Appendix B: MAAP Attach & Plot Files

1.0 attach.dat

```
C attach file for all Palisades runs
    PARAMETER FILE PNP406_060209(1).par 25
    ALIAS
     IEVNT(3)  AS RPV FAILED
     TIM       AS TIME
     TIMER 2   AS TIME SINCE RPV FAILURE
    END
    FUNCTION WHPIGPM = WHPIXX * 60 * 2.205 / 62.4 * 7.4805
    FUNCTION WLPIGPM = WLPI1X * 60 * 2.205 / 62.4 * 7.4805
    FUNCTION TDSEC = TDOLD
    FUNCTION WRB14GPM = WWRB(14) * 60 * 2.205 / 62.4 * 7.4805
    FUNCTION WRB18GPM = WWRB(18) * 60 * 2.205 / 62.4 * 7.4805
    FUNCTION FUNZJUNC = ZJUNC(18,2) + 0.05
    FUNCTION TPEAKSG = TBHTO(1,1) + TPUMXB
    FUNCTION TAVHLB = 0.25 * TBH(2,1) + 0.5 * TBH(2,2) + 0.25 * TBH(2,3)
    FUNCTION TAVHLU = 0.25 * TUH(2,1) + 0.5 * TUH(2,2) + 0.25 * TUH(2,3)
    plotfil 87
      wrb(18),wrb(14),mwrb(4),zwrb(4),mwrb(13),zwrb(13),mwrb(12),
      zwrb(12),prb(4),prb(13),prb(12),wwrb(18),wwrb(14),
      whpigpm,tpumxb,tpeaksg,TAVHLB,TAVHLU,TSRN(1,1),TBHTO(1,1),
      TUHTO(1,1),TBHTB(5,1),TUHTB(5,1)
      end
```

2.0 attach_charging2.dat

```
C Charging Data References:
C FSAR Rev.23, TABLE 9-13
C EMAIL: Steve Mongeau, Entergy, to Alex Huning, ERIN.
C      SUBJECT: FW: MAAP 4.0.6 Success Criteria Runs, 1/22/09
 PARAMETER CHANGE
  PCHP0 = 1605  PSI
  TDCHP = 5.0  S
  WCHPX = 1.e10  LB/HR
  NCHPG = 1
```

NORCHP = 6

NSCHP = 3

NDCHP = 2

RECCHP = 6

RSCHP = 3

RDCHP = 2

SNPCHP = 0

WECHP = 0.0 LB/HR

TDNCHP = 0.0 S

DEGCHP = 6

ZCHPRW = 30.39 FT

ZCHPCS = 30.39 FT

ZCHPSI = 30.39 FT

NPOI6 = 5

ZHDP6(1) = 5850. FT

ZHDP6(2) = 5750. FT

ZHDP6(3) = 5000. FT

ZHDP6(4) = 3600. FT

ZHDP6(5) = 1450. FT

WVPM6(1) = 80. GPM

WVPM6(2) = 80. GPM

WVPM6(3) = 80. GPM

WVPM6(4) = 80. GPM

WVPM6(5) = 80. GPM

ZHDR6(1) = 7.65 FT

ZHDR6(1) = 7.65 FT

ZHDR6(1) = 7.65 FT

ZHDR6(1) = 7.65 FT

ZHDR6(1) = 7.65 FT

END PARAMETER CHANGE

3.0 attach_charging1_D11_2(2).dat

C Charging Data References:

C FSAR Rev.23, TABLE 9-13

C EMAIL: Steve Mongeau, Entergy, to Alex Huning, ERIN.

C SUBJECT: FW: MAAP 4.0.6 Success Criteria Runs, 1/22/09

PARAMETER CHANGE

PCHP0 = 1605 PSI

TDCHP = 5.0 S

WCHPX = 1.e10 LB/HR

NCHPG = 1

NORCHP = 6

NSCHP = 3

NDCHP = 2

RECCHP = 6

RSCHP = 3

RDCHP = 2

SNPCHP = 0

WECHP = 0.0 LB/HR

TDNCHP = 0.0 S

DEGCHP = 6

ZCHPRW = 30.39 FT

ZCHPCS = 30.39 FT

ZCHPSI = 30.39 FT

NPOI6 = 5

ZHDP6(1) = 5850. FT

ZHDP6(2) = 5750. FT

ZHDP6(3) = 5000. FT

ZHDP6(4) = 3600. FT

ZHDP6(5) = 1450. FT

WVPM6(1) = 80. GPM

WVPM6(2) = 80. GPM

WVPM6(3) = 80. GPM

WVPM6(4) = 80. GPM

WVPM6(5) = 80. GPM

ZHDR6(1) = 7.65 FT

ZHDR6(1) = 7.65 FT

ZHDR6(1) = 7.65 FT

ZHDR6(1) = 7.65 FT

ZHDR6(1) = 7.65 FT

END PARAMETER CHANGE

4.0 sc_plots(1).dat

C Volumetric Flow Rates, Charging, HPSI, LPSI (GPM)

