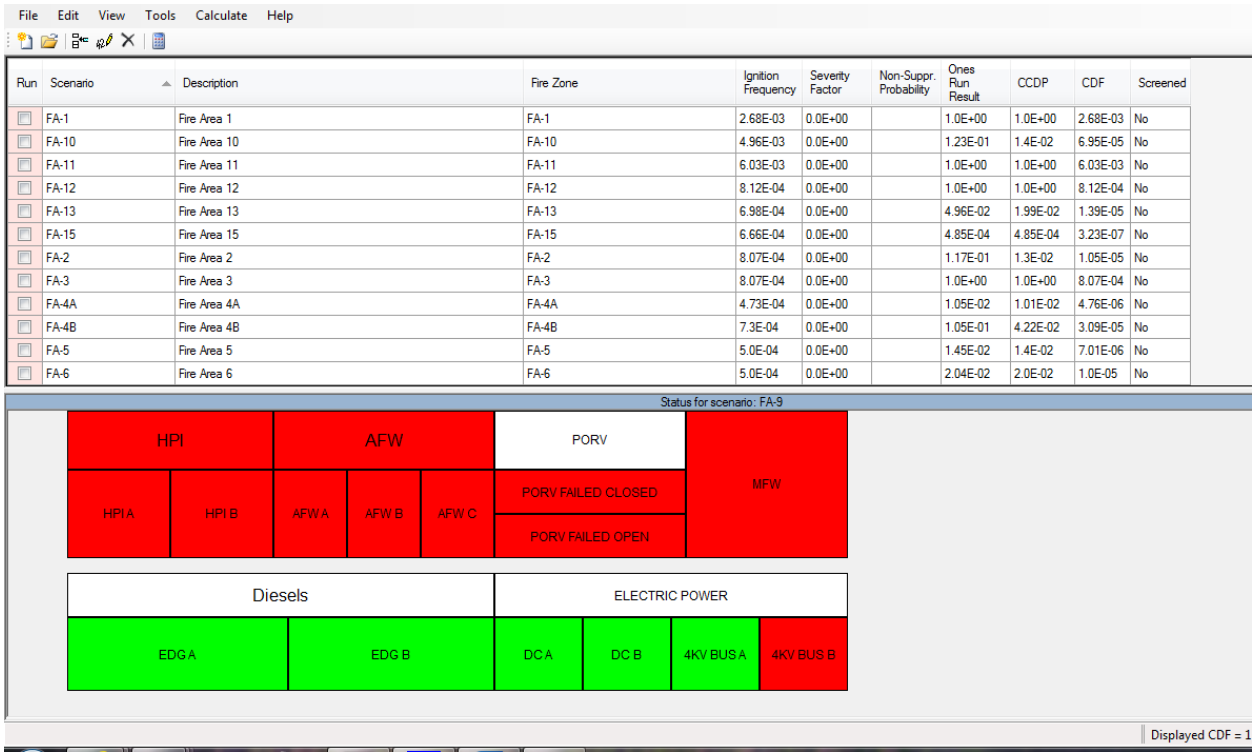
TASK 7 – DEMONSTRATION

METHOD 1 – BASIC EVENTS SET TO “TRUE” OR “ONE”



File Edit View Tools Calculate Help

Run	Scenario	Description	Fire Zone	Ignition Frequency	Severity Factor	Non-Suppr. Probability	Ones Run Result	CCDP	CDF	Screened
	FA-1	Fire Area 1	FA-1	2.68E-03	0.0E+00		1.0E+00	1.0E+00	2.68E-03	No
	FA-10	Fire Area 10	FA-10	4.96E-03	0.0E+00		1.23E-01	1.4E-02	6.95E-05	No
	FA-11	Fire Area 11	FA-11	6.03E-03	0.0E+00		1.0E+00	1.0E+00	6.03E-03	No
	FA-12	Fire Area 12	FA-12	8.12E-04	0.0E+00		1.0E+00	1.0E+00	8.12E-04	No
	FA-13	Fire Area 13	FA-13	6.98E-04	0.0E+00		4.96E-02	1.99E-02	1.39E-05	No
	FA-15	Fire Area 15	FA-15	6.66E-04	0.0E+00		4.85E-04	4.85E-04	3.23E-07	No
	FA-2	Fire Area 2	FA-2	8.07E-04	0.0E+00		1.17E-01	1.3E-02	1.05E-05	No
	FA-3	Fire Area 3	FA-3	8.07E-04	0.0E+00		1.0E+00	1.0E+00	8.07E-04	No
	FA-4A	Fire Area 4A	FA-4A	4.73E-04	0.0E+00		1.05E-02	1.01E-02	4.76E-06	No
	FA-4B	Fire Area 4B	FA-4B	7.3E-04	0.0E+00		1.05E-01	4.22E-02	3.09E-05	No
	FA-5	Fire Area 5	FA-5	5.0E-04	0.0E+00		1.45E-02	1.4E-02	7.01E-06	No
	FA-6	Fire Area 6	FA-6	5.0E-04	0.0E+00		2.04E-02	2.0E-02	1.0E-05	No

Figure 1: FIRE SCENARIO RESULTS SUMMARY AND SYSTEM STATUS (METHOD 1)

Zone_to_Raceway

Zone	ToEvent	ToType	Unknown	Click to Add
FA-1	AFWA-FTS	0		
FA-1	AFWB-FTS	0		
FA-1	AFWC-FTR	0		
FA-1	AFWC-FTS	0		
FA-1	ANN-1_FH	0		
FA-1	AOV-1_FTO	0		
FA-1	AOV-1_TO	0		
FA-1	AOV-2-FTC	0		
FA-1	AOV-2-TC	0		
FA-1	AOV-3-FTC	0		
FA-1	AOV-3-TO	0		
FA-1	AOV-4_TO	0		
FA-1	EPS-480VLC1F	0		
FA-1	EPS-480VLC2F	0		
FA-1	EPS-480VLCAF	0		
FA-1	EPS-480VLCBF	0		
FA-1	EPS-4VBUS1F	0		
FA-1	EPS-4VBUS2F	0		
FA-1	EPS-4VBUSAF	0		
FA-1	EPS-4VBUSBF	0		
FA-1	EPS-DGAF	0		
FA-1	EPS-DGBF	0		

Figure 2: SCENARIO TO BASIC EVENT MAPPING TABLE (METHOD 1)

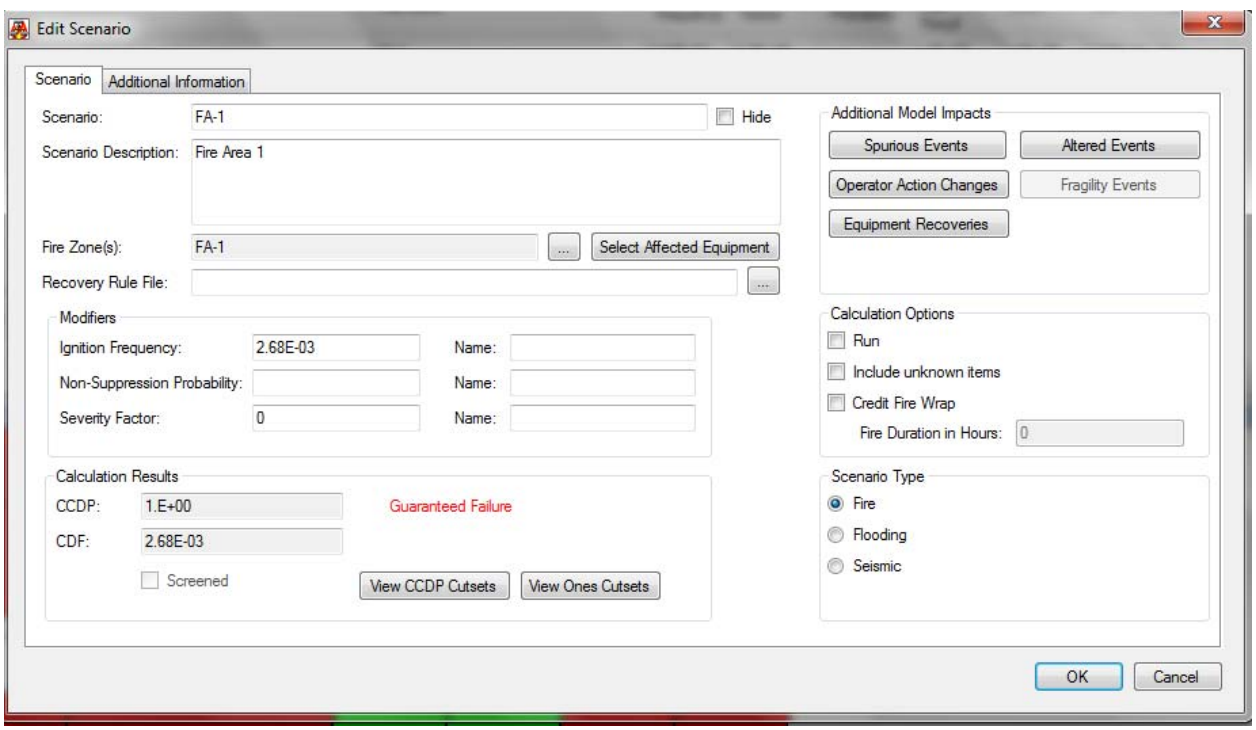


Figure 3: SCENARIO DEFINITION (METHOD 1)

