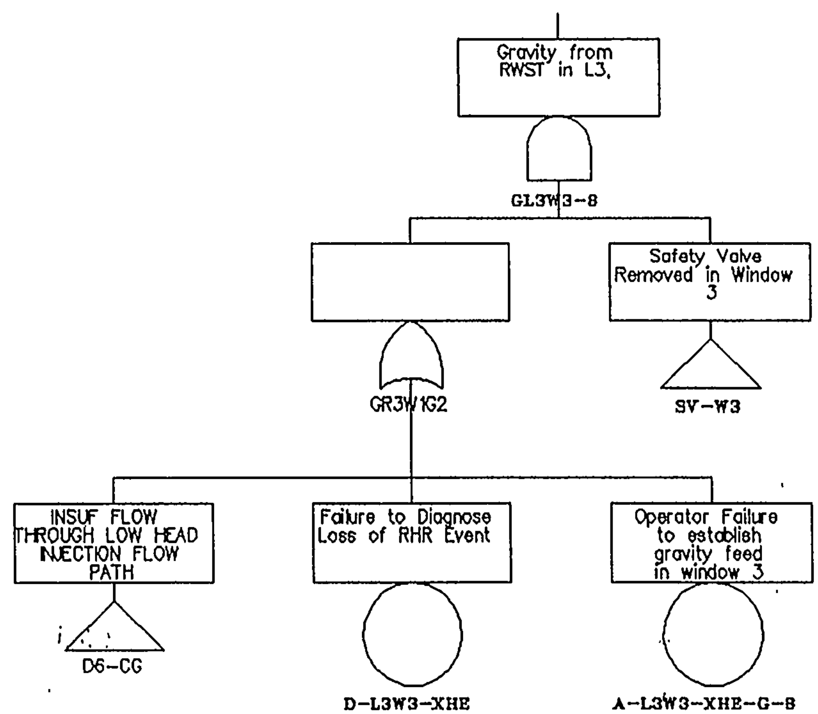
Feed and Bleed the RCS in L3, Window 3

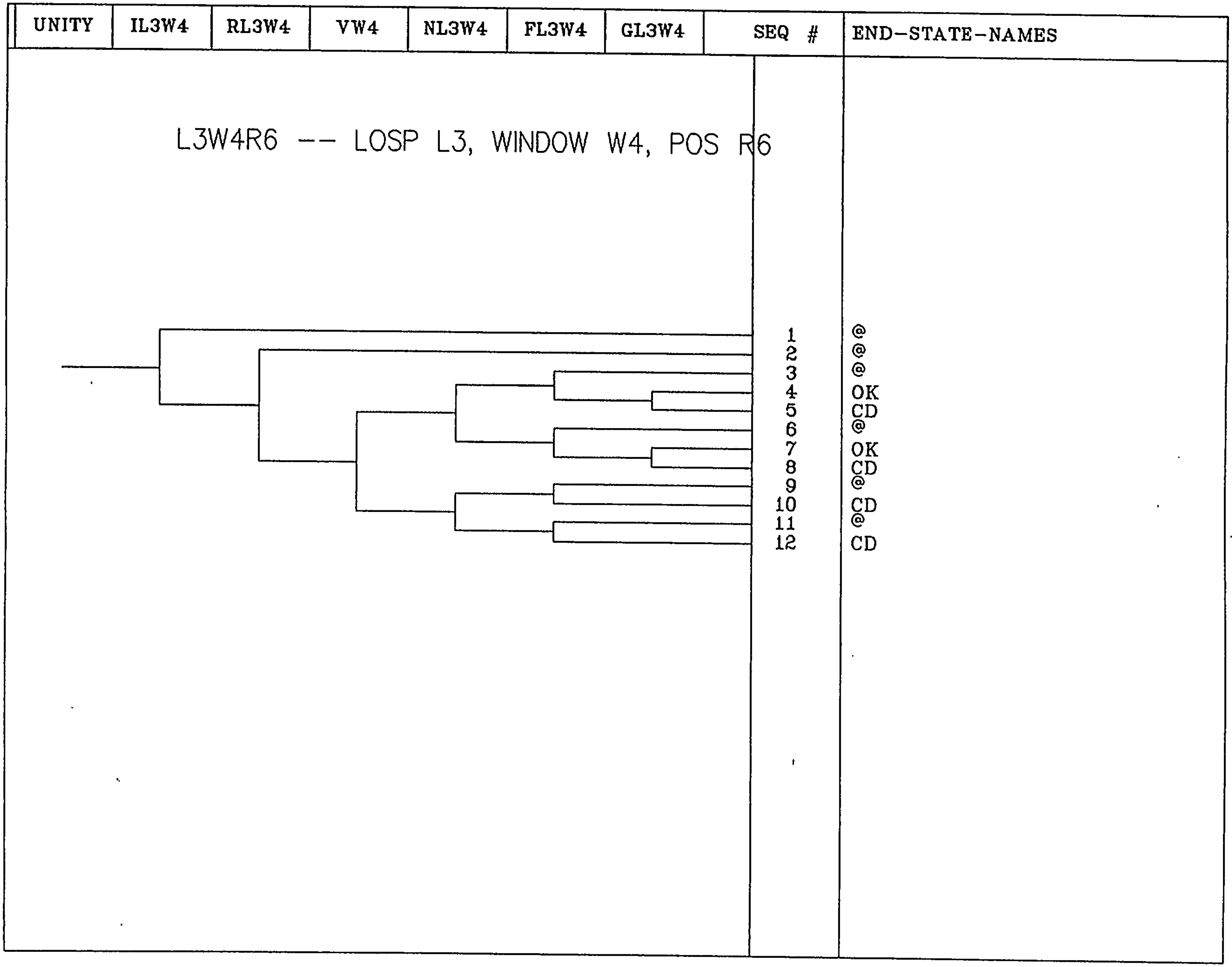


Gravity from RWST in L3, Window 3

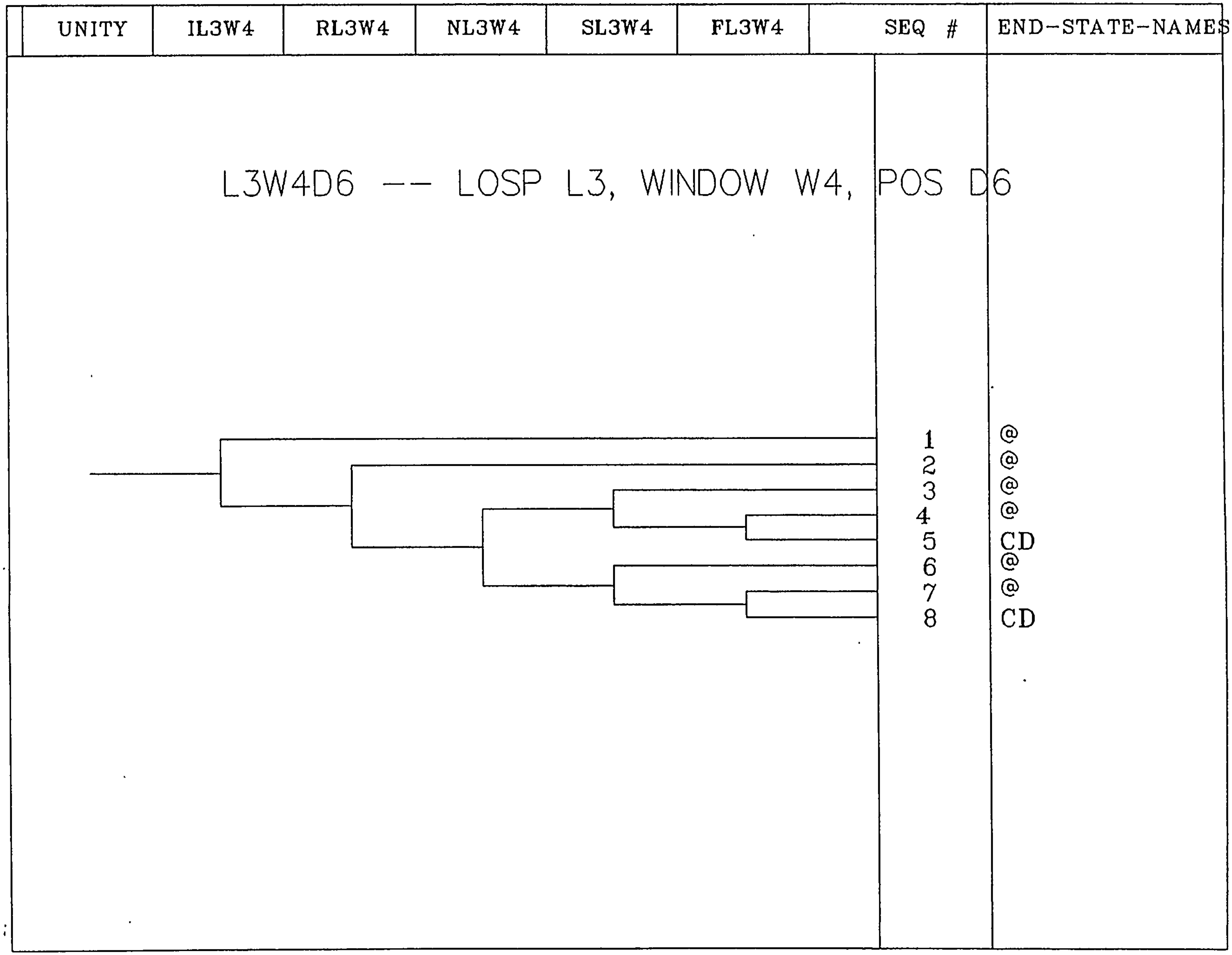


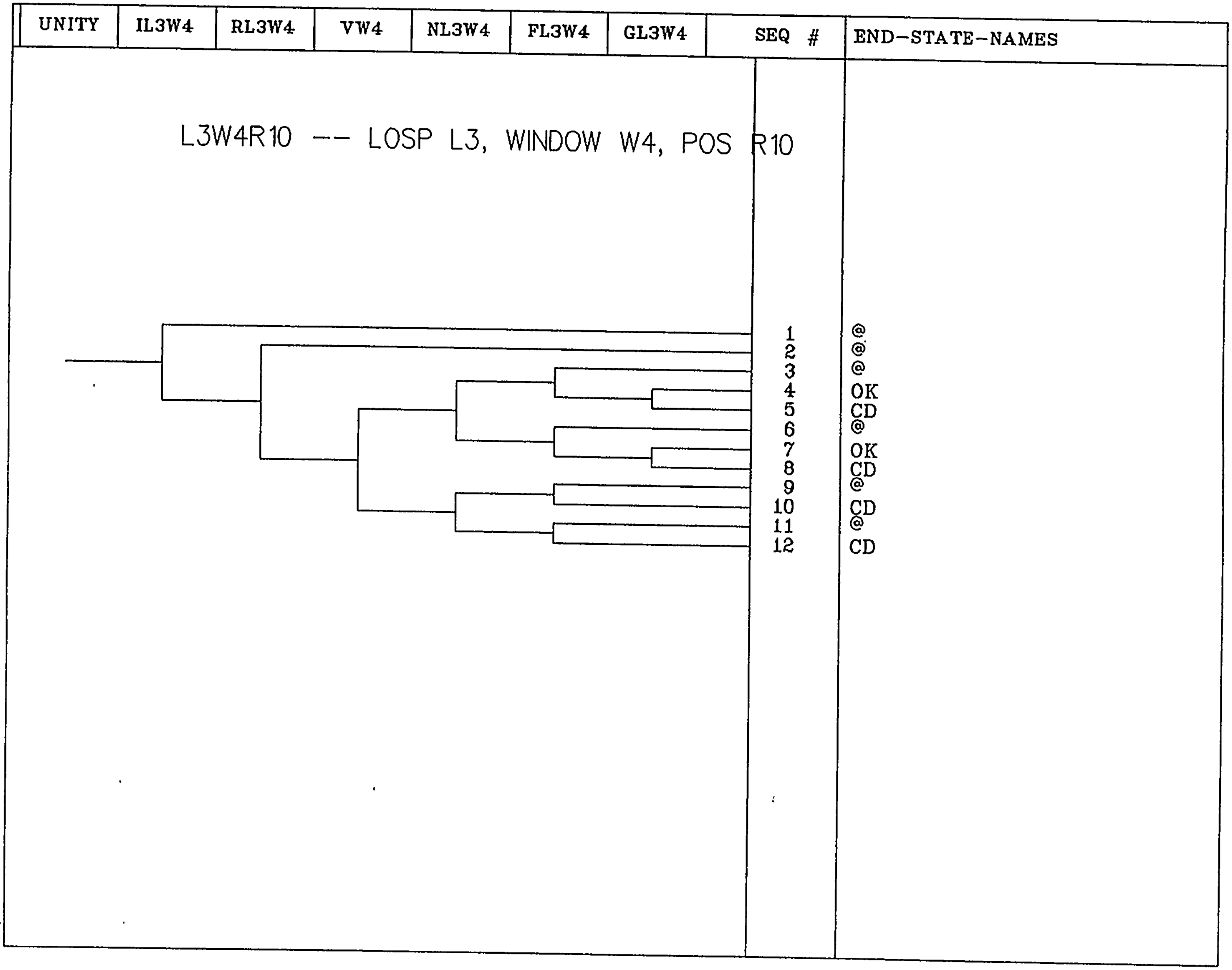
Gravity from RWST in L3, Window 3





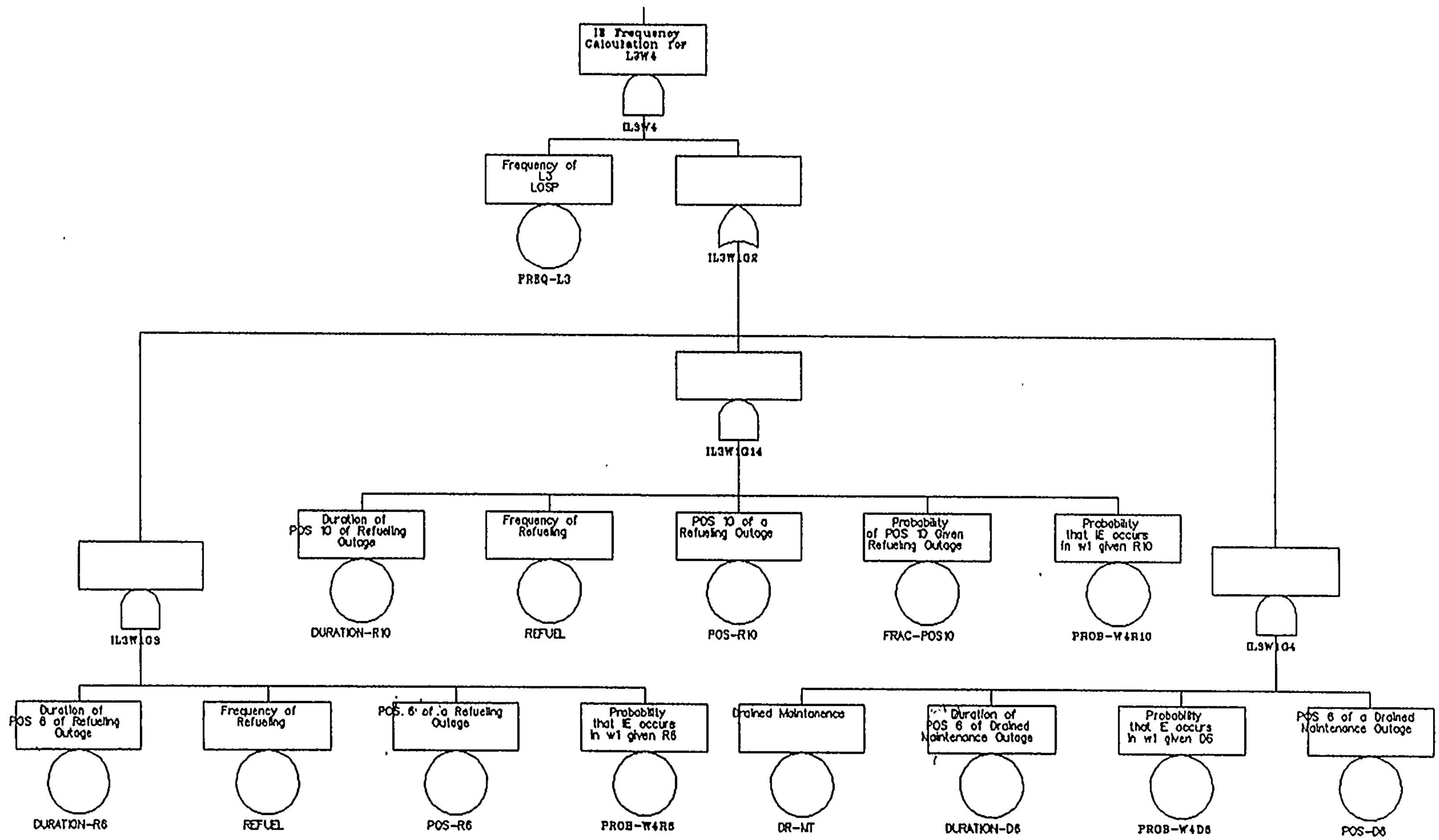
UNITY
IL3W4
RL3W4
VW4
NL3W4
FL3W4
GL3W4
SEQ #
END-STATE-NAMES
L3W4R6 -- LOSP L3, WINDOW W4, POS R6