C MAAP Uses metric units of [KG/s] for mass flow rate

C 1 [KG/S]= 1 [KG/S] * 3600 [S/HR] * 2.20462 [LB/KG] = 7936.63 [LB/HR]

C Specific volume assumed constant for water = 0.0161557 [Ft**3/lbm]

C 1 [LB/HR] * 0.0161557 [FT3/LB] * 1/0.1336805556[GAL/FT3] * 1/60[HR/MIN]

C 1 [LB/HR] = 0.002014 [GAL/MIN]

C 1 [KG/S] = 15.9844 [GAL/MIN]

FUNCTION

VDOTCHP = WCHPXX * 15.9844

VDOTHPI = WHPIXX * 15.9844

VDOTLPI = WLPI1X * 15.9844

VDOTSPA = WSPAXX * 15.9844

VDOTSPB = WSPBXX * 15.9844

VDOTSPC = WSPCXX * 15.9844

VAFWB = WWFWBS * 15.9844

VAFWU = WWFWUS * 15.9844

VMWCST = MWCST * 0.00101164 * 35.14 * 7.48

ZWCST = MWCST * 0.00101164/ACST * 3.28

END

FUNCTION

C Primary-Secondary Pressure Differential, BROKEN SG

PSPDBSG = (PPS - PBS)*0.0001450377377

C Primary-Secondary Pressure Differential, UNBROKEN SG

PSPDUSG = (PPS - PUS)*0.0001450377377

C PERCENT STEAM GENERATOR LEVEL - BROKEN S/G

C (((SZWBSC$-6.7612)*21.8723) < 100.0) > (-138.0)

BSGLVL=(23.685 + 21.8723*(ZWBS-7.84)+1.542E-3*((ZWBS-7.84)**2))

PERCENT STEAM GENERATOR LEVEL - UNBROKEN S/G

C (((SZWUSC$-6.7612)*21.8723) < 100.0) > (-138.0)

USGLVL=(23.685 + 21.8723*(ZWUS-7.84)+1.542E-3*((ZWUS-7.84)**2))

```
C PERCENT PRESSURIZER LEVEL (APPROXIMATE)
PZRLVL=(((ZWPZ-0.3247)*14.288))
C PERCENT SIRWT LEVEL
SIRWTLVL=(ZWRWST-0.4572)*14.5815
END
C CALCULATE SUBCOOLING MARGIN
FUNCTION
  TSATCR = TSAT(PPS)
  SUBCM = TSAT(PPS) - TWCR
  SUBCMF = SUBCM * 1.8
END
C 1 PA = 0.0001450377377 PSI
 FUNCTION OVERPRES = (PRB(12) - PSAT(TWRB(12)))*0.0001450377377
C 1 M = 3.28083 FT
C 1 FT(pressure) = 2.30414765 PSI
C 3.28083 x 2.30414765 = 7.55952
 FUNCTION HPNPSHAV = (4.1148 + ZWRB(13))*7.55952 + OVERPRES
 FUNCTION TSAT12 = TSAT(PRB(12))*9./5.-459.7
 FUNCTION SUBCOOL1 = (TSAT(PRB(12)) - TWRB(12))*9./5.
C Containment Volume Averaged Gas Temperature and Pressure
C Voltot = total containment volume
C *     = SUM(VOLRB(i),i,1,16)
C *     = 1.64027E6 FT**3
 FUNCTION
  VOLTOT = 1.64027E6
  SUMTGR1 = TGRB(1)*711400+TGRB(3)*489900+TGRB(4)*6822
  SUMTGR2 = TGRB(5)*55210+TGRB(6)*62090+TGRB(7)*84210
  SUMTGR3 = TGRB(8)*43720+TGRB(9)*1884+TGRB(10)*22280
  SUMTGR4 = TGRB(11)*386+TGRB(12)*75660+TGRB(13)*1364
  SUMTGR5 = TGRB(14)*33930+TGRB(15)*20830+TGRB(16)*30580
  SUMTGRB = SUMTGR1+SUMTGR2+SUMTGR3+SUMTGR4+SUMTGR5
  TGRBTOT = (SUMTGRB/VOLTOT)*9./5.-459.7
  SUMPRB1 = pRB(1)*711400+pRB(3)*489900+pRB(4)*6822
  SUMPRB2 = pRB(5)*55210+pRB(6)*62090+pRB(7)*84210
  SUMPRB3 = pRB(8)*43720+pRB(9)*1884+pRB(10)*22280
```

```
  SUMPRB4 = pRB(11)*386+prB(12)*75660+pRB(13)*1364
  SUMPRB5 = pRB(14)*33930+pRB(15)*20830+pRB(16)*30580
  SUMPRB = SUMPRB1+SUMPRB2+SUMPRB3+SUMPRB4+SUMPRB5
  PRBTOT = (SUMPRB/VOLTOT)*0.0001450377377
 END
PARAMETER CHANGE
END PARAMETER CHANGE
C attach file for all Palisades runs
C PLOTS
PLOTFIL 88
WHPIXX    // GENESF HPSI FLOW
WLPI1X    // GENESF LPSI FLOW
WSPAXX    // GENESF UPPER COMPT SPRAY FLOW
ZWRWST    // water level in refueling water storage tank
WESFDC    // flow rate of ESF water to downcomer nodes
WESFCL    // flow rate of ESF water to cold leg nodes
PQT       // pressure in quench tank
TWQT      // temperature of water in quench tank
MH2QT1    // mass of H2 in quench tank
PACUM     // pressure in accumulator
END
PLOTFIL 90 //
PPZ       // pressure in pressurizer
ZWPZ      // collapsed water level in pressurizer
TWCR      // core water temperature
SUBCMF    // subcooling margin (TSATCR - TWCR) in F
ZWBS      // collapsed water level in broken S/G downcomer
PBS       // pressure in broken S/G
TWBS      // temperature of water in broken S/G
END
PLOTFIL 92 //
ZWBS      // collapsed water level in broken S/G downcomer
PBS       // pressure in broken S/G
ZWUS      // collapsed water level in unbroken S/G downcomer
PUS       // pressure in unbroken S/G
```