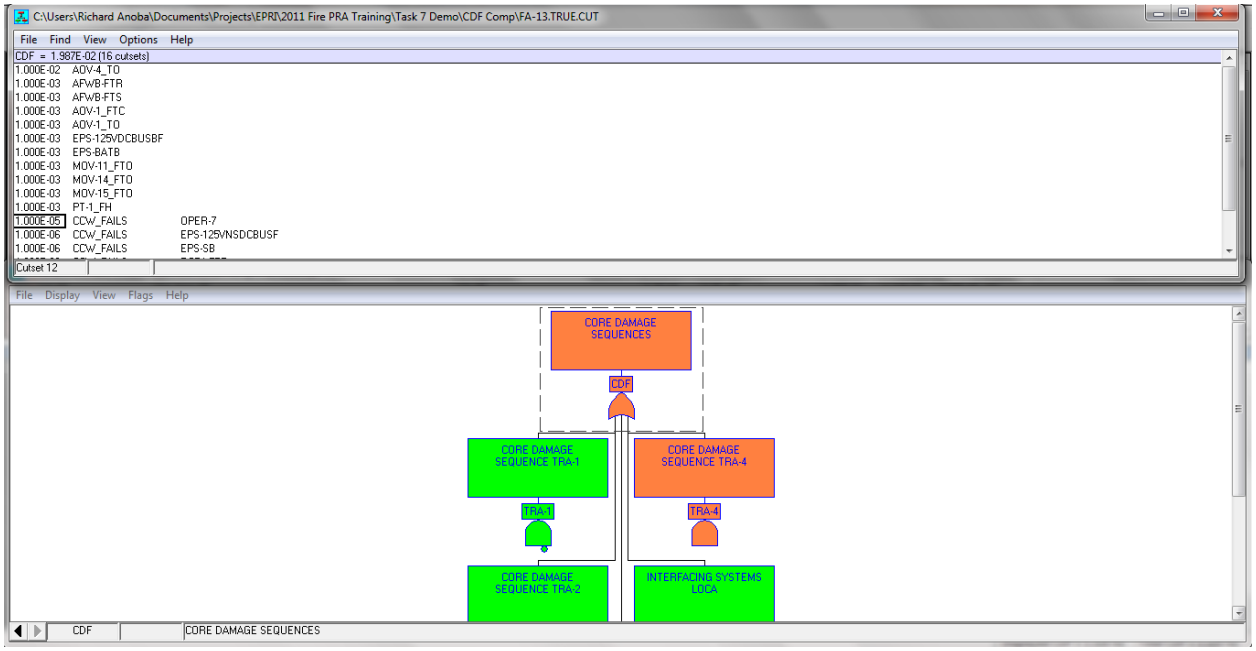


Figure 4: RESULTS PRESENTATION (METHOD 1)

METHOD 2 – FIRE INITIATING EVENTS INSERTED IN FAULT TREE LOGIC – SINGLE-TOP CDF/LERF

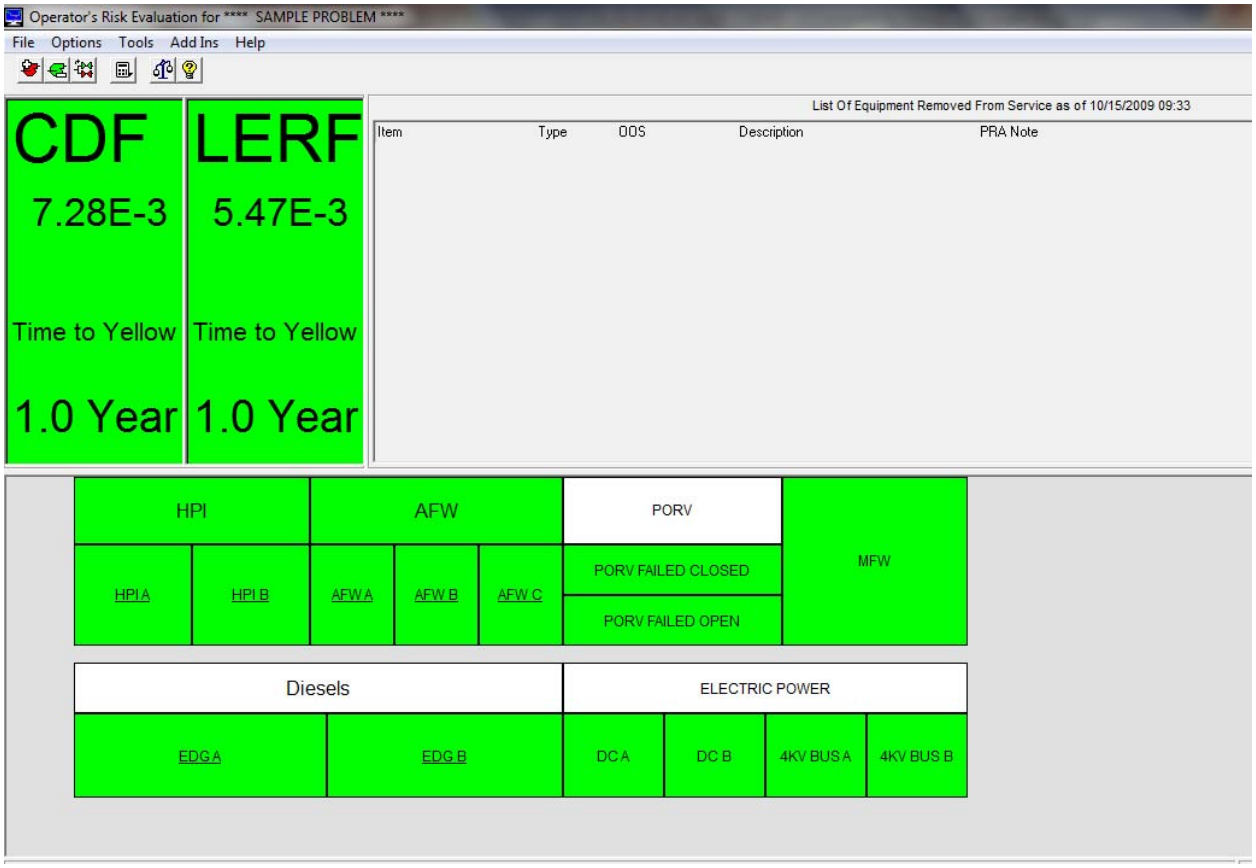


Figure 5: RISK MONITOR PANEL (METHOD 2)