1 @
2 @
3 @
4 OK
5 CD
6 @
7 OK
8 CD
9 @
10 CD
11 @
12 CD


UNITY
IL3W4
RL3W4
NL3W4
SL3W4
FL3W4
SEQ #
END-STATE-NAMES
L3W4D6 -- LOSP L3, WINDOW W4, POS D6
1 @
2 @
3 @
4 @
5 CD
6 @
7 @
8 CD

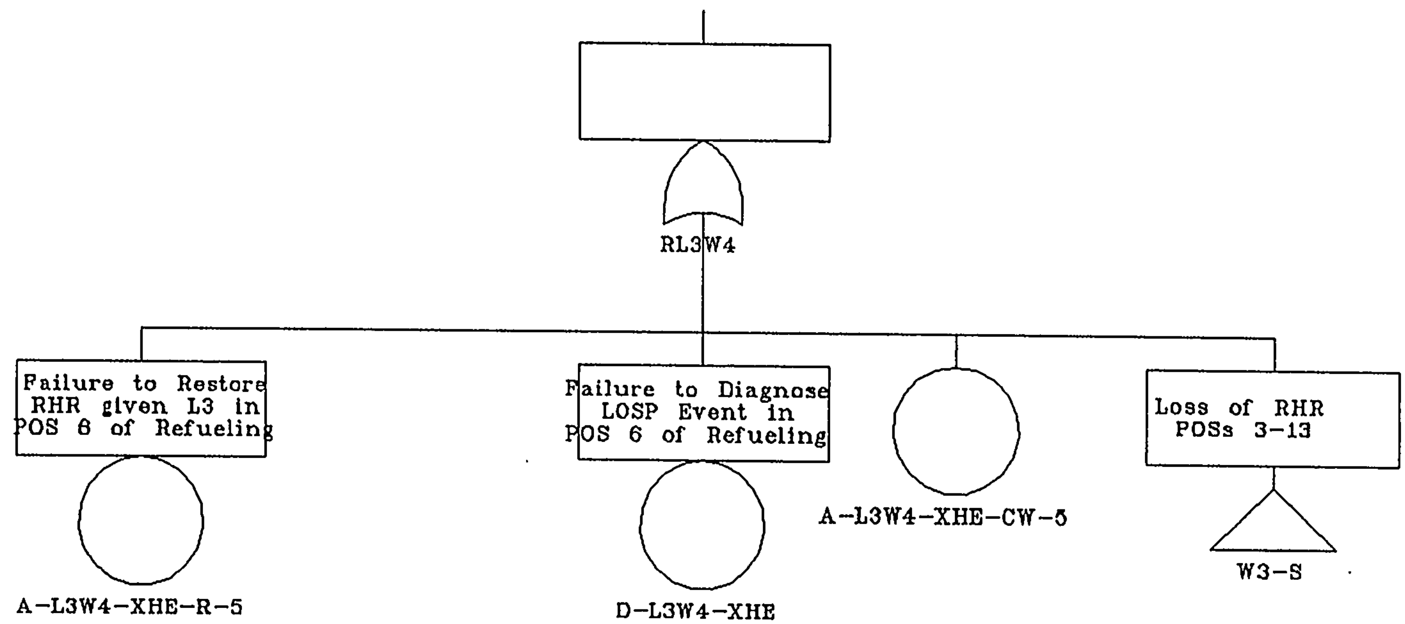


UNITY
IL3W4
RL3W4
VW4
NL3W4
FL3W4
GL3W4
SEQ #
END-STATE-NAMES
L3W4R10 -- LOSP L3, WINDOW W4, POS R10
1 @
2 @
3 @
4 OK
5 CD
6 @
7 OK
8 CD
9 @
10 CD
11 @
12 CD