TWBS // temperature of water in broken S/G

TWUS // temperature of water in unbroken S/G

END

PLOTFIL 93 //

WWFWBS // FEEDWATER, INCLUDING AUX FEED, TO BROKEN S/G

WWFWUS // FEEDWATER, INCLUDING AUX FEED, TO UNBROKEN S/G

WSTTDB // FEEDWATER TURBINE EXTR STEAM

WSTTDU // FEEDWATER TURBINE EXTR STEAM

average WGBST // flow B S/G relief, safety, MSIVs (gas)

average WGUST // flow U S/G relief, safety, MSIVs (gas)

WGBST // flow B S/G relief, safety, MSIVs (gas)

WGUST // flow U S/G relief, safety, MSIVs (gas)

END

C Flag For Determining when PZR Sprays Turn On

WHEN TIM > 0.

PZRSPRAY = 0.

END

PLOTFIL 94

TSATCR // saturation temperature at primary system pressure

SUBCM // saturation temperauter - core water temperature

SUBCMF // subcooling margin in degrees F

ZWBS // collapsed water level in broken S/G downcomer

ZWUS // collapsed water level in unbroken S/G downcomer

ZWPZ // collapsed water level in pressurizer

WWFWBS // MFW including AFW, TO broken S/G

WWFWUS // MFW including AFW, TO unbroken S/G

PSPDBSG // Primary-Secondary Pressure Differential, BROKEN SG

PSPDUSG // Primary-Secondary Pressure Differential, UNBROKEN SG

VDOTCHP // Volumetric Flow Rate in GPM for Charging Pumps

VDOTHPI // Volumetric Flow Rate in GPM for HPSI Pumps

VDOTLPI // Volumetric Flow Rate in GPM for LPSI Pumps

OVERPRES // overpressure of containment compartment 13

HPNPSHAV // average NPSH availible at the HPSI pump

TSAT12 // saturation temperature of containment compartment 13

SUBCOOL1 // amount of subcooling of containment compartment 13

MWCST0 // mass of water in CST Tank

ZWRWST // water level of CST Tank

TGRBTOT // volume averaged containment gas temperature

PRBTOT // volume averaged containment pressure

BSGLVL // % S/G Water Level in Broken

USGLVL // % S/G Water Level in Unbroken

PZRLVL // % PZR Water Level

SIRWTLVL // % SIRWT Water Level

END

PLOTFIL 95

TCRHOT // Peak Core Temperature (mass averaged over matl in node)