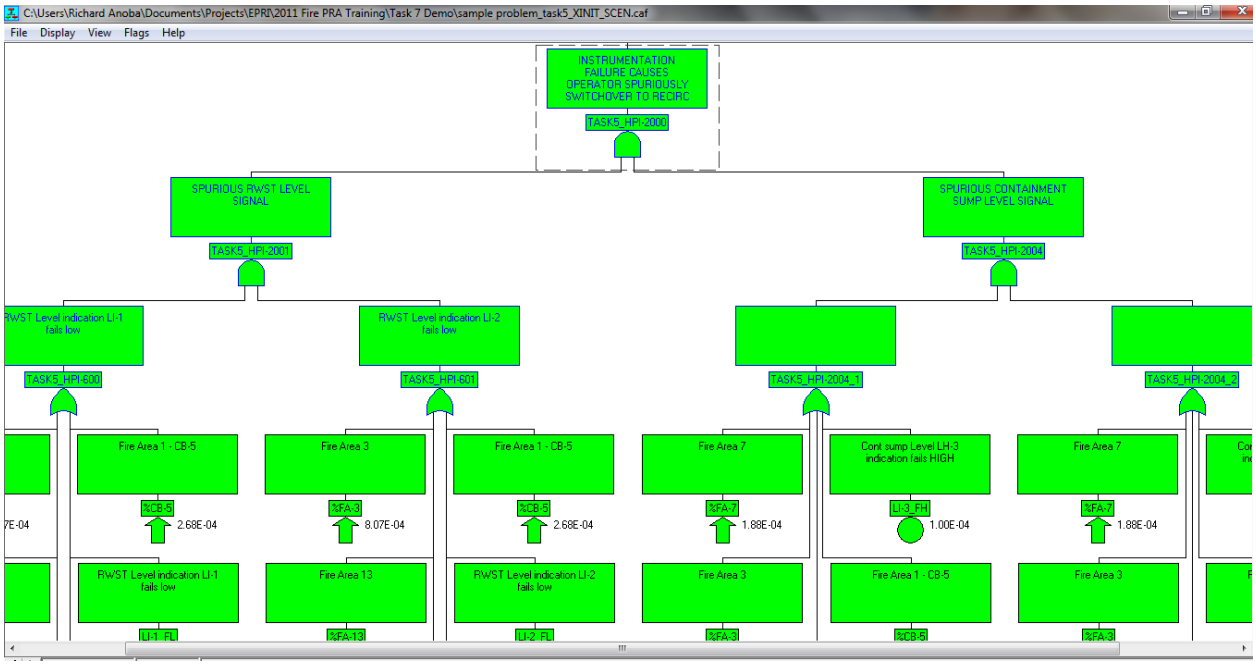


Figure 6: FAULT TREE EXAMPLE (METHOD 2)

C:\Users\Richard Anoba\Documents\Projects\EPRI\2011 Fire PRA Training\Task 7 Demo\E

File Find View Options Help

CDF = 7.282E-03 (1362 cutsets)

4.189E-03	%FA-9		
8.120E-04	%FA-12		
8.072E-04	%FA-3		
4.729E-04	%FA-4A		
2.678E-04	%CB-6		
7.047E-05	%FA-8B	AOV-4_TO	
6.025E-05	%FA-11	AOV-4_TO	
5.880E-05	%T6	OPER-4	
4.959E-05	%FA-10	AOV-4_TO	
1.000E-05	%T15	AOV-4_TO	
1.000E-05	%T15	OPER-7	
8.072E-06	%FA-2	AOV-4_TO	
8.000E-06	%T1	AOV-4_TO	OPER-4
7.350E-06	%T6	AOV-1_FTO	
7.350E-06	%T6	AOV-3_FTC	
7.350E-06	%T6	CCW_FAILS	
7.350E-06	%T6	COMP1_FTR	
7.350E-06	%T6	EPS-120VBUSAF	
7.350E-06	%T6	EPS-120VBUSAINVF	
7.350E-06	%T6	EPS-120VBUSBF	
7.350E-06	%T6	EPS-120VBUSBINVF	
7.350E-06	%T6	EPS-125VDCBUSAF	
7.350E-06	%T6	EPS-125VDCBUSBF	
7.350E-06	%T6	EPS-125VDCPNLAF	
7.350E-06	%T6	EPS-125VDCPNLBF	
7.350E-06	%T6	EPS-480VLC1F	
7.350E-06	%T6	EPS-480VLC1XTF	
7.350E-06	%T6	EPS-480VLCAF	
7.350E-06	%T6	EPS-480VLCAXTF	
7.350E-06	%T6	EPS-480VLCBF	
7.350E-06	%T6	EPS-480VLCBXTF	
7.350E-06	%T6	EPS-480VMCCA1F	
7.350E-06	%T6	EPS-480VMCCB1F	
7.350E-06	%T6	EPS-4VBUS1F	
7.350E-06	%T6	EPS-4VBUSAF	
7.350E-06	%T6	EPS-4VBUSBF	
7.350E-06	%T6	EPS-BATA	
7.350E-06	%T6	EPS-BATB	
7.350E-06	%T6	MOV-13_TC	
7.350E-06	%T6	MOV-2_FTC	
7.350E-06	%T6	MOV-3_TO	
7.350E-06	%T6	MOV-4_TO	
7.350E-06	%T6	MOV-5_FTC	

Figure 7: EXAMPLE RESULTS (METHOD 2)

METHOD 3 – EVENT TREE WITH FIRE COMPARTMENT HOUSE EVENTS INSERTED IN FAULT TREE

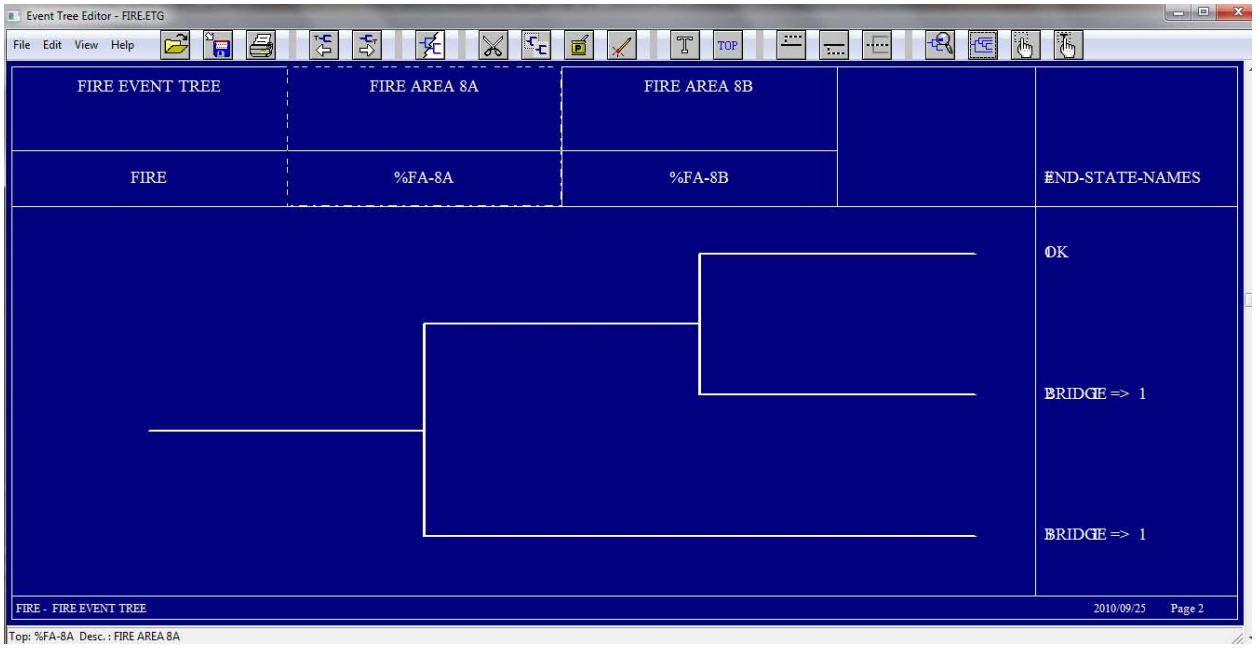


Figure 8: EXAMPLE FIRE EVENT TREE (METHOD 3)