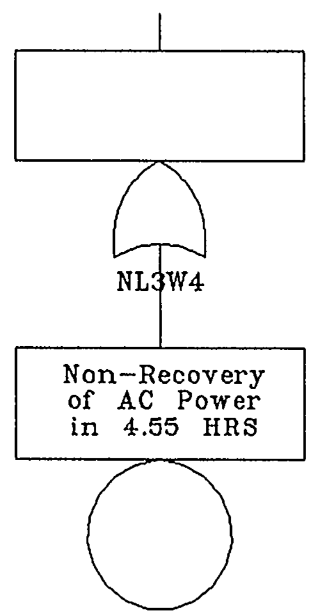
I top event for L3 LOSP - L3 in window 4



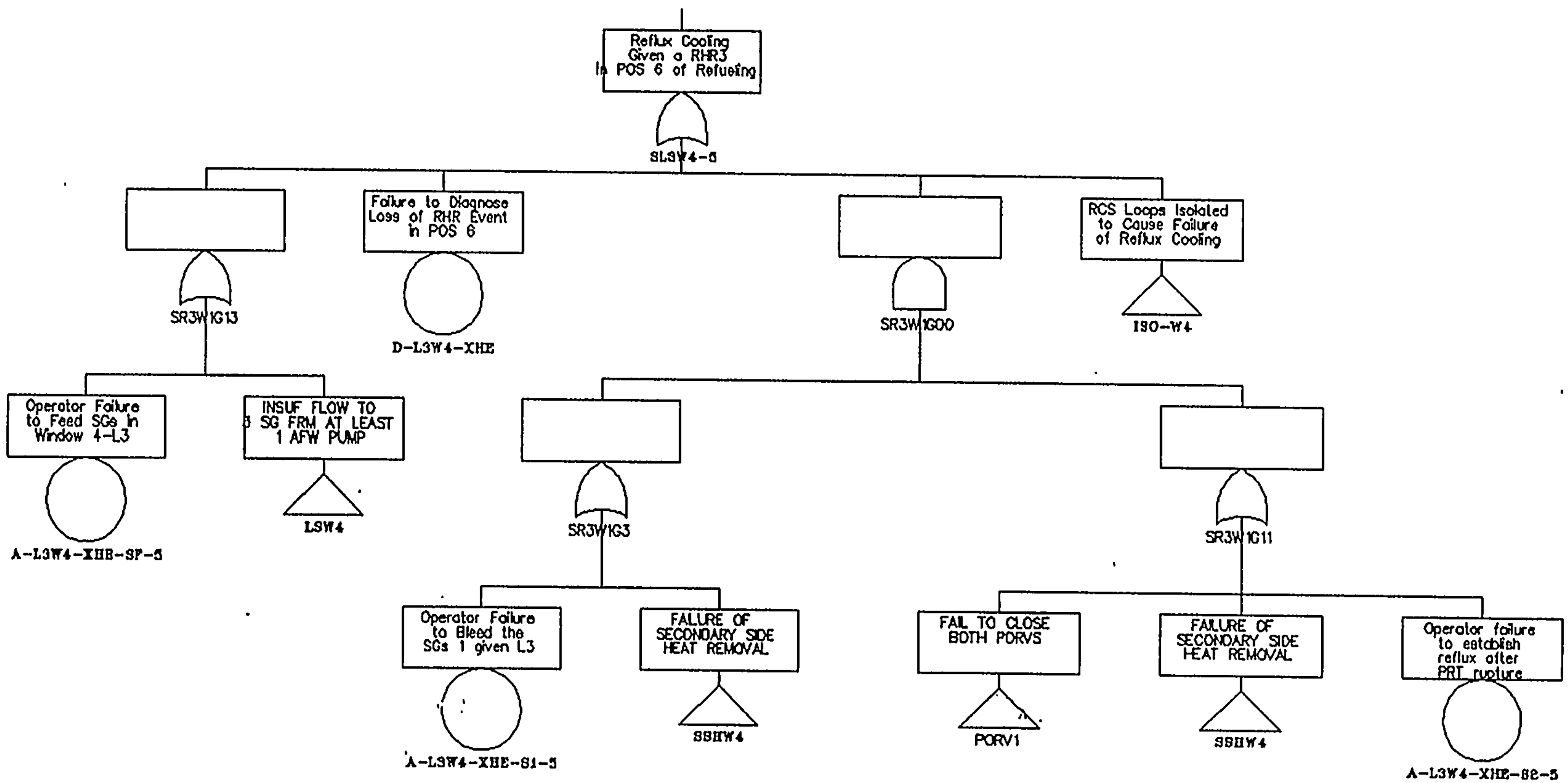
Restore RHR given L3 in POS 6 – Refueling