PPS // PCS Pressure

TWHPS // Temperature of water in the hot leg

TWLPS // Temperature of water in the cold leg

TWPS // Average temperature of water in the primary system

WWFWUS // Total FW (main or aux) to the unbroken steam generators, LB/HR

WWFWBS // Total FW (main or aux) to the broken steam generators, LB/HR

VAFWB // Feedwater Volumetric Flow Rate (MFW & Aux) to broken S/G GPM

VAFWU // Feedwater Volumetric Flow Rate (MFW & Aux) to unbroken S/G GPM

ZWUS // Collapsed water level in unbroken SG downcomer

ZWBS // Collapsed water level in broken SG downcomer

WWBST // Total water flow through the broken SG relief valves, safety valves, and the main steam line (includes the MSLB flow)

WGBST // Total gas flow through the broken SG relief valves, safety valves, and the main steam line (includes MSLB flow)

WGUST // Total gas flow through the broken SG relief valves, safety valves, and the main steam line (includes MSLB flow)

MWCST0 // Mass of Water in Condensate(CST)& PCS Makeup Storage Tank (T-2)

ZWRWST // water level of CST Tank

BSGLVL // % S/G Water Level in Broken

USGLVL // % S/G Water Level in Unbroken

PZRLVL // % PZR Water Level

SIRWTLVL // % SIRWT Water Level

WSTRV // Total flow of steam through the pressurizer valves

WGRV // Combined flow rate of gas out of pressurizer through relief valves and safety valves

WWRV // Total water flow through the pressurizer relief valves and safety valves

VDOTCHP // Volumetric Flow Rate in GPM for Charging Pumps

VDOTHPI // Volumetric Flow Rate in GPM for HPSI Pumps

VDOTLPI // Volumetric Flow Rate in GPM for LPSI Pumps

VDOTSPA // Spray 54-A Volumetric Flow Rate in GPM

VDOTSPB // Spray 54-B Volumetric Flow Rate in GPM

VDOTSPC // Spray 54-C Volumetric Flow Rate in GPM

PRB(1) // Crane to Dome - North and South (corresponding to GOTHIC nodes 1 & 2) pressure

TGRB(1) // Crane to Dome - North and South (corresponding to GOTHIC nodes 1 & 2) gas temp

VMWCST // Volume of Remaining Water in Condensate Storage Tank (T-2)& PCS Makeup Storage Tank (T-81)

ZWCST // CST Level

ZWCPS // Collapsed Water Level in the Primary System Relative to the Bottom of the Vessel

END

Attachment 06 Event Trees

TR-MCND

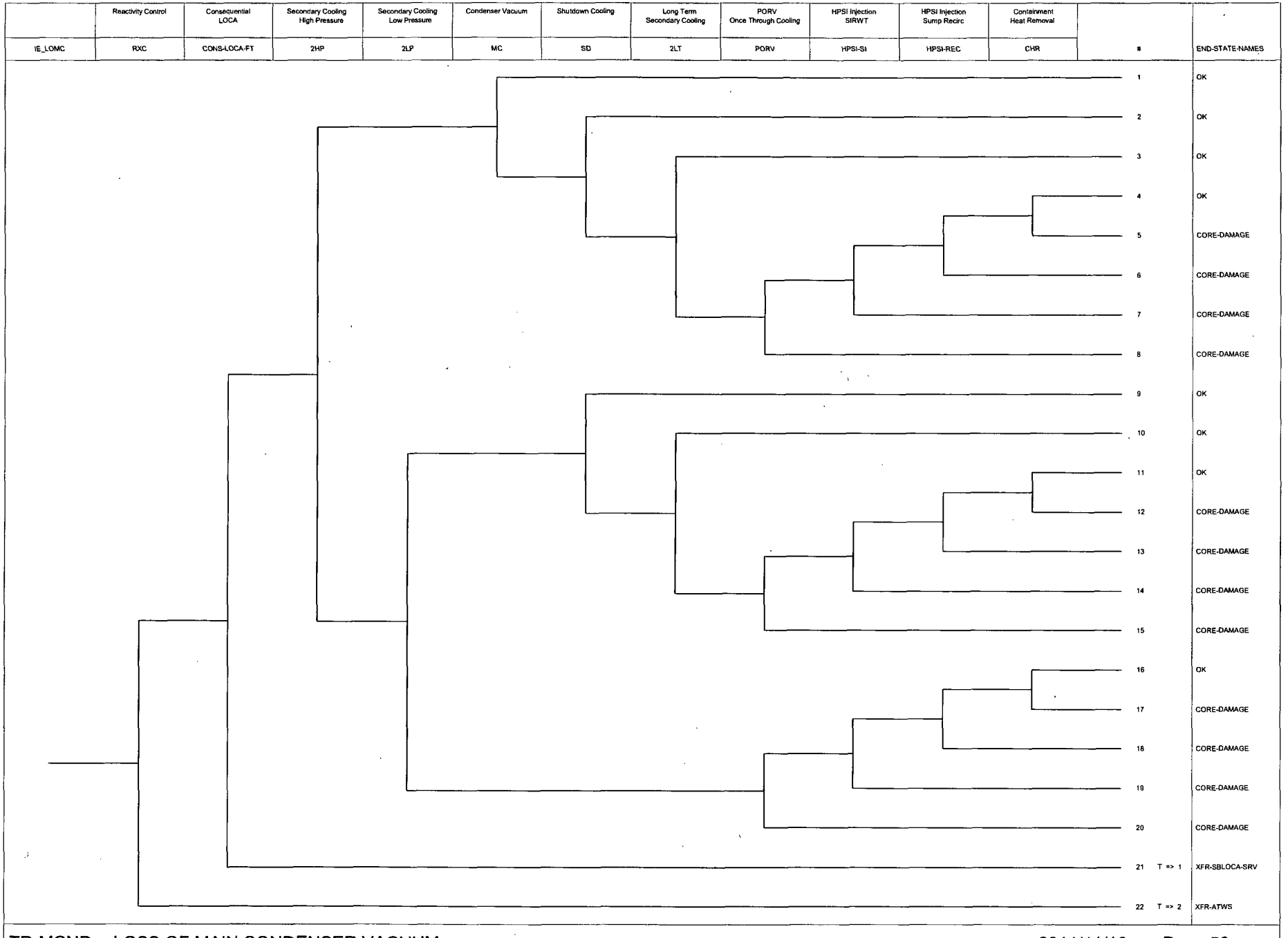
Figure A06-1: Transient with Loss of Main Condenser (TR-MCND)