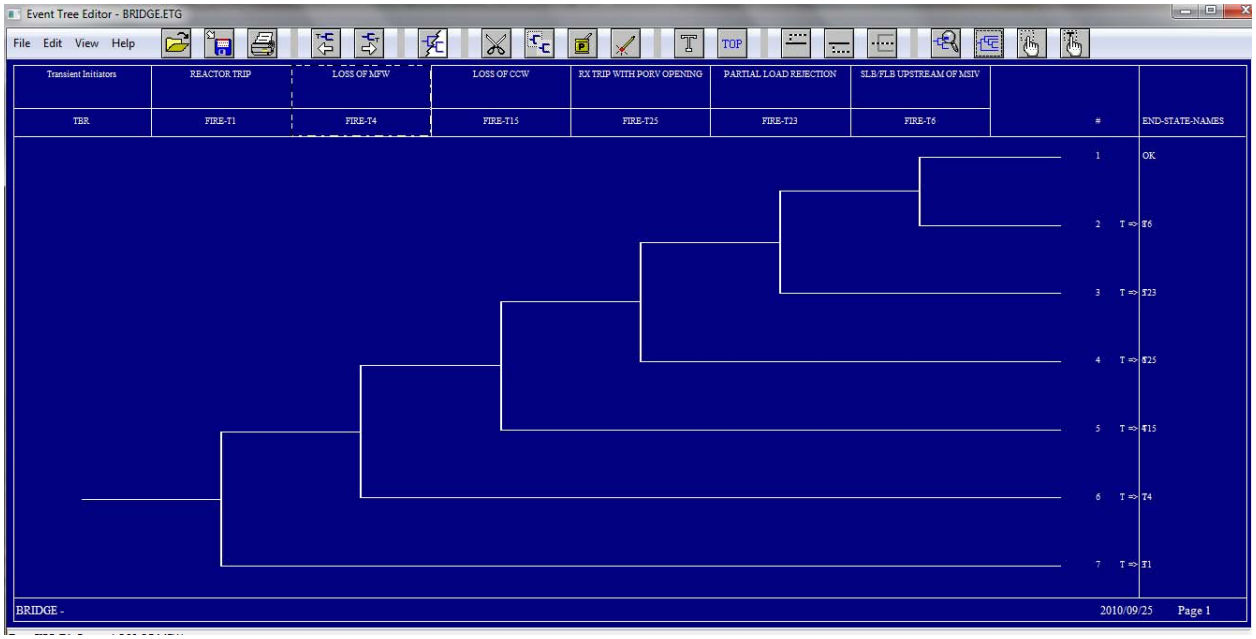


Figure 9: EXAMPLE BRIDGE TREE (METHOD 3)

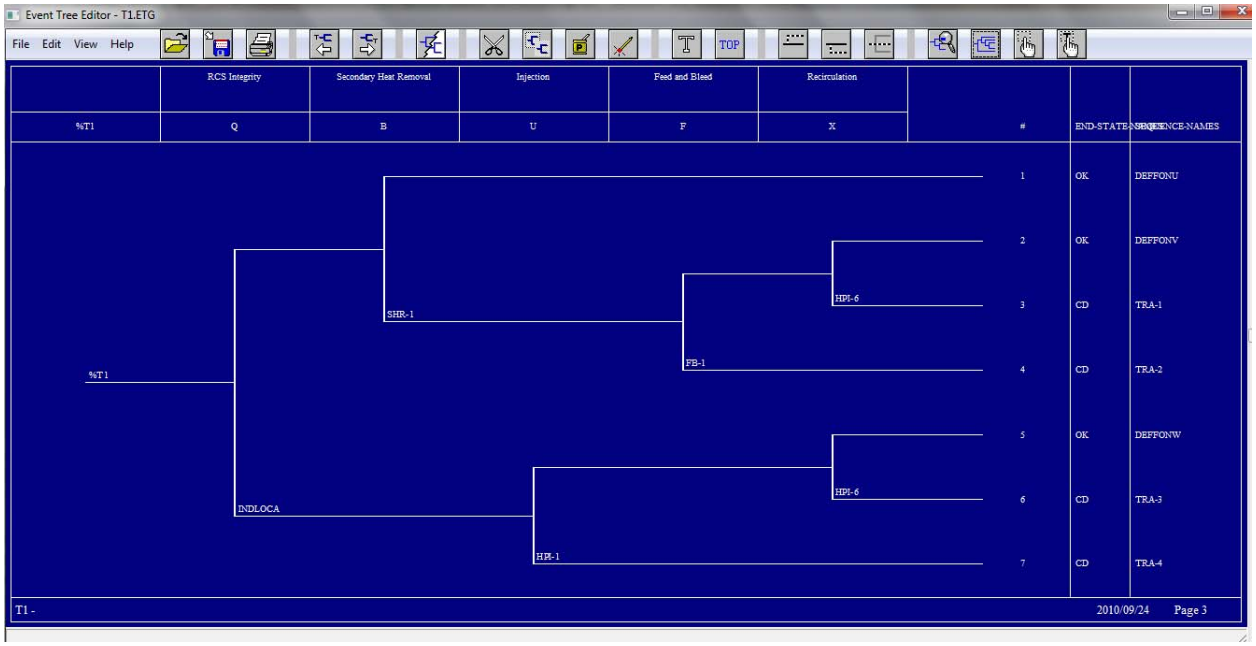


Figure 10: INTERNAL EVENT TREE (METHOD 3)