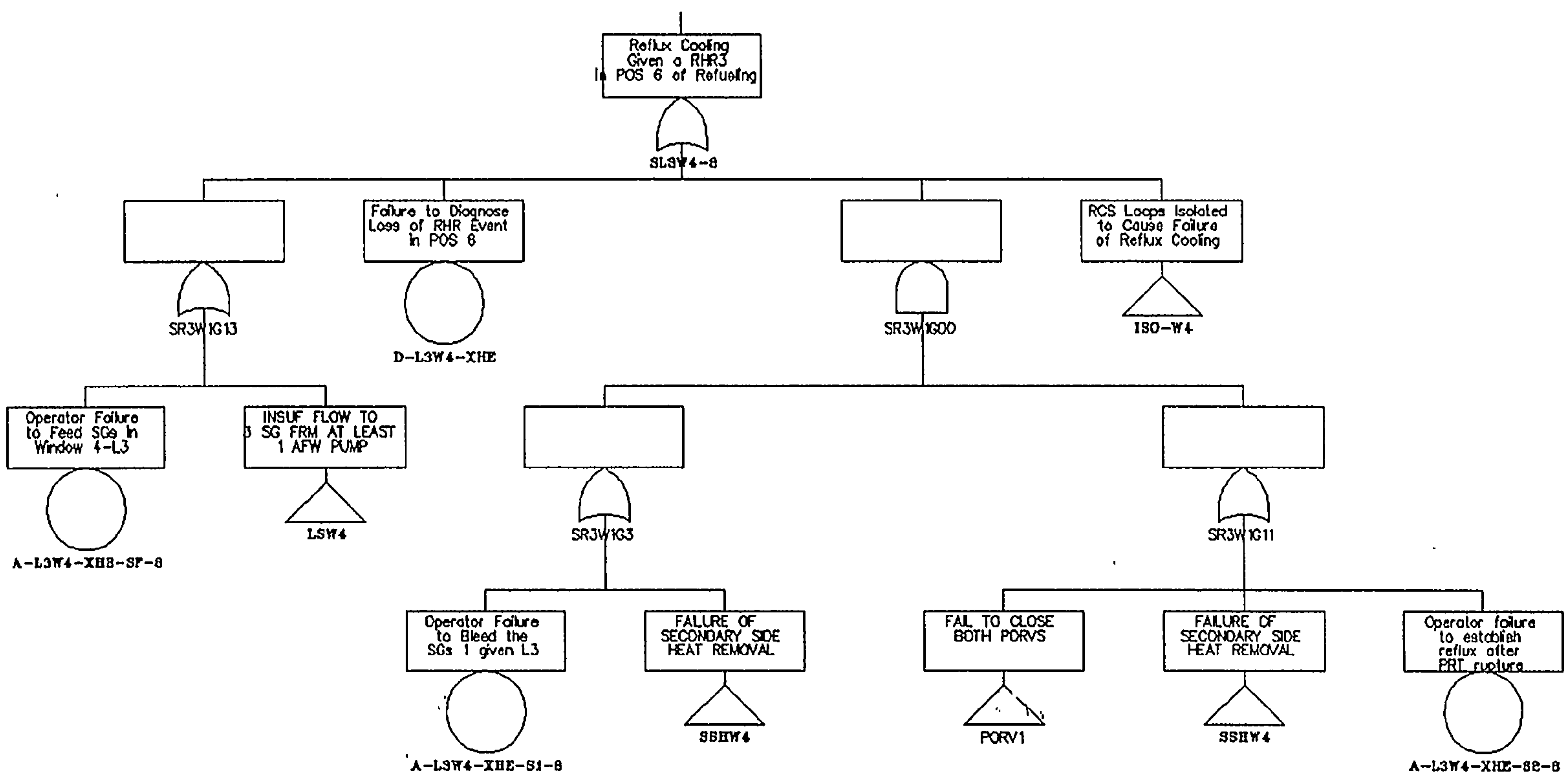
Non-Recovery of AC Power



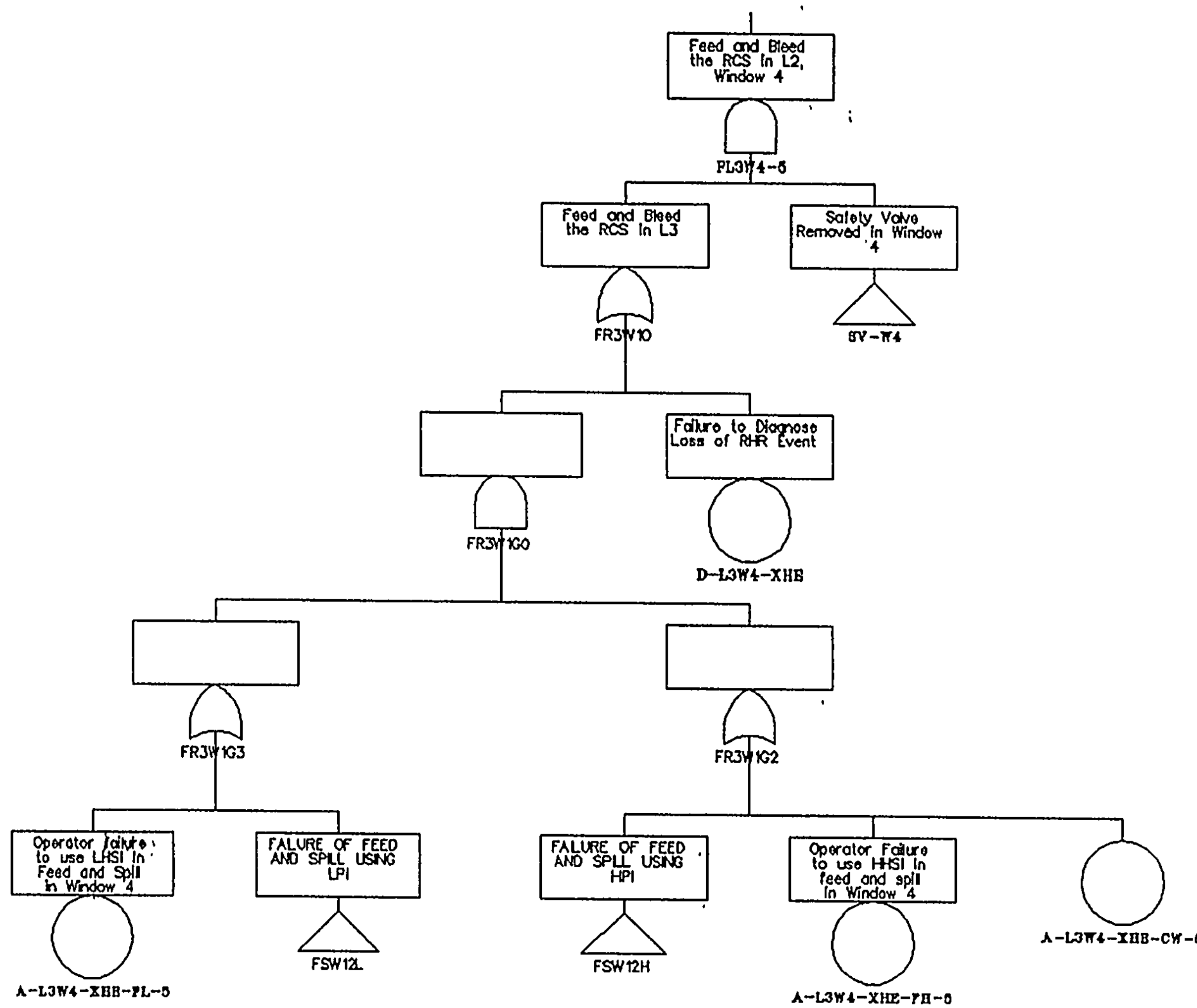
Reflux Cooling in window 4



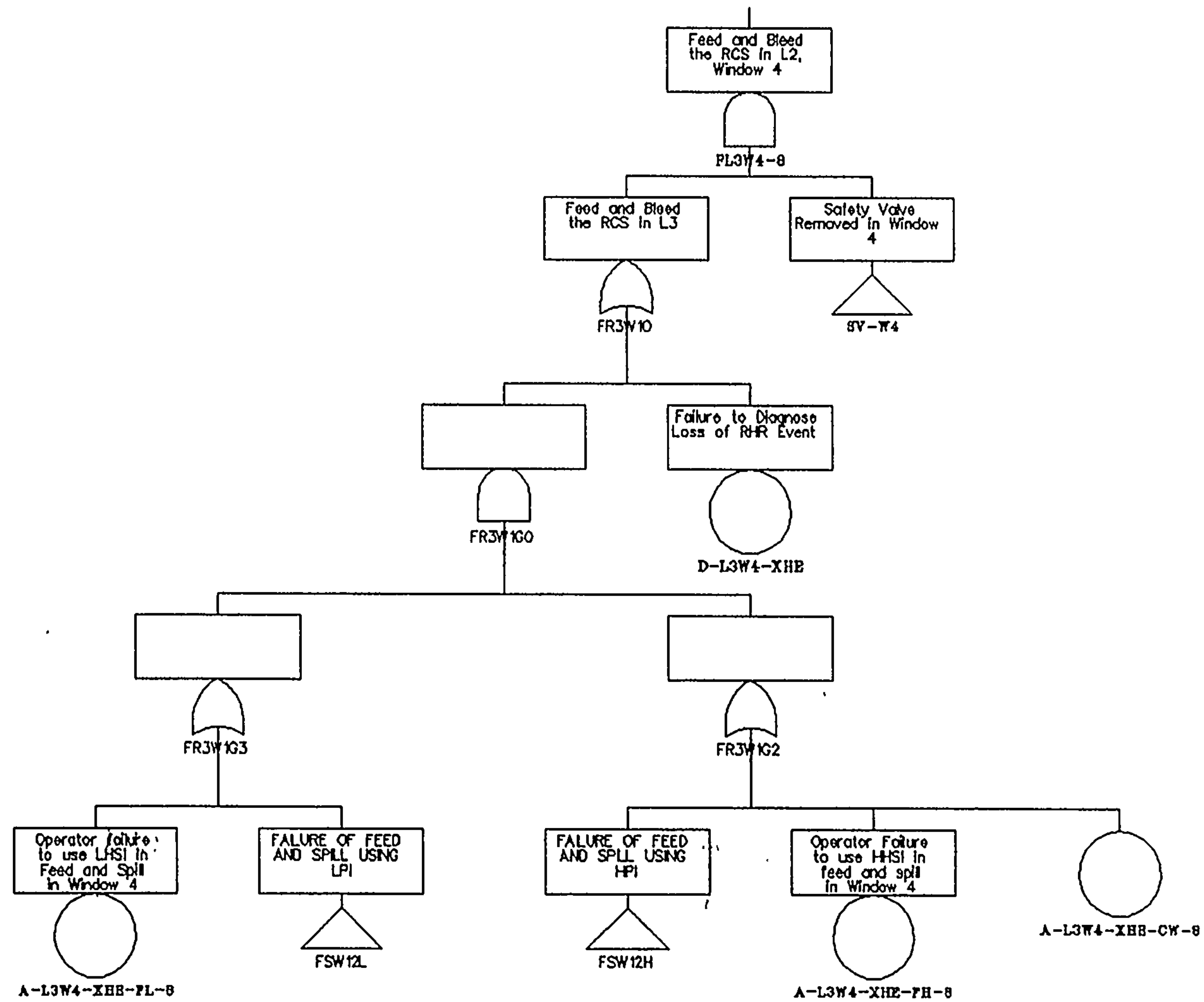
Reflux Cooling in window 4



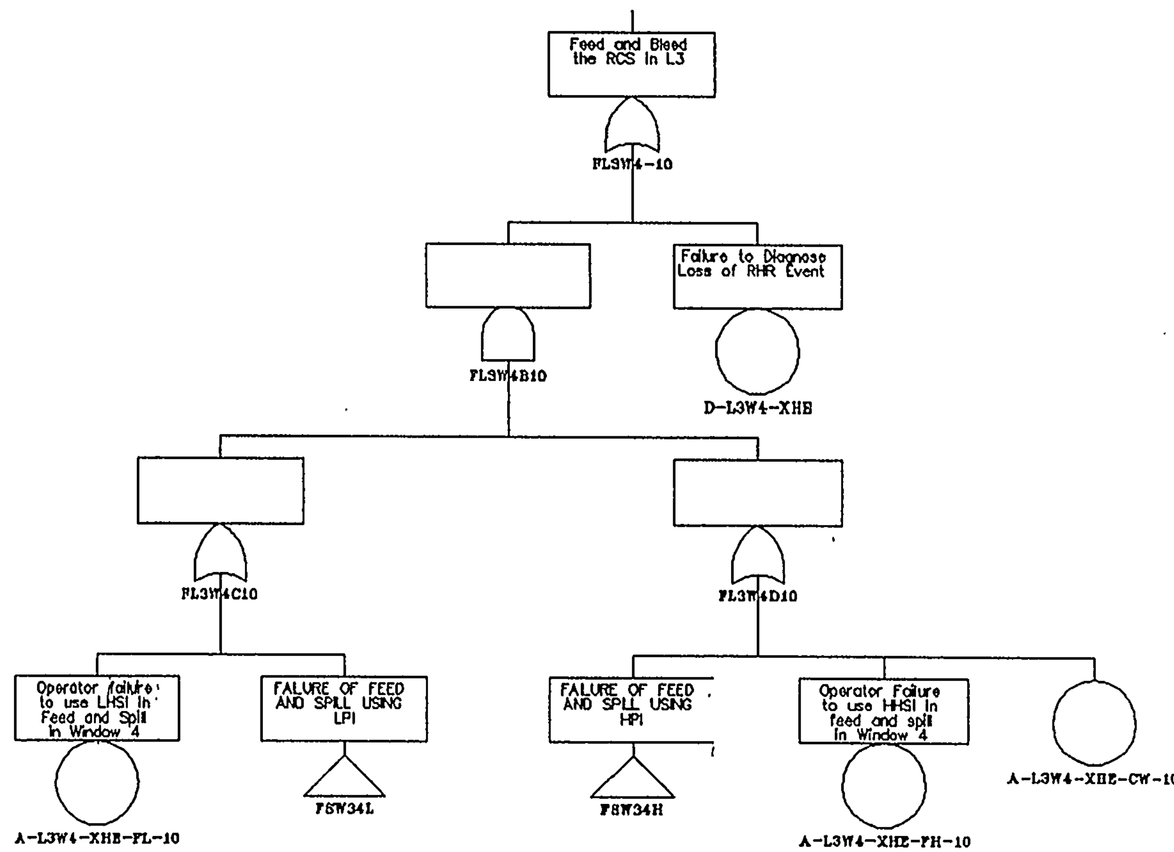
Feed and Bleed the RCS in L3, Window 4



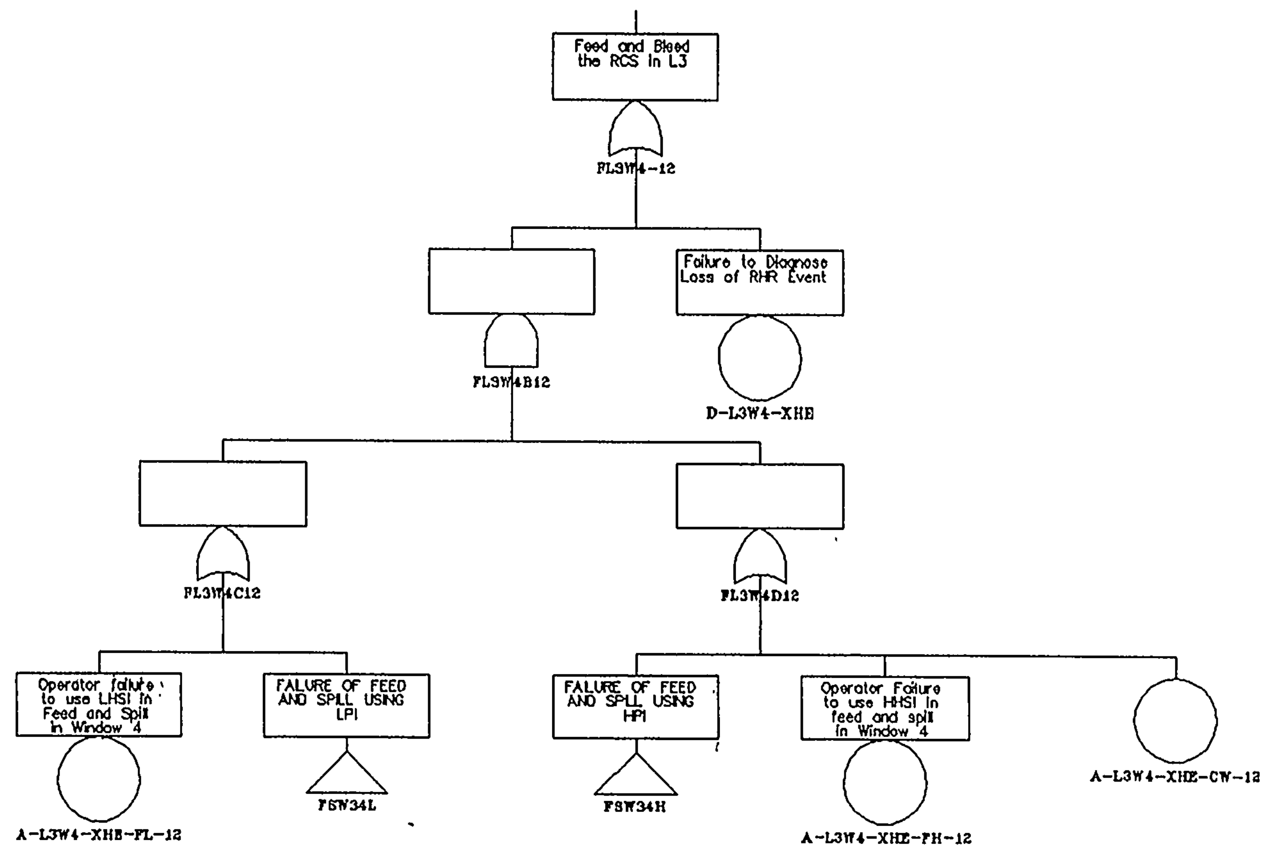
Feed and Bleed the RCS in L3, Window 4



Feed and Bleed the RCS in L3, Window 4



Feed and Bleed the RCS in L3, Window 4



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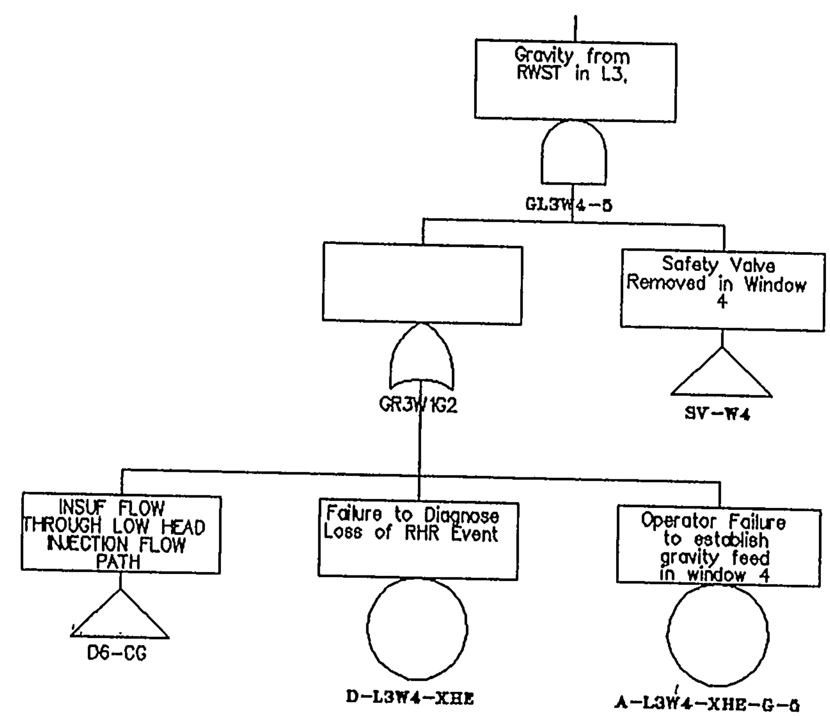

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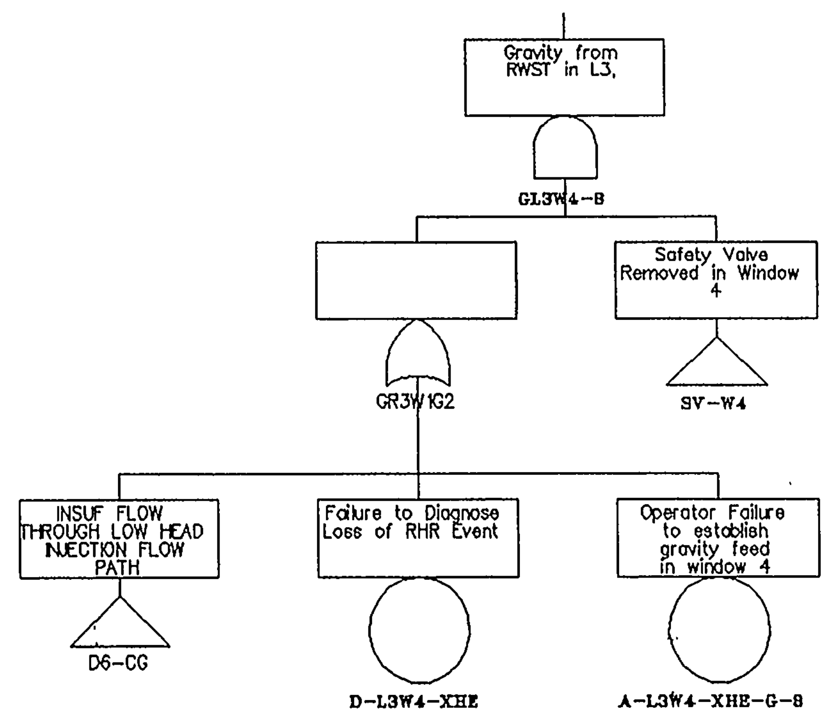

Kiyoharu Abe
Dept. of Reactor Safety Research
Nuclear Safety Research Center
Tokai Research Establishment
JAERI
Tokai-mura, Naga-gun
Ibaraki-ken,
JAPAN

Sarbes Acharya
Department of Energy
NS-1/FORS
Washington, DC 20585

Dr. Ulvi Adalioglu
Cekmece Nukleer Arastraima ve
Egitim Merekezi
P.K. 1
Havaalani/ISTANBUL