XFR-SBLOCA-SRV

Figure A06-2: Transfer to Loss of Coolant Accident via Pressurizer Safety Relief Valve(s) (XFR-SBLOCA-SRV)

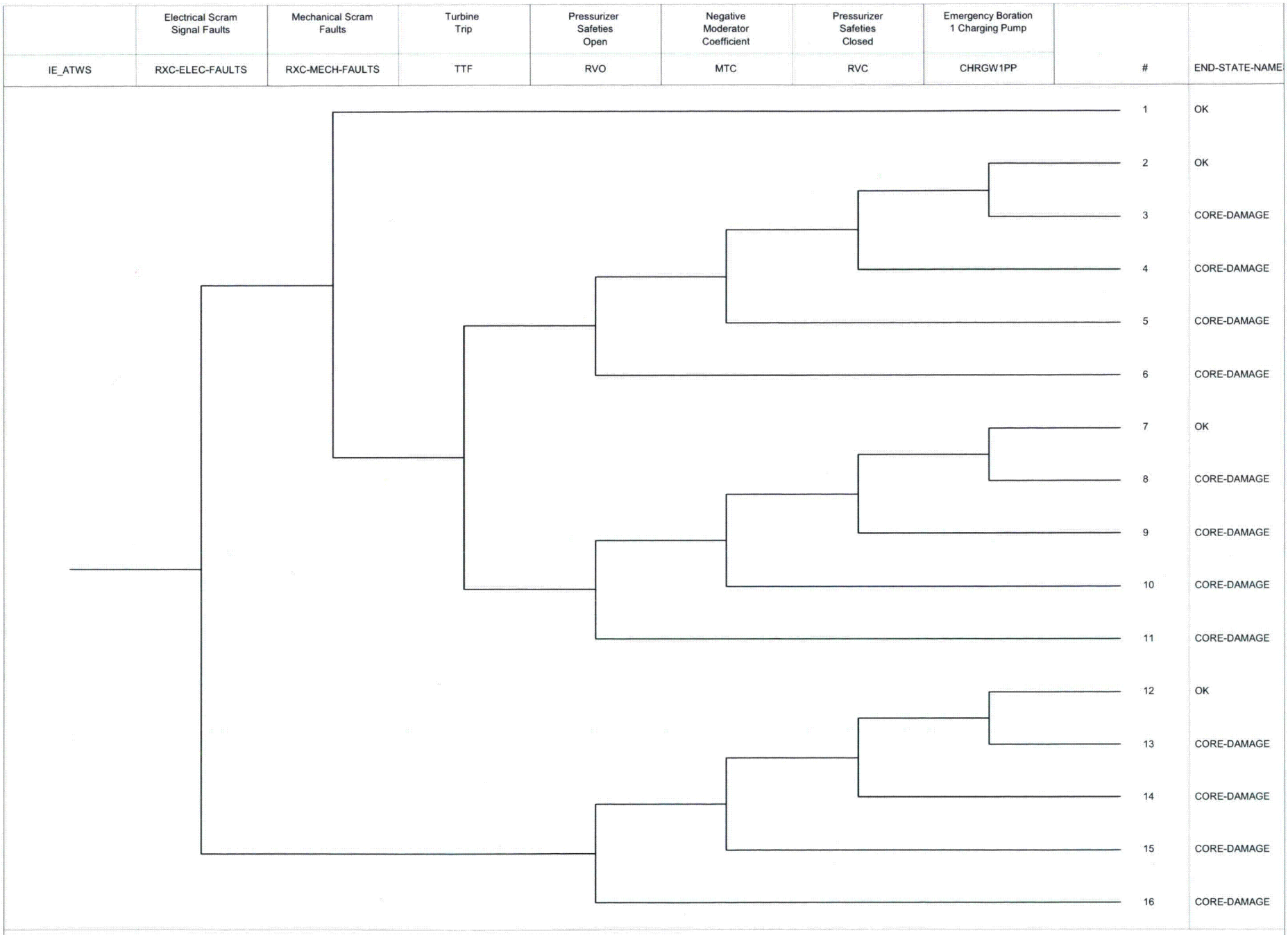
XFR-ATWS

Figure A06-3: Transfer to Anticipated Transient Without SCRAM (XFR-ATWS)


Reactivity Control
Consequential LOCA
Secondary Cooling High Pressure
Secondary Cooling Low Pressure
Condenser Vacuum
Shutdown Cooling
Long Term Secondary Cooling
PORV Once Through Cooling
HPSI Injection SIRWT
HPSI Injection Sump Recirc
Containment Heat Removal
IE_LOMC
RXC
CONS-LOCA-FT
2HP
2LP
MC
SD
2LT
PORV
HPSI-SI
HPSI-REC
CHR
#
END-STATE-NAMES
1 OK
2 OK
3 OK
4 OK
5 CORE-DAMAGE
6 CORE-DAMAGE
7 CORE-DAMAGE
8 CORE-DAMAGE
9 OK
10 OK
11 OK
12 CORE-DAMAGE
13 CORE-DAMAGE
14 CORE-DAMAGE
15 CORE-DAMAGE
16 OK
17 CORE-DAMAGE
18 CORE-DAMAGE
19 CORE-DAMAGE
20 CORE-DAMAGE
21 T => 1 XFR-SBLOCA-SRV
22 T => 2 XFR-ATWS