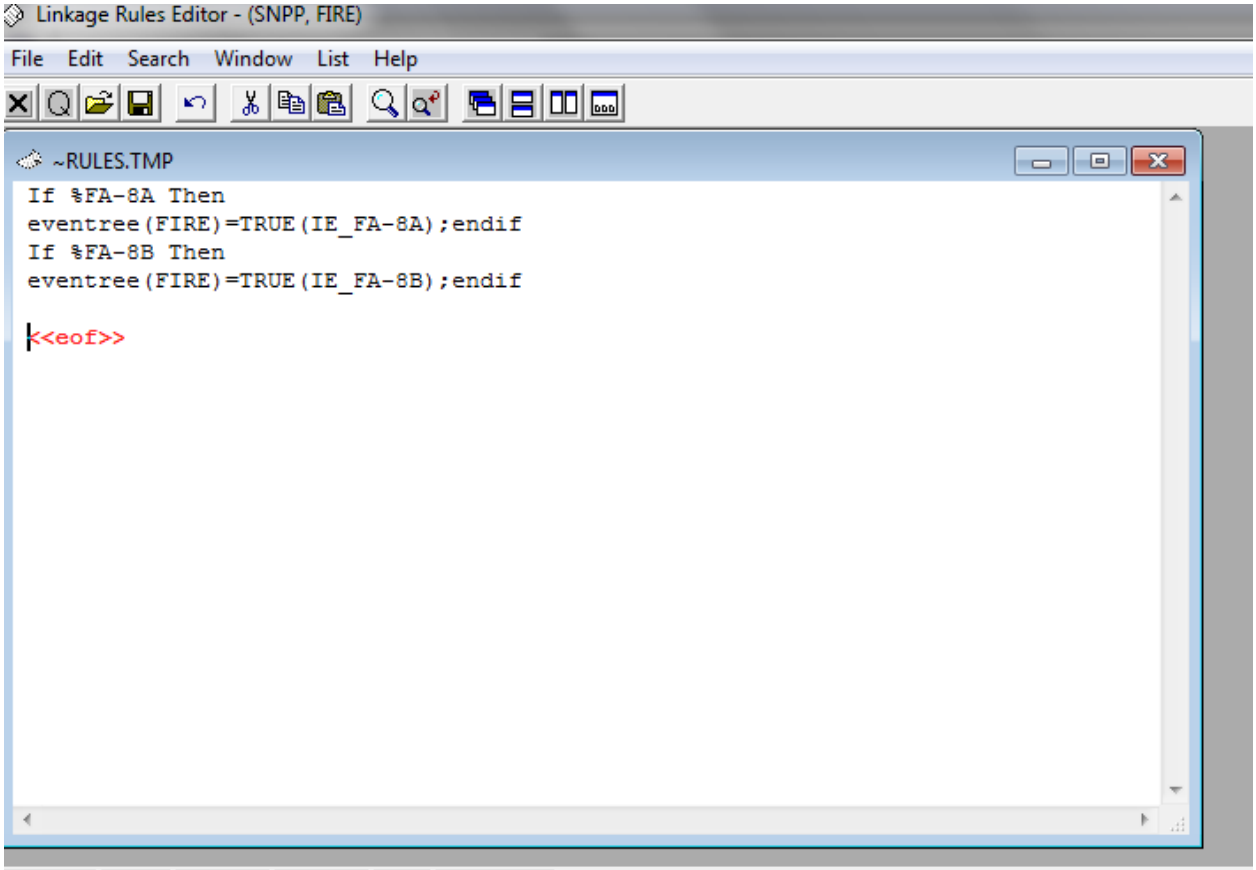


Figure 11: FIRE EVENT TREE LINKAGE RULES

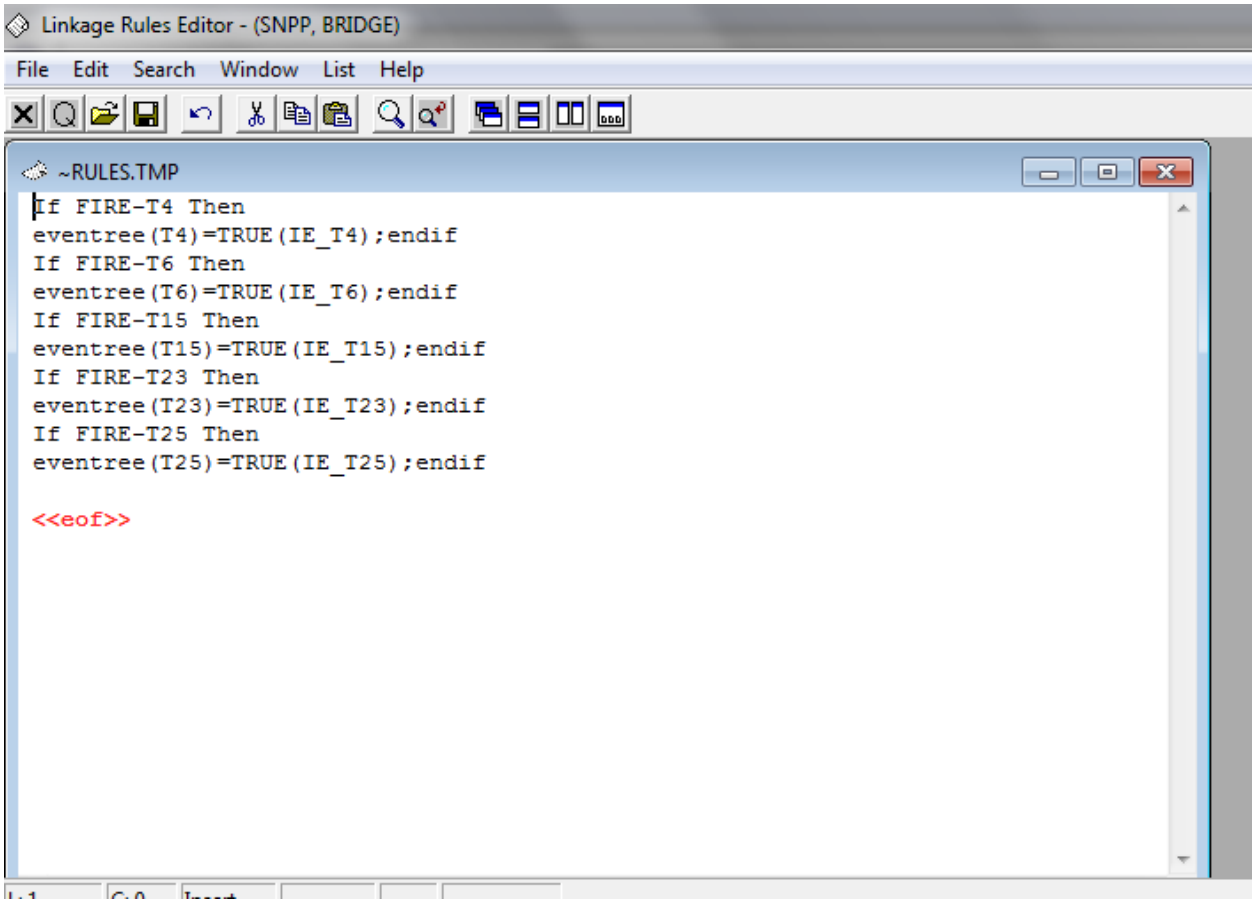


Figure 12: BRIDGE TREE LINKAGE RULES

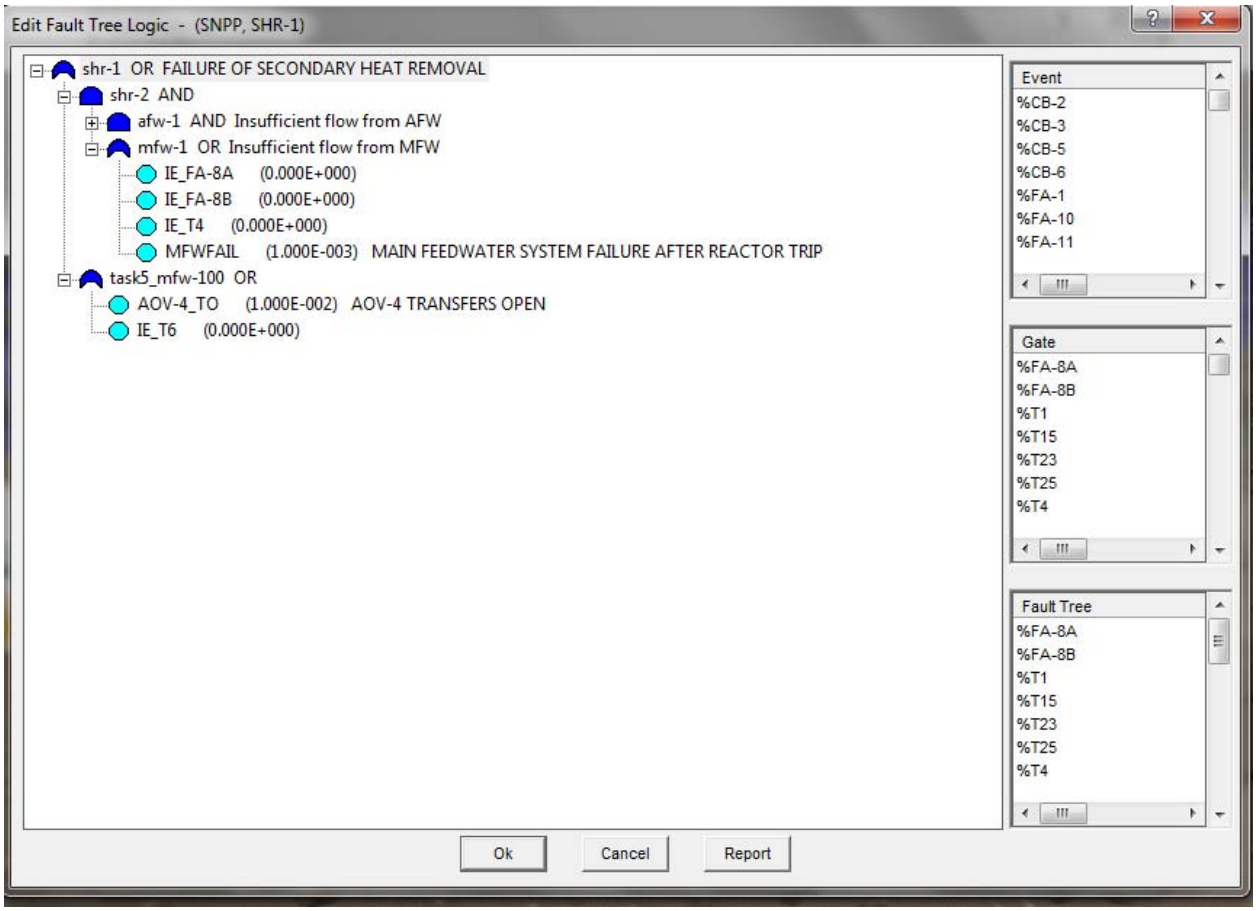
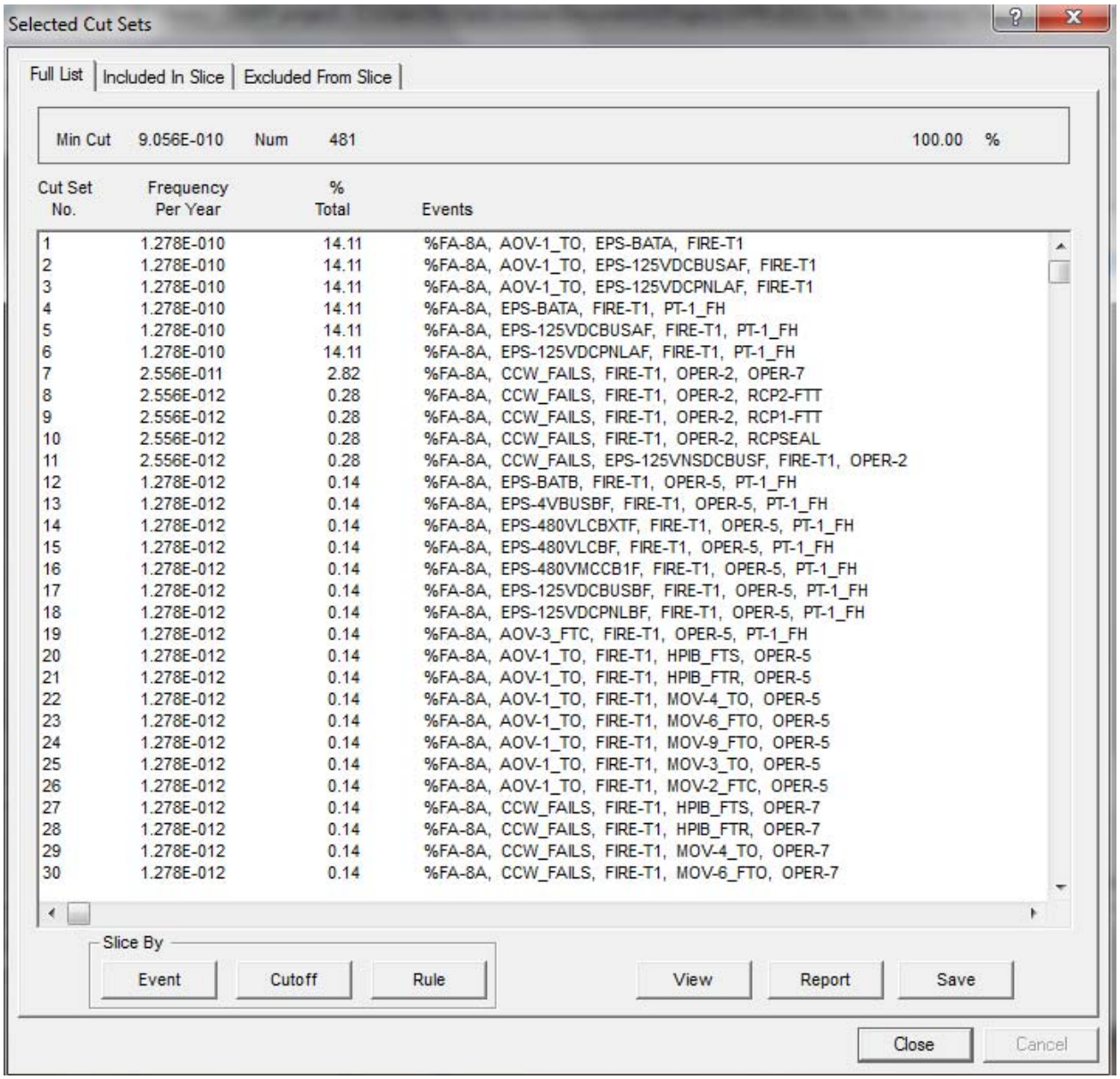