TURKEY

Dr. Eng. Kiyoto Aizawa
Senior Engineer
Reactor Eng. Dev. Department
PNC
9-13, Chome, Akasaka
Minato-K, Tokyo
JAPAN

Harry Alter
Manager Applied Tech
Nuclear Systems Tech
NE-46
US DOE
Washington, DC 20585

R.M. Andrews
Nuclear Installations Insp.
St. Peters House
Balliol Raod, Bootle
Merseyside L20 31Z
UNITED KINGDOM

George Apostolakis
UCLA
Boelter Hall, Room 5532
Los Angeles, CA 90024-1597

Director of Reactor Engineering
Argonne National Laboratory
9700 S Cass Ave
Bldg 208
Argonne, IL 60439

Ephraim Asculai
Division of Nuclear Safety
Wagramestrasse, 5
P.O. Box 100
A-1400 Wien
AUSTRIA

Vladimar Asmolov
Head, Nuclear Safety Department
I. V. Kurchatov Institute
of Atomic Enegry
Moscow, 123181
RUSSIA

J. de Assuncao
Cabinete de Proteccao è
Seguranca Nuclear
Ministerio da Industria
Ave. de Republica 45-6
1000 Lisbon
PORTUGAL

H.P. Balfanz, Head
Institute of Probabilistic
Safety Analysis
TUV Nord
Grosse Bahnstrasse 31
D-22525 Hamburg 54
GERMANY