Challenge to Pressurizer Safety Relief Valve - Potential Stuck Open PZR SRV SBLOCA	Secondary Cooling Hi-Press	Pressurizer Safety Relief Valves Closure (Given Steam or Water Relief)	Charging (2/3 Charging Pumps based on MAAP runs)	HPSI Injection SIRWT	Shutdown Cooling (requires DC recovery for ADVs)	Secondary Cooling Long Term	HPSI Injection SIRWT	PORVs Once-Thru Cooling	HPSI Injection RAS	Containment Heat Removal	#	END-STATE-NAMES
IE_SRV-SBLOCA	2HP	PZR-SAFETIES-FTC	CHRG	HPSI-SI	SD	2LT	HPSI-SI	PORV	HPSI-REC	CHR	1	OK
											2	CORE-DAMAGE
											3	OK
											4	CORE-DAMAGE
											5	CORE-DAMAGE
											6	CORE-DAMAGE
											7	CORE-DAMAGE
											8	OK
											9	CORE-DAMAGE
											10	CORE-DAMAGE
											11	OK
											12	CORE-DAMAGE
											13	CORE-DAMAGE
											14	CORE-DAMAGE
											15	CORE-DAMAGE
											16	OK
											17	CORE-DAMAGE
											18	CORE-DAMAGE
											19	CORE-DAMAGE
											20	CORE-DAMAGE