Figure 13: FAULT TREE MODEL WITH INSERTED FIRE COMPARTMENT HOUSE EVENTS (METHOD 3)



Selected Cut Sets

Full List | Included In Slice | Excluded From Slice

Min Cut 9.056E-010 Num 481 100.00 %

Cut Set No.	Frequency Per Year	% Total	Events
1	1.278E-010	14.11	%FA-8A, AOV-1_TO, EPS-BATA, FIRE-T1
2	1.278E-010	14.11	%FA-8A, AOV-1_TO, EPS-125VDCBUSAF, FIRE-T1
3	1.278E-010	14.11	%FA-8A, AOV-1_TO, EPS-125VDCPNLAF, FIRE-T1
4	1.278E-010	14.11	%FA-8A, EPS-BATA, FIRE-T1, PT-1_FH
5	1.278E-010	14.11	%FA-8A, EPS-125VDCBUSAF, FIRE-T1, PT-1_FH
6	1.278E-010	14.11	%FA-8A, EPS-125VDCPNLAF, FIRE-T1, PT-1_FH
7	2.556E-011	2.82	%FA-8A, CCW_FAILS, FIRE-T1, OPER-2, OPER-7
8	2.556E-012	0.28	%FA-8A, CCW_FAILS, FIRE-T1, OPER-2, RCP2-FTT
9	2.556E-012	0.28	%FA-8A, CCW_FAILS, FIRE-T1, OPER-2, RCP1-FTT
10	2.556E-012	0.28	%FA-8A, CCW_FAILS, FIRE-T1, OPER-2, RCPSEAL
11	2.556E-012	0.28	%FA-8A, CCW_FAILS, EPS-125VNSDCBUSF, FIRE-T1, OPER-2
12	1.278E-012	0.14	%FA-8A, EPS-BATB, FIRE-T1, OPER-5, PT-1_FH
13	1.278E-012	0.14	%FA-8A, EPS-4VBUSBF, FIRE-T1, OPER-5, PT-1_FH
14	1.278E-012	0.14	%FA-8A, EPS-480VLCBXTF, FIRE-T1, OPER-5, PT-1_FH
15	1.278E-012	0.14	%FA-8A, EPS-480VLCBF, FIRE-T1, OPER-5, PT-1_FH
16	1.278E-012	0.14	%FA-8A, EPS-480VMCCB1F, FIRE-T1, OPER-5, PT-1_FH
17	1.278E-012	0.14	%FA-8A, EPS-125VDCBUSBF, FIRE-T1, OPER-5, PT-1_FH
18	1.278E-012	0.14	%FA-8A, EPS-125VDCPNLBF, FIRE-T1, OPER-5, PT-1_FH
19	1.278E-012	0.14	%FA-8A, AOV-3_FTC, FIRE-T1, OPER-5, PT-1_FH
20	1.278E-012	0.14	%FA-8A, AOV-1_TO, FIRE-T1, HPIB_FTS, OPER-5
21	1.278E-012	0.14	%FA-8A, AOV-1_TO, FIRE-T1, HPIB_FTR, OPER-5
22	1.278E-012	0.14	%FA-8A, AOV-1_TO, FIRE-T1, MOV-4_TO, OPER-5
23	1.278E-012	0.14	%FA-8A, AOV-1_TO, FIRE-T1, MOV-6_FTO, OPER-5
24	1.278E-012	0.14	%FA-8A, AOV-1_TO, FIRE-T1, MOV-9_FTO, OPER-5
25	1.278E-012	0.14	%FA-8A, AOV-1_TO, FIRE-T1, MOV-3_TO, OPER-5
26	1.278E-012	0.14	%FA-8A, AOV-1_TO, FIRE-T1, MOV-2_FTC, OPER-5
27	1.278E-012	0.14	%FA-8A, CCW_FAILS, FIRE-T1, HPIB_FTS, OPER-7
28	1.278E-012	0.14	%FA-8A, CCW_FAILS, FIRE-T1, HPIB_FTR, OPER-7
29	1.278E-012	0.14	%FA-8A, CCW_FAILS, FIRE-T1, MOV-4_TO, OPER-7
30	1.278E-012	0.14	%FA-8A, CCW_FAILS, FIRE-T1, MOV-6_FTO, OPER-7