Pat Baranowsky
USNRC-AEOD/TPAB
MS: T-4A9

Robert A. Bari, Deputy Chairman
Dept of Nuclear Energy
Bldg 197C
Brookhaven National Laboratory
Upton, NY 11973

Librarian
Technical Information Section
Battelle Pacific Northwest Lab
P. O. Box 999
Richland, WA 99352

Dr. John Baum
Dept of Nuclear Energy
Radiological Sciences Div
Bldg 703 M
Brookhaven National Laboratory
Upton, NY 11973

Eric Beckjord
USNRC-RES/DO
MS: T-10F12

Robert Bernero
USNRC-NMSS/DO
MS: T-8A23

Andrea Besi
Institute for Systems Engineering
and Informatics
CEC Joint Research Centre
CP N 1
1-21020 Ispra (Varese)
ITALY

John Bickel
Idaho National Engineering Lab.
EG&G MS: 3850
P.O. Box 1625
Idaho Falls, ID 83415

Vicki Bier
Dept. of Industrial Engineering
University of Wisconsin-Madison
1513 University Avenue, Room 389
Wisconsin, WI 53706

Scott Bigelow
S-CUBED
2501 Yale SE, Suite 300
Albuquerque, NM 87106

Prof. Dr. Dr.-Ing. E. H. Adolf
Birkhofer
Gesellschaft für Anlagen und
Reaktorsicherheit (GRS) mbH
Forschungsgelände
D-8046 Garching
Federal Republic of Germany

David Black
American Electric Power
1 Riverside Plaza
Columbus, OH 43215

Harold Blackman
Idaho National Engineering Lab.
EG&G MS: 3850
P.O. Box 1625
Idaho Falls, ID 83415-3850

Dennis Bley
Buttonwood Consulting
17291 Buttonwood St.
Fountain Valley, CA 92708

Roger Blond
Booz-Allen & Hamilton
4330 East West Highway
Bethesda, MD 20814

M. P. Bohn
Division 6449
Sandia National Laboratories
Albuquerque, NM 87185

Dr. Mario Bonaca
Manager, Reactor Engineering
Northeast Utilities
P.O. Box 270
Hartford, Conn. 06141

Robert B. Borsum
Nuclear Power Division
B & W Nuclear Tech
1700 Rockville Pike
Suite 525
Rockville, MD 20852

Stephen Boult
Electrowatt Engineering Services
(UK) Ltd.
Grandford House
16 Carfax, Horsham
West. Sussex RH12 IUP
ENGLAND

Gary Boyd
Safety & Reliability Optimization
Services
9724 Kingston Pike, Suite 102
Knoxville, TN 37922

Brookhaven National Laboratory (2)
Attn: Lev Neymotin
Arthur Tingle
Building 130
Upton, NY 11973

David M. Brown
Paul C. Rizzo Associates, Inc.
300 Oxford Drive
Monroeville, PA 15146-2347

Tom D. Brown
Sandia National Laboratories
Dept. 6413
P.O. Box 5800
Albuquerque, NM 87185

Robert J. Budnitz
Future Resources Associates, Inc.
2039 Shattuck Avenue, Suite 402
Berkeley, CA 94704

Gary Burdick
USNRC-RES/SAIB
MS: T-10F13

Arthur Buslik
USNRC-RES/PRAB
MS: T-9F31

Edward Butcher
USNRC-NRR/SPSB
MS: O-10E4

Technical Library
B&W Nuclear Service Co
P. O. Box 10935
Lynchburg, VA 24506

Stefaan Caeymaex
Safety & Systems Section
Nuclear Generation Dept.
TRACTEBEL
Avenue Ariane 7
B-1200 Bruxelles
BELGIUM

Leonard Callan, Administrator
U.S. Nuclear Regulatory Commission
Harris Tower and Pavilion
611 Ryan Plaza Drive, Suite 400
Arlington, TX 76011-8064

J. Calvo
Division of PSA & Human Factors
Consejo de Seguridad Nuclear
Calle Justo Dorado, 11
28040 Madrid
SPAIN

A. L. Camp
Division 6412
MS: 0748
Sandia National Laboratories
Albuquerque, NM 87185-0748

John Forbes Campbel
HM Superintending Inspector
Health & Safety Executive
St. Peter's House
Balliol Road
Bootle L20 31Z
UNITED KINGDOM

Leonel Canelas
New University of Lisbon
Quinta de Torre
2825 Monte de Caparica
PORTUGAL

Harold Careway
General Electric Co., M/C 754
175 Curtner Ave.
San Jose, CA 95129

D. D. Carlson
Division 6411
Sandia National Laboratories
Albuquerque, NM 87185

Jose E. De Carlos
CSN International Coordinator
Consejo de Seguridad Nuclear
Calle Justo Dorado 11
28040 Madrid
SPAIN

Annick Carnino
International Atomic Energy Agency
Wagramerstrasse 5, P.O. Box 100
A-1400 Vienna
AUSTRIA

S. Chakraborty
Swiss Federal Nuclear Safety
Inspectorate
Hauptabteilung für die Sicherheit
der Kernanlagen
CH-5232 Villigen-HSK
SWITZERLAND

Erulappa Chelliah
USNRC-RES/PRAB
MS: T-9F31

Mike Cheok
NUS
910 Clopper Road
Gaithersburg, MD 20878

Nilesh Chokshi
USNRC-RES/SSEB
MS: T-10L1

T. L. Chu
Brookhaven National Laboratory
Department of Nuclear Energy
Bldg. 130
Upton, NY 11973

Peter Cooper
SRD/AEA Technology
Wigshaw Lane
Culcheth
Cheshire WA3 4NE
England

Susan E. Cooper
Science Applications Int'l. Corp.
11251 Roger Bacon Drive
Reston, VA 22090

Michael Corradini
University of Wisconsin
1500 Johnson Drive
Madison, WI 53706

E.R. Corran
ANSTO Reasearch Establishment
Lucas Heights Reserch Labs.
Private Mail Bag 1
Manai, NSW 2234
AUSTRALIA

Massimo Cozzone
A.N.P.A.
Via V. Brancati, 48
I-00144 Rome
ITALY

George Crane
1570 E. Hobble Creek Dr.
Springville, Utah 84663

Mark Cunningham
USNRC-RES/PRAB
MS: T-9F31

S. Daggupaty
Environment Canada
4905 Dufferin Street
Downsview
Ontario, M3H ST4
CANADA

Louise Dahlerup
Inspectorate of Nuclear Inst.
Danish Civil Defense &
Emergency Planning Agency
16, Datavej
DK-3460 Birkerod
DENMARK

John Darby
SEA, Inc.
6100 Uptown Blvd. NE
Albuquerque, NM 87110

Gerald Davidson
Fauske and Associates, Inc.
16 W 070 West 83rd Street
Burr Ridge, IL 60521

Peter Davis
PRD Consulting
P.O. Box 2046
Sheridan, WY 82801

P. De Gelder
Secretary, BELGIAN NUCLEAR
SOCIETY (BNS)
A V Nuclear
Avenue du Roi 157
B-1060 Brussels
BELGIUM

Lennart Devell
Studsvik Nuclear
Studsvik Energiteknik AB
S-611 82 Nykoping
SWEDEN

J. Devooght
Service de la Metrologie Nucl
University Libre de Bruxelles
Faculte des Sciees Appliqu.
50 Avenue F-D Roosevelt
Bruxelles 5
BELGIUM

G. Diederick
Commonwealth Edison Co.
LaSalle County Station
RR1, Box 220
2601 North 21st Rd.
Marsielles, IL 61341

Chuck Dobbe
Idaho National Engineering Lab.
EG&G MS: 3840
P.O. Box 1625
Idaho Falls, ID 83415

Mary Drouin
USNRC-RES\SAIB
MS: T-10F13

Duke Power Co. (2)
Attn: Duncan Brewer
Steve Deskevich
422 South Church Street
Charlotte, NC 28242

Bill Eakin
Northeast Utilities
Box 270
Hartford, CT 06141

Stewart D. Ebneter
USNRC
101 Marietta St., Suite 2900
Atlanta, GA 30323-0199

Adel A. El-Bassioni
USNRC-NRR/PRAB
MS: O-10E4

ENEA/DISP (2)
Attn: Alvaro Valeri
Alfredo Bottino
Via Vitaliano Brancati, 48
00144 Roma EUR
ITALY

Walter P. Engel
PRAG MGR Analysis & Reg Matter
NE-60
CRYCITY
US DOE
Washington, DC 20585

John Flack
USNRC-RES/SAIB
MS: T-10F13

Karl Fleming
Pickard, Lowe & Garrick
2260 University Drive
Newport Beach, CA 92660

Terry Foppe
Safety Analysis Engineering
Rocky Flats Plant
Energy Systems Group
Rockwell International Corp
P.O. Box 464
Golden, CO 80401

R H. Gauger
Manager-Reliability Engr
A/E Div
Holmes & Narver Inc.
R Roanne Circle
Irvine, CA 92714

Robert Gobel
Clark University
Center for Technology, Environment
and Development
950 Main St.
Worcester, MA 01610-1477

Paul Govaerts
Studiecentrum voor Kernenergie
(SCK/CEN)
Boeretang, 200
B-2400 Mol
BELGIUM

Mr. Gubler
International Atomic Energy Agency
NENS/SAD BO842
Wagramerstrasse 5, P.O. Box 100
A-1140 Vienna
AUSTRIA

Paul M. Haas, President
Concord Associates, Inc.
725 Pellissippi Parkway
Suite 101, Box 6
Knoxville, TN 37933

P. T. Harper
Division 6413
MS: 0748
Sandia National Laboratories
Albuquerque, NM 87185-0748

Dr. U. Hauptmanns
Gesellschaft Für Anlagen und
Reaktorsicherheit (GRS) mgH
Schwertnergasse 1
D-5000 Köln 1
GERMANY

Sharif Heger
UNM Chemical and Nuclear
Engineering Department
Farris Engineering, Room 209
Albuquerque, NM 87131

Jon C. Helton
Dept. of Mathematics
Arizona State University
Tempa, AZ 85287

Dr. P. M. Herttrich
Gesellschaft für Anlagen und
Reaktorsicherheit (GRS) mbH
Schwertnergasse 1
5000 Köln 1
GERMANY