XFR-SBLOCA-SRV - PZR SAFETY SPURIOUS OPENING INDUCED SMALL BREAK LOCA (TRANSFER EVENT TREE) 2012/01/05 Page 1


Electrical Scram Signal Faults
Mechanical Scram Faults
Turbine Trip
Pressurizer Safeties Open
Negative Moderator Coefficient
Pressurizer Safeties Closed
Emergency Boration 1 Charging Pump
IE_ATWS
RXC-ELEC-FAULTS
RXC-MECH-FAULTS
TTF
RVO
MTC
RVC
CHRGW1PP
#
END-STATE-NAME
1 OK
2 OK
3 CORE-DAMAGE
4 CORE-DAMAGE
5 CORE-DAMAGE
6 CORE-DAMAGE
7 OK
8 CORE-DAMAGE
9 CORE-DAMAGE
10 CORE-DAMAGE
11 CORE-DAMAGE
12 OK
13 CORE-DAMAGE
14 CORE-DAMAGE
15 CORE-DAMAGE
16 CORE-DAMAGE

Attachment 07: Change Sets

Table A07-1: Change Sets for SAPHIRE Project: PSAR2C(D11-2)				
Change/Flag Set	**Event**	**Calc. Type**	**Prob/Freq**	**Description**
0_BASE				SET TRIP CHARGING PUMP HEP TO 0 FOR CONSISTENCY WITH PSAR2C
	G-PMOA-TRIP-PUMP	1	0.00E+00	OPERATOR FAILS TO TRIP CHARGING PUMP(S) PRIOR TO CHALLENGING PZR SRVS
0_BYPASS_REG_FIX				SET P-CBOB-BYREG HEP TO 1.7E-2 VICE 0.5 FOR CONSISTENCY WITH HRA
	P-CBOB-BYREG	1	1.70E-02	WHEN "TRUE" OP RECOVERY OF THE BYPASS REG IS CREDITED
0_D11-2_EVENT_REC0				09/25/2011 D11-2 FAULT EVENT WITH RECOVERIES APPLIED
	A-PMME-P-8B	1	1.53E-02	AFW TURBINE PUMP P-8B FAILS TO START
				(EVENT CONSEQUENTIAL FAILURE – SURROGATE FOR RECOVERY HEP)
	D-BCMT-ED-15	1	1.00E+00	BATTERY CHARGER #1 FAILS TO FUNCTION
				(EVENT CONSEQUENTIAL FAILURE)
	D-BCMT-ED-17	1	1.00E-01	BATTERY CHARGER #3 FAILS TO FUNCTION
				(EVENT CONSEQUENTIAL FAILURE – SURROGATE FOR RECOVERY HEP)
	D-CBMC-72-119	1	1.00E+00	72-119 DC BREAKER FAILS TO REMAIN CLOSED
				(EVENT CONSEQUENTIAL FAILURE)
	D-HSE-CHGR3-INS	T		SET TO 'T' - CHARGER #3 IN SERVICE
	D-HSMC-HS-72-01	1	1.00E-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED
				(EVENT CONSEQUENTIAL FAILURE – SURROGATE FOR RECOVERY HEP)
	G-PMOA-TRIP-PUMP	1	6.80E-03	OPERATOR FAILS TO TRIP CHARGING PUMP(S) PRIOR TO CHALLENGING PZR SRVS
	M-OOOT-LPF-INIT	T	1.00E+00	OP FAILS TO SUPPLY CONDENSATE TO DEPRESSURIZED S/G (LP FEED)
				(EVENT CONSEQUENTIAL FAILURE – SURROGATE FOR RECOVERY HEP – NO RECOVERY)

Table A07-1: Change Sets for SAPHIRE Project: PSAR2C(D11-2)				
Change/Flag Set	**Event**	**Calc. Type**	**Prob/Freq**	**Description**
	P-B1MK-EA-13	1	2.60E-03	FAULT ON BUS 1E
				(EVENT CONSEQUENTIAL FAILURE – SURROGATE FOR RECOVERY HEP)
	P-PAMK-EY-10	1	3.30E-02	FAULT ON 120V PREFERRED AC BUS Y10
				(EVENT CONSEQUENTIAL FAILURE – SURROGATE FOR RECOVERY HEP)
	P-PAMK-EY-30	1	1.00E-01	FAULT ON 120V PREFERRED AC BUS Y30
				(EVENT CONSEQUENTIAL FAILURE – SURROGATE FOR RECOVERY HEP)
0_D11-2_EVENT_REC1				09/25/2011 D11-2 FAULT EVENT WITH RECOVERIES APPLIED
	A-PMME-P-8B	1	1.05E-01	AFW TURBINE PUMP P-8B FAILS TO START
				(EVENT CONSEQUENTIAL FAILURE – SURROGATE FOR RECOVERY HEP)
	D-BCMT-ED-15	1	1.00E+00	BATTERY CHARGER #1 FAILS TO FUNCTION
				(EVENT CONSEQUENTIAL FAILURE)
	D-BCMT-ED-17	1	1.00E-01	BATTERY CHARGER #3 FAILS TO FUNCTION
				(EVENT CONSEQUENTIAL FAILURE – SURROGATE FOR RECOVERY HEP)
	D-CBMC-72-119	1	1.00E+00	72-119 DC BREAKER FAILS TO REMAIN CLOSED
				(EVENT CONSEQUENTIAL FAILURE)
	D-HSE-CHGR3-INS	T		SET TO 'T' - CHARGER #3 IN SERVICE
	D-HSMC-HS-72-01	1	1.00E-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED
				(EVENT CONSEQUENTIAL FAILURE – SURROGATE FOR RECOVERY HEP)
	G-PMOA-TRIP-PUMP	1	6.80E-03	OPERATOR FAILS TO TRIP CHARGING PUMP(S) PRIOR TO CHALLENGING PZR SRVS
	M-OOOT-LPF-INIT	T	1.00E+00	OP FAILS TO SUPPLY CONDENSATE TO DEPRESSURIZED S/G (LP FEED)
				(EVENT CONSEQUENTIAL FAILURE – SURROGATE FOR RECOVERY HEP – NO RECOVERY)
	P-B1MK-EA-13	1	2.60E-03	FAULT ON BUS 1E
				(EVENT CONSEQUENTIAL FAILURE – SURROGATE FOR RECOVERY HEP)