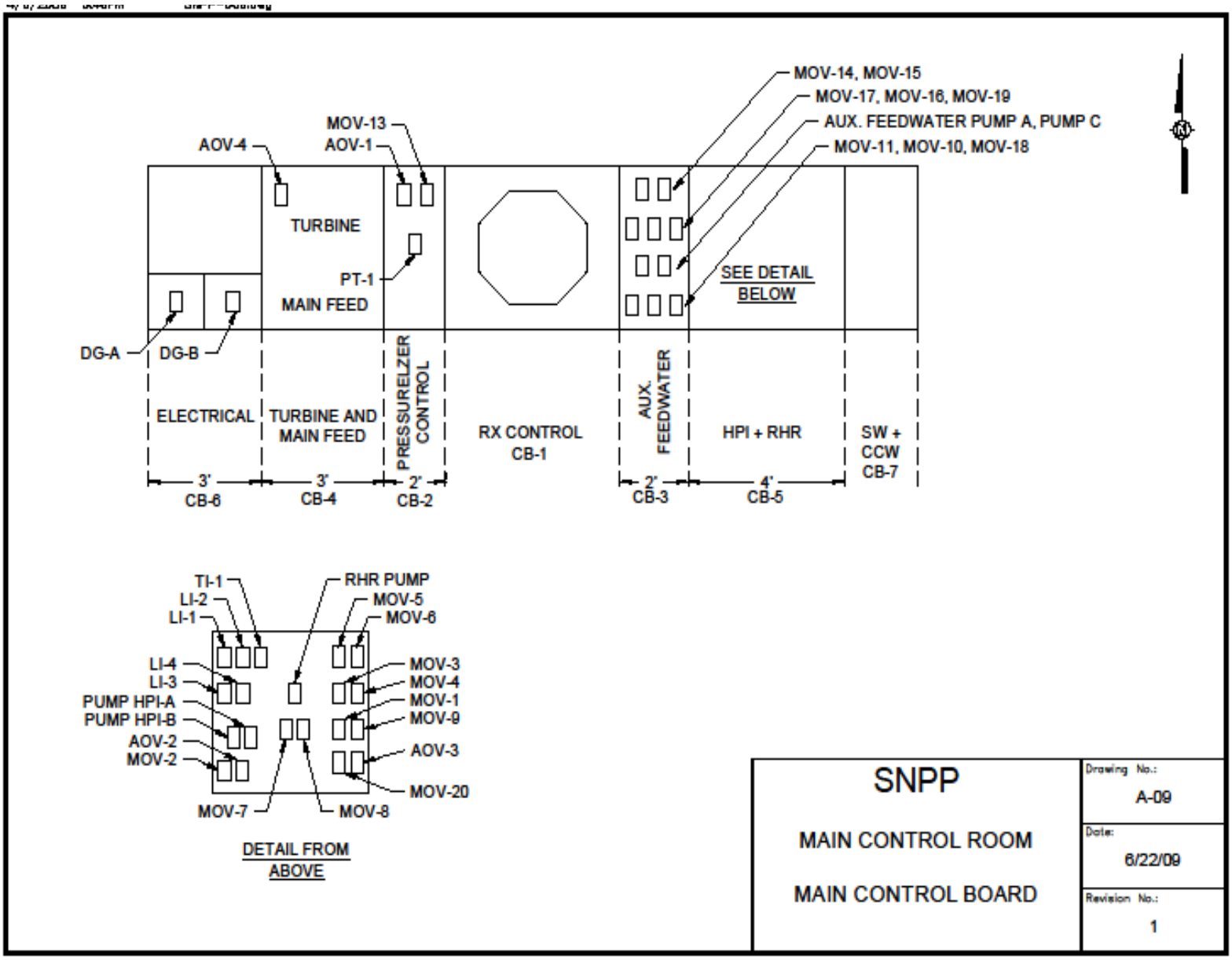
Slice By: Event | Cutoff | Rule

View | Report | Save

Close | Cancel

Figure 14: EXAMPLE RESULTS (METHOD 3)

FIRE SCENARIO EXAMPLES



Target Set ID	Items in the target set	Basis for selecting target set
MCR-01	AOV-4 Steam Generator Atmospheric Dump Valve AOV-1 PORV MOV-13 PORV Isolation Valve PT-1 Pressurizer pressure indication	A fire affecting CB-2 and CB-4 can fail ability to depressurize the pressurizer and use of atmospheric dump valves for heat removal. A fire limited to these panels may have a significant CCDP.
MCR-02	AFW-A Motor driven AFW pump A AFW-C Motor driven AFW pump C MOV-10 AFW discharge valve MOV-11 AFW discharge valve MOV-14 AFW turbine steam line isolation valve MOV-15 AFW steam inlet throttle valve MOV-16 AFW test line isolation valve MOV-17 AFW test line isolation valve MOV-18 AFW C Pump Discharge MOV-19 AFW test line isolation valve A-1 AFW motor high temp	CB-3 contains post shutdown secondary cooling equipment controls. A fire affecting the equipment controlled from this panel may have a significant CCDP. MOV-16, MOV-17, MOV-19, and A-1 screened in component selection
MCR-03	HPI-A High pressure safety injection pump A HPI-B High pressure safety injection pump B RHR-B RHR pump AOV-2 (SOV-2) Letdown isolation valve AOV-3 (SOV-3) Charging pump injection valve MOV-1 HPI valve MOV-2 VCT isolation valve MOV-3 Cont. sump recirc valve MOV-4 Cont. sump recirc valve MOV-5 RWST isolation valve MOV-6 RWST isolation	CB-5 contains a large number of safety related component controls. A fire affecting the equipment controlled from this panel may have a significant CCDP.

Target Set ID	Items in the target set	Basis for selecting target set
	valve MOV-7 RHR inboard suction valve MOV-8 RHR outboard suction valve MOV-9 HPI valve LI-1 RWST level LI-2 RWST level LI-3 Cont. sump level LI-4 Cont. sump level TI-1 Letdown heat exchanger outlet temp	
MCR-04	HPI-A High pressure safety injection pump A HPI-B High pressure safety injection pump B AOV-2 (SOV-2) Letdown isolation valve MOV-2 VCT isolation valve LI-3 Cont. sump level LI-4 Cont. sump level AFW-A Motor driven AFW pump A AFW-C Motor driven AFW pump C MOV-14 AFW turbine steam line isolation valve MOV-15 AFW steam inlet throttle valve	The shortest distance between the controls of the HPI and AFW systems that can render the pumps from both system inoperable is the distance from MOV-15 control switch to HPI-A control switch (i.e., CB-3 and CB-5 are affected by the same fire.) Loss of both systems may have a significant CCDP.
MCR-05	HPI-A High pressure safety injection pump A HPI-B High pressure safety injection pump B RHR-B RHR pump Control MOV-7 RHR inboard suction valve MOV-8 RHR outboard suction valve	The shortest distance between the controls of the HPI and RHR systems that can render the pumps from both systems inoperable is the distance from HPI-B control switch to RHR Pump control switch. Loss of both systems may have a significant CCDP.

<u>MCR-01 Quantification</u>

The farthest distance between the postulated control devices on the board is 4 ft.

$d = 4 \text{ ft} = 1.2 \text{ m}$

Assumed non-qualified cables since a portion of the cables are non-qualified. From Figure L-1 it is concluded:

$[SFxP_{NS}]_{MCR-01}$ = 3.0E-03

λ_{MCR-01} = 2.5E-03 x 3.0E-03 = 7.5E-06 per reactor year

<u>Results</u>

IGN: 2.50E-03

SF:

NSP: 3.00E-03

CCDP: 1.00E+00

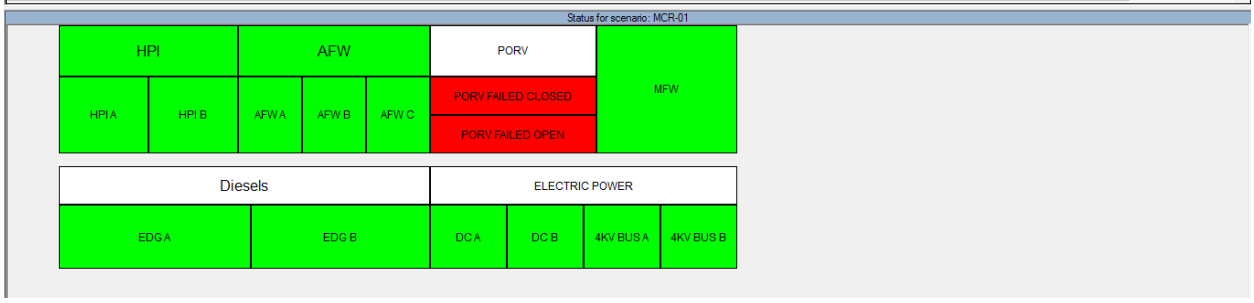
CDF: 7.50E-06

Affected Equipment

MCR-01 Zone

AOV-1_FTC	Basic Event
AOV-1_FTO	Basic Event
AOV-1_TO	Basic Event
AOV-4_TO	Basic Event
MOV-13_FTC	Basic Event
MOV-13_TC	Basic Event
PT-1_FH	Basic Event
PT-1_FL	Basic Event

Run	Scenario	Description	Fire Zone	Ignition Frequency	Severity Factor	Non-Suppr. Probability	Ones Run Result	CCDP	CDF	Screened
☐	FA-5	Fire Area 5	FA-5	5.0E-04	0.0E+00			1.4E-02	7.01E-06	No
☐	FA-6	Fire Area 6	FA-6	5.0E-04	0.0E+00			2.0E-02	1.0E-05	No
☐	FA-7	Fire Area 7	FA-7	1.88E-04	0.0E+00			2.29E-02	4.29E-06	No
☐	FA-8A	Fire Area 8A	FA-8A	1.28E-04	0.0E+00			1.4E-02	1.79E-06	No
☐	FA-8B	Fire Area 8B	FA-8B	7.05E-03	0.0E+00			1.01E-02	7.13E-05	No
☐	FA-9	Fire Area 9	FA-9	2.68E-03	0.0E+00			1.0E+00	2.68E-03	No
☑	MCR-01	Main Control Room Scenario 1	MCR-01	2.5E-03	0.0E+00	3.0E-03	1.0E+00	1.0E+00	7.5E-06	No
☐	MCR-02	Main Control Room Scenario 2	MCR-02	2.6E-03	0.0E+00	3.0E-03	1.36E-03	4.8E-04	3.74E-09	No
☐	MCR-03	Main Control Room Scenario 3	MCR-03	2.68E-04	0.0E+00	1.0E-01	1.91E-01	1.01E-02	2.7E-07	No
☐	MCR-04	Main Control Room Scenario 4	MCR-04	2.68E-04	0.0E+00	1.0E-01	8.72E-02	1.1E-02	2.96E-07	No
☐	MCR-05	Main Control Room Scenario 5	MCR-05	4.96E-03	0.0E+00		5.91E-02	1.0E-02	4.98E-05	No