Dr. D.J. Higson
Radiological Safety Bureau
Australian Nuclear Science &
Technology Organisation
P.O. Box 153
Roseberry, NSW 2018
AUSTRALIA

Dr. Mitsumasa Hirano
Deputy General Manager
Institute of Nuclear Safety
NUPEC
3-6-2, Toranomon, Minato-ku
Tokyo 108
JAPAN

Dr. S. Hirschberg
Paul Scherrer Institute
Vurenlingen and Villigen
CH-5232 Villigen PSI
SWITZERLAND

Steven Hodge
Oak Ridge National Laboratories
P. O. Box Y
Oak Ridge, TN 37831

Gary Holahan
USNRC-AEOD/OSP
MS: T-4A9

N.J. Holloway
A72.1
Atomic Weapons Establishment
Ademaston
Reading RG7 4PR
UNITED KINGDOM

Griff Holmes
Westinghouse Electric Co.
Energy Center East
Bldg. 371
P.O. Box 355
Pittsburgh, PA 15230

William Hopkins
Bechtel Power Corporation
15740 Shady Grove Road
Gaithersburg, MD 20877

Dean Houston
USNRC-ACRS
MS: P-315

Der-Yu Hsia
Institute of Nuclear Energy Research
Lung-Tan 325
TAIWAN

Alejandro Huerta-Bahena
National Commission on Nuclear
Safety and Safeguards (CNSNS)
Insurgentes Sur N. 1776
C. P. 04230 Mexico, D. F.
MEXICO

Peter Humphreys
US Atomic Energy Authority
Wigshaw Lane, Culcheth
Warrington, Cheshire
UNITED KINGDOM, WA3 4NE

W. Huntington
Commonwealth Edison Co.
LaSalle County Station
RR1, Box 220
2601 North 21st Rd.
Marsielles, IL 61341

J.S. Hyslop
USNRC-RES/PRAB
MS: T-9F31

Idaho National Engineering Lab. (2)
Attn: Doug Brownson
Darrel Knudson
EG&G MS: 3840
P.O. Box 1625
Idaho Falls, ID 83415

Idaho National Engineering Lab. (2)
Attn: Art Rood
Mike Abbott
EG&G MS: 2110
P.O. Box 1625
Idaho Falls, ID 83415

Hanspeter Isaak
Abteilung Strahlenschutz
Hauptabteilung für die Sicherheit
der Kernanlagen (HSK)
CH-5303 Wurenlingen
SWITZERLAND

Brian Ives
UNC Nuclear Industries
P. O. Box 490
Richland, WA 99352

Kamiar Jamili
DP-62/FTN
Department of Energy
Washington, D.C. 20585

Robert Jones
USNRC-NRR/DSSA
MS: O-8E1

Edward Jordan
USNRC-AEOD/DO
MS: T-4D18

Dr. H. Kalfsbeek
DG/XII/D/1
Commission of the European
Communities
Rue de la Loi, 200
B-1049 Brussels
BELGIUM

Yoshio Kano
General Mngr. & Sr. Engineer
Systems Analysis Section
O-arai Engineer. Centr, PNC
Higashi-Ibaraki-gun
Ibaraki-Ken, 133-13
JAPAN

William Kastenberg
UCLA
Boelter Hall, Room 5532
Los Angeles, CA 90024

Barry Kaufer
OECD/NEA
"Le Seine St. Germain" 12
Boulevard des Iles
92130 Issy-les-Moulineaux
FRANCE

Paul Kayser
Division de la Radioprotection
Avenue des Archiducs, 1
L-1135 Luxembourg-Belair
LUXEMBOURG

Ken Keith
TVA
W 20 D 201
400 West Summit Hill
Knoxville, TN 37092

G. Neale Kelly
Commission of the European
Communities
Joint Research Centre
Rue de la Loi 200
B-1049 Brussels
BELGIUM

John Kelly
Sandia National Laboratories
P. O. Box 5800
MS 0742
Albuquerque, NM 87185

Knolls Atomic Power Laboratory (2)
Attn: Ken McDonough
Dominic Sciaudone
Box 1072
Schenectady, NY 12301

Dr. K. Koberlein
Gesellschaft für
Reaktorsicherheit mbH
Forschungsgelände
D-8046 Garching
GERMANY

Alan Kolaczkowski
Science Applications International
Corporation
2109 Air Park Rd. S. E.
Albuquerque, NM 87106

Jim Kolanowski
Commonwealth Edison Co.
35 1st National West
Chicago, IL 60690

John G. Kollas
Institute of Nuclear Technology and
Radiation Protection
N.R.C.P.S. "Demokritos"
P.O. Box 60228
GR-153 10 Aghia Paraskevi
Attiki
GREECE

S. Kondo
Department of Nuclear Engineering
Facility of Engineering
University of Tokyo
3-1, Hongo 7, Bunkyo-ku
Tokyo
JAPAN

D. Lamy
CEN/SCK
Dept. Scientific Irradiation
Experiment & Study BR2
Boeretang, 200
B-2400 Mol
BELGIUM

Dr. J.M. Lanore
CEA/IPSN/DAS
Centre d'Etudes Nucléaires de
Fontenay-aux-Roses
B.P. n° 6
92265 Fontenay-aux-Roses CEDEX
FRANCE

Jose A. Lantaron
Consejo de Seguridad Nuclear
Sub. Analisis y Evaluaciones
Calle Justo Dorado, 11
28040 Madrid
SPAIN

Josette Larchier-Boulanger
Electricte de France
Direction des Etudes Et Recherches
30, Rue de Conde
75006 Paris
FRANCE

H. Larsen
Head of Department
Riso National Laboratory
P.O. Box 49
DK-4000 Roskilde
DENMARK

Lawrence Livermore Nat'l Lab. (4)
Attn: George Greenly
Marvin Dickerson
Rolf Lange
Sandra Brereton
Livermore, CA 94550

Shengdar Lee
Yankee Atomic Electric Company
580 Main St.
Boston, MA 17407

B.T.F. Liwaang
Dept. of Plant Safety Assessment
Swedish Nuclear Power Inspec.
P.O. Box 27106
S-10252 Stockholm
SWEDEN

Peter Lohnberg
Expresswork International, Inc.
1740 Technology Drive
San Jose, CA 95110

Steven M. Long
USNRC-NRR/SPSB
MS: O-10E4

D. Eugenio Gil Lopez
Consejo de Seguridad Nuclear
Calle Justo Dorado, 11
28040 Madrid
SPAIN

Los Alamos National Laboratory (2)
Attn: Kent Sasser
N-6, K-557
Los Alamos, NM 87545

Christiana H. Lui
USNRC-RES/PRAB
MS: T-9F31

John Luke
Florida Power & Light
P.O. Box 14000
Juno Beach, FL 33408

Daniel Manesse
ISPN
Boite Postale n° 6
92265 Fontenay-aux-Roses CEDEX
FRANCE

Fred Mann
Westinghouse Hanford Co.
WIA-53
P.O. Box 1970
Richland, WA 99352

Nadia Soido Falcao Martins
Comissao Nacional de Energia Nuclear
R General Severianao 90 S/408-1
Rio de Janeiro
BRAZIL

Harry F. Martz
Analysis and Assessment Division
Los Alamos National Laboratory
Los Alamos, NM 87545

Herbert Massin
Commonwealth Edison Co.
35 1st National West
Chicago, IL 60690

Hideo Matsuzuru
Tokai Research Establishment
Tokai-mur
Maka-gun
Ibaraki-ken, 319-11
JAPAN

Jim Mayberry
Ebasco Services
60 Chubb Ave.
Lyndhurst, NJ 07071

Andrew S. McClymont
IT-Delian Corporation
1340 Saratoga-Sunnyvale Rd.
Suite 206
San Jose, CA 95129

Michael McKay
Los Alamos National Laboratory
A-1, MS F600 Services
P.O. Box 1663
Los Alamos, NM87545

Zen Mendoza
SAIC
5150 El Camino Real
Suite C3 1
Los Altos, CA 94022

Dr. J. Mertens
Division of Risk Analysis &
Reactor Technology
Institute of Safety Research
Research Centre Julich (KFA)
D-52425 Julich
GERMANY

Jim Meyer
Scientech
11821 Parklawn Dr.
Suite 100
Rockville, MD 20852

Joe Minarick
Science Applications Int'l Corp.
301 Laboratory Road
P.O. Box 2501
Oak Ridge, TN 37830

Jose I. Calvo Molins, Head
Division of P.S.A. and Human Factors
Consejo de Seguridad Nuclear
Calle Justo Dorado, 11
28040 Madrid
SPAIN

Ken Muramatsu
Risk Analysis Laboratory
Japan Atomic Energy Research
Institute
Tokai-mura, Naka-gun
Ibaraki-ken, 319-11, Tokyo
JAPAN

Joseph A. Murphy
Division of Safety Issue Resolution
U.S. Nuclear Regulatory Commission
MS: T-10E50
Washington, DC 20555

Kenneth G. Murphy, Jr.
US Department of Energy
19901 Germantown Rd.
Germantown, MD 20545

Shankaran Nair
Central Electricity
Generating Board
Berkeley Nuclear Laboratories
Berkeley
Gloucestrshire CL13 9PB
UNITED KINGDOM

Ray Ng
NEI
1776 Eye St. N
Suite 300
Washington, DC 20006-2496

G. Niederauer
Los Alamos National Laboratory
P. O. Box 1663
MSK 575
Los Alamos, NM 87545

Oak Ridge National Laboratory (2)
Attn: Steve Fisher
Sherrel Greene
MS-8057
P.O. Box 2009
Oak Ridge, TN 37831

Ken O'Brien
University of Wisconsin
Nuclear Engineering Dept.
153 Engineering Research Blvd.
Madison, WI 53706

Theresa Oh
INEL Tech Library
EG&G MS: 2300
P. O. Box 1625
Idaho Falls, ID 83415-2300