Table A07-1: Change Sets for SAPHIRE Project: PSAR2C(D11-2)				
Change/Flag Set	**Event**	**Calc. Type**	**Prob/Freq**	**Description**
	P-PAMK-EY-10	1	1.00E-01	FAULT ON 120V PREFERRED AC BUS Y10
				(EVENT CONSEQUENTIAL FAILURE – SURROGATE FOR RECOVERY HEP)
	P-PAMK-EY-30	1	1.00E-01	FAULT ON 120V PREFERRED AC BUS Y30
				(EVENT CONSEQUENTIAL FAILURE – SURROGATE FOR RECOVERY HEP)
0_IE_SET				SET IE_LOMC (LOSS OF MAIN CONDENSER) TO 1
	IE_LOMC	1	1.00E+00	(EVENT CONSEQUENTIAL FAILURE)
0_PRE-EVENT_EOOS				09/25/2011 PRE- D11-2 FAULT EVENT EQUIPMENT OUT OF SERVICES
	P-CBMB-252-302	T		CIRCUIT BREAKER 252-302 FAILS TO CLOSE
				(OUT OF SERVICE PRIOR TO EVENT)
	P-CBMC-252-302	T		CIRCUIT BREAKER 252-302 FAILS TO REMAIN CLOSED
				(OUT OF SERVICE PRIOR TO EVENT)

Table A07-2: Change Sets Applied to Each Endstate			
Endstate:	0_LOMC_BASE	0_LOMC_D11-2_REC0	0_LOMC_D11-2_REC1
Change Sets:	HEVENTS(LGCLS-NRML-CNF)	HEVENTS(LGCLS-NRML-CNF)	HEVENTS(LGCLS-NRML-CNF)
	0_BYPASS_REG_FIX	0_BYPASS_REG_FIX	0_BYPASS_REG_FIX
	0_PRE-EVENT_EOOS	0_PRE-EVENT_EOOS	0_PRE-EVENT_EOOS
	0_IE_SET	0_IE_SET	0_IE_SET
	0_BASE	0_D11-2_EVENT_REC0	0_D11-2_EVENT_REC1

Attachment 08: Cutsets

Top 100 cut sets

Project : PSAR2C(D11-2)

End State: 0_LOMC_D11-2_REC0

Min Cut Upper Bound: 6.445E-006

This Partition: 3.426E-006

Table A08-1: Top 100 Cutsets

Cut No.	% Total	% Cut Set	Prob.	Basic Event	Description	Event Prob.
1	17.15	17.15	1.11E-06	IE_LOMC		1.00E+00
				MTC2	PERCENTAGE OF TIME W/MTC NOT SUFFICIENTLY POSITIVE	2.30E-01
				/RVO	Pressurizer Safeties Open	9.99E-01
				RXC-ELEC-FAULTS	Electrical Scram Signal Faults	4.81E-06
2	25.28	8.13	5.24E-07	IE_LOMC		1.00E+00
				G-PMOE-P-55ABC	OPERATOR FAILS TO INITIATE CHARGING FLOW	1.10E-01
				/RVC	Pressurizer Safeties Closed	9.91E-01
				/RVO	Pressurizer Safeties Open	9.99E-01
				RXC-ELEC-FAULTS	Electrical Scram Signal Faults	