MCR-02 Quantification

The farthest distance between the postulated control devices on the board is 2 ft.

d = 2 ft = 0.6 m

Assumed non-qualified cables since a portion of the cables are not qualified. From Figure L-1 it is concluded:

$[SFxP_{NS}]_{MCR-02}$ = 5.0E-03

λ_{MCR-02} = 2.5E-03 x 5.0E-03 = 1.25E-05 per reactor year

Results

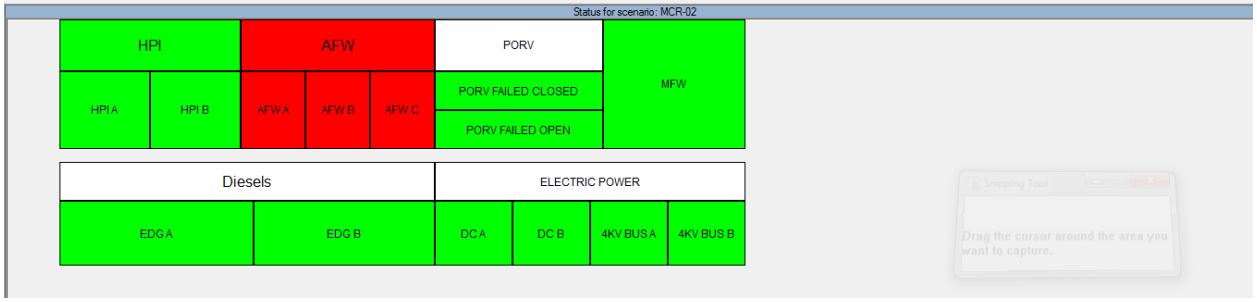
IGN: 2.60E-03
SF:
NSP: 3.00E-03
CCDP: 4.80E-04
CDF: 3.74E-09

Affected Equipment

MCR-02 Zone

AFWA-FTR	Basic Event
AFWA-FTS	Basic Event
AFWC-FTR	Basic Event
AFWC-FTS	Basic Event
MOV-10_FTO	Basic Event
MOV-11_FTO	Basic Event
MOV-14_FTO	Basic Event
MOV-15_FTO	Basic Event
MOV-18_FTO	Basic Event

Run	Scenario	Description	Fire Zone	Ignition Frequency	Severity Factor	Non-Suppr. Probability	Ones Run Result	CCDP	CDF	Screened
☐	FA-5	Fire Area 5	FA-5	5.0E-04	0.0E+00			1.4E-02	7.01E-06	No
☐	FA-6	Fire Area 6	FA-6	5.0E-04	0.0E+00			2.0E-02	1.0E-05	No
☐	FA-7	Fire Area 7	FA-7	1.88E-04	0.0E+00			2.29E-02	4.29E-06	No
☐	FA-8A	Fire Area 8A	FA-8A	1.28E-04	0.0E+00			1.4E-02	1.79E-06	No
☐	FA-8B	Fire Area 8B	FA-8B	7.05E-03	0.0E+00			1.01E-02	7.13E-05	No
☐	FA-9	Fire Area 9	FA-9	2.68E-03	0.0E+00			1.0E+00	2.68E-03	No
☐	MCR-01	Main Control Room Scenario 1	MCR-01	2.5E-03	0.0E+00	3.0E-03	1.0E+00	1.0E+00	7.5E-06	No
☑	MCR-02	Main Control Room Scenario 2	MCR-02	2.6E-03	0.0E+00	3.0E-03	1.36E-03	4.8E-04	3.74E-09	No
☐	MCR-03	Main Control Room Scenario 3	MCR-03	2.68E-04	0.0E+00	1.0E-01	1.91E-01	1.01E-02	2.7E-07	No
☐	MCR-04	Main Control Room Scenario 4	MCR-04	2.68E-04	0.0E+00	1.0E-01	8.72E-02	1.1E-02	2.96E-07	No
☐	MCR-05	Main Control Room Scenario 5	MCR-05	4.96E-03	0.0E+00		5.91E-02	1.0E-02	4.98E-05	No



<u>HRA Recovery Rule Example</u>

```
**RECOVERY RULES**
**MAX RECOVERIES** 1
**CLEAR RECOVERY FLAGS**
;HRA Dependency Rules

**RECOVERY** x-HRACOMB 1.0E-05
OPER-1 OPER-5

;HRA - Independent Probability assignement rules

**RECOVERY** X-OPER-1 1.0E-03
OPER-1

**RECOVERY** X-OPER-2 2.0E-02
OPER-2

**RECOVERY** X-OPER-4 8.0E-03
OPER-4

**RECOVERY** X-OPER-5 1.0E-02
OPER-5

**RECOVERY** X-OPER-7 1.0E-02
OPER-7

**SET EVENT PROBS**
OPER-1 1.0
OPER-2 1.0
OPER-4 1.0
```

OPER-5 1.0
OPER-7 1.0

Example Cutsets with HRA Dependency Combination Events

CDF = 4.799E-04 (331 cutsets)				
1.000E-08	AOV-1_TO	MOV-5_FTC	OPER-5	X-OPER-5
1.000E-08	MOV-5_FTC	OPER-5	PT-1_FH	X-OPER-5
1.000E-08	AOV-1_TO	MOV-6_FTC	OPER-5	X-OPER-5
1.000E-08	MOV-6_FTC	OPER-5	PT-1_FH	X-OPER-5
1.000E-08	AOV-4_TO	MOV-5_FTO	MOV-6_FTO	
1.000E-08	EPS-120VBUSBF	OPER-5	PT-1_FH	X-OPER-5
1.000E-08	EPS-120VBUSBINVF	OPER-5	PT-1_FH	X-OPER-5
1.000E-08	EPS-125VDCBUSBF	OPER-5	PT-1_FH	X-OPER-5
1.000E-08	EPS-BATB	OPER-5	PT-1_FH	X-OPER-5
1.000E-08	EPS-480VLC1F	OPER-5	PT-1_FH	X-OPER-5
1.000E-08	EPS-480VLC1XTF	OPER-5	PT-1_FH	X-OPER-5
1.000E-08	EPS-4VBUS1F	OPER-5	PT-1_FH	X-OPER-5
1.000E-08	OPER-5	PT-1_FH	UATF	X-OPER-5
1.000E-08	AOV-1_FTC	OPER-5	PT-1_FL	X-OPER-5
1.000E-08	AOV-1_TO	OPER-5	PT-1_FL	X-OPER-5
1.000E-08	OPER-5	PT-1_FH	PT-1_FL	X-OPER-5
1.000E-08	AOV-1_TO	OPER-5	RHRB-FTS	X-OPER-5
1.000E-08	OPER-5	PT-1_FH	RHRB-FTS	X-OPER-5
1.000E-08	AOV-1_TO	OPER-5	RHRB-HVAC	X-OPER-5
1.000E-08	OPER-5	PT-1_FH	RHRB-HVAC	X-OPER-5
1.000E-08	AOV-4_TO	EPS-DGAF	SUTF	
1.000E-08	AOV-1_TO	OPER-1	OPER-5	X-HRACOMB
1.000E-08	OPER-1	OPER-5	PT-1_FH	X-HRACOMB
1.000E-09	AOV-1_FTC	EPS-120VBUSBF	EPS-125VDCBUSAF	
1.000E-09	AOV-1_FTC	EPS-120VBUSBF	EPS-480VLCAF	
1.000E-09	AOV-1_FTC	EPS-120VBUSBF	EPS-480VLCAXTF	
1.000E-09	AOV-1_FTC	EPS-120VBUSBF	EPS-480VMCCA1F	
1.000E-09	AOV-1_FTC	EPS-120VBUSBF	EPS-4VBUSAF	
1.000E-09	AOV-1_FTC	EPS-120VBUSBF	EPS-BATA	
1.000E-09	AOV-1_FTC	EPS-120VBUSBF	MOV-13_FTC	