N. R. Ortiz, Director
Nuclear Energy Technology
Division 6400
Sandia National Laboratories
Albuquerque, NM 87185

Robert Ostmeyer
U.S. Department of Energy
Rocky Flats Area Office
P. O. Box 928
Golden, CO 80402

Robert Palla
USNRC-NRR/SPSB
MS: O-10E4

Gareth Parry
NUS Corporation
910 Clopper Rd.
Gaithersburg, MD 20878

Vern Peterson
Building T886B
EG&G Rocky Flats
P.O. Box 464
Golden, CO 80402

G. Petrangeli
ENEA Nuclear Energy ALT Disp
Via V. Brancati, 48
00144 Rome
ITALY

Ing. Jose Antonio Becerra Perez
Comision Nacional De Seguridad
Nuclear Y Salvaguardias
Insurgentes Sur 1806
01030 Mexico, D. F.
MEXICO

William T. Pratt
Brookhaven National Laboratory
Building 130
Upton, NY 11973

Urho Pulkkinen
Technical Research Centre of Finland
Laboratory of Electrical & Automation Engineeering
Otakaari 7B, 02150 Espoo 15
FINLAND

Blake Putney
Science Applications International Corporation
5150 El Camino Real, Suite C31
Los Altos, Ca 94022

Dr. V. M. Raina
Project Manager-Risk Assessment
Ontario Hydro H11 G1
700 University Ave.
Toronto, Ontario M5G 1X6
CANADA

William Raisin
NEI
1726 M. St. NW
Suite 904
Washington, DC 20036

Ann Ramey-Smith
USNRC-RES/PRAB
MS: T-9F31

Dale Rasmuson
USNRC-AEOD/TPAB
MS: T-4A9

John Ridgely
USNRC-RES/SAIB
MS: T-10F13

Richard Robinson (2)
USNRC-RES/PRAB
MS: T-9F31

M. Roch
Manager of Design, Nuclear Department
TRACTEBEL
Avenue Ariane 7
B-1200 Bruxelles
BELGIUM

A.E. Rogers
General Electric Co
175 Curtner Ave
MC-489
San Jose, CA 95125

Judy Rollstin
GRAM Inc
8500 Menual Blvd. NE
Albuquerque, NM 87112

Marc Rothschild
Halliburton NUS
1303 S. Central Ave.
Suite 202
Kent, WA 98032

Christopher Ryder
USNRC-RES/PRAB
MS: T-9F31

Takashi Sato, Deputy Manager
Nuclear Safety Engineering Section
Reactor Design Engineering Dept.
Nuclear Energy Group, Toshiba Corp.
Isogo Engineering Center
8, Shinsugita-cho, Isogo-ku,
Yokohama 235, JAPAN

Martin Sattison
Idaho National Engineering Lab.
P. O. Box 1625
Idaho Falls, ID 83415

Dr. U. Schmocker
Hauptabteilung für die Sicherheit der Kernanlagen
CH-5232 Villigen HSK
SWITZERLAND

A.J. Seebregts
ECN Nuclear Energy
Westerduinweg, 3
Postbus 1
NL-1755 Petten ZG
THE NETHERLANDS

Dr. S. Serra
Ente Naxionale per I'Energia
Electtrica (ENEL)
via G.B. Martini 3
I-00198 Rome
ITALY

H. Shapiro
Licensing & Risk Branch
Atomic Energy of Canada Ltd.
Sheridan Park Research Comm.
Mississauga, Ontario L5K 1B2
CANADA

Nathan O. Siu
Center for Reliability and Risk
Assessment
Idaho National Engineering Lab.
EG&G MS: 3850
P.O. Box 1625
Idaho Falls, ID 83415-3855

E. Soederman
ES-Konsult AB
Energy and Safety
P.O. Box 3096
S-16103 Bromma
SWEDEN

Desmond Stack
Los Alamos National Laboratory
Group Q-6, Mail Stop K556
Los Alamos, NM 87545

Jao Van de Steen
KEMA Laboratories
Utrechtseweg, 310
Postbus 9035
NL 800 ET Arnhem
THE NETHERLANDS

Eli Stern
Israel AEC Licensing Div.
P.O. Box 7061
Tel-Aviv 61070
ISRAEL

Dr. Egil Stokke
Advisory Group
OECD Halden Reactor Project
P.O. Box 173
N-1751 Halden
NORWAY

Stone & Webster Engineering Corp
Technical Information Center
A. Hosford
245 Summer Street
245/01
Boston, MA 02210

Dennis Strenge
Pacific Northwest Laboratory
RTO/ 125
P.O. Box 999
Richland, WA 99352

Technadyne Engineer. Consultants (3)
Attn: David Chanin
Jeffery Foster
Walt Murfin
Suite A225
8500 Menual Blvd. N
Albuquerque, NM 87112

Ashok Thadani
USNRC-NRR/ADT
MS: O-12G18

T. G. Theofanous
University of California, S. B.
Department of Chemical and Nuclear
Engineering
Santa Barbara, CA 93106

Catherine Thompson
USNRC-RES/SAIB
MS: T-10F13

Soren Thykier-Nielsen
Riso National Laboratory
Postbox 49
DK4000 Roskile
DENMARK

R. Toossi
Physical Research, Inc.
25500 Hawthorn Blvd.
Torrance, CA 90505

Ennio Traine
ENEL
Via Vialiano, 48
00144 Rome
ITALY

Ulf Tveten
Environmental Physics Section
Institutt for Energiteknikk
Postboks 40
N-2007 Kjeller
NORWAY

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U.S. Environmental
Protection Agency (2)
Attn: Allen Richardson
Joe Logsdon
Office of Radiation Programs
Environmental Analysis Division
Washington, DC 20460

Harold VanderMolen
USNRC-RES/PRAB
MS: T-9F31

Dr. A. Valeri
A.N.P.A.
Via Vitaliano Brancati, 48
I-00144 Rome
ITALY

Magiel F. Versteeg
Ministry of Social Affairs
and Employment
P.O. Box 90804
2509 LV Den Haag
THE NETHERLANDS

Martin Virgilio
USNRC-NRR/DSSA
MS: O-8E2

R. Virolainen, (Chairman PWG5)
Systems Integ. Off. (STUK)
P.O. Box 268
Kumpulanite 7
SF-60101 Helsinki
FINLAND

Seppo Vuori
Technical Research Centre of Finland
Nuclear Engineering Laboratory
Lonnrotinkatu 37
P.O. Box 169
Sf-00181 Helsinki 18
FINLAND

Dr. Ian B. Wall
81 Irving Avenue
Atherton, CA 94027

Edward Warman
Stone & Webster Engineering Corp.
P.O. Box 2325
Boston, MA 02107

J.E. Werner
Reactor Research & Techn Division
US DOE Idaho Operations
MS: 1219
850 Energy Drive
Idaho Falls, ID 83401-1563

Dr. Wolfgang Werner
Safety Assessment Consulting GmbH
Veilchenweg 8
D 83254 Breitbrunn
GERMANY

Westinghouse Electric Corp
Technical Library
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Westinghouse Electric Company (3)
Attn: John Lacovin
Burt Morris
Griff Holmes
Energy Center East, Bldg. 371
P.O. Box 355
Pittsburgh, PA 15230

Westinghouse Savannah River Co. (2)
Attn: Kevin O'Kula
      Jackie East
Safety Technology Section
1991 S. Centennial Ave., Bldg. 1
Aiken, SC 29803

Donnie Whitehead
Department 6412, MS: 0747
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185-0747

Keith Woodard
PLG, Inc.
7315 Wisconsin Ave.
Suite 620 East
Bethesda, MD 20814-3209

John Wreathall
John Wreathall & Co.
4157 MacDuff Way
Dubin, OH 43017

M. K. Yeung
University of Hong Kong
Mechanical Engineering Dept.
Polfulam
HONG KONG

Bob Youngblood
Brookhaven National Laboratory
Department of Nuclear Energy
Bldg. 130
Upton, NY 11973

Carlo Zaffiro
A.N.P.A.
Directorate for Nuclear
Via Vitaliano Brancate, 48
I-00144 Rome
ITALY

Dr. X. Zikidis
Greek Atomic Energy Comm.
N.R.C.P.S. "Demokritos"
GR-153 10 Agia Paraskevi
Attiki
GREECE

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T.L. Chu, Z. Musicki, P. Kohut, D. Bley[1], J.Yang, B. Holmes[2], G. Bozoki, C.J. Hsu, D.J. Diamond, D. Johnson[1], J. Lin[1], R.F. Su[3], V. Dang[3], D. Ilberg[4], S.M. Wong, N. Siu[3]

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Brookhaven National Laboratory
Upton, NY 11973

[1]PLG Inc., 4590 McArthur Blvd. Newport Bch. CA 92660-2027
[2]AEA Technology, Winfrith, Dorchester, Dorset, England, DT2 8DH
[3]MIT, Cambridge, MA 02139 (N. Siu currently at EG&G, Idaho Falls, ID 84315)
[4]Soreq Nuclear Research Center, Yavne 70600, Israel

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11. ABSTRACT (200 words or less)

During 1989, the Nuclear Regulatory Commission (NRC) initiated an extensive program to carefully examine the potential risks during low power and shutdown operations. The program includes two parallel projects being performed by Brookhaven National Laboratory (BNL) and Sandia National Laboratories (SNL). Two plants, Surry (pressurized water reactor) and Grand Gulf (boiling water reactor), were selected as the plants to be studied. The objectives of the program are to assess the risks of severe accidents initiated during plant operational states other than full power operation and to compare the estimated core damage frequencies, important accident sequences and other qualitative and quantitative results with those accidents initiated during full power operation as assessed in NUREG-1150. The objective of this report is to document the approach utilized in the Surry plant and discuss the results obtained. A parallel report for the Grand Gulf plant is prepared by SNL. This study shows that the core-damage frequency during mid-loop operation at the Surry plant is comparable to that of power operation. We recognize that there is very large uncertainty in the human error probabilities in this study. This study identified that only a few procedures are available for mitigating accidents that may occur during shutdown. Procedures written specifically for shutdown accidents would be useful.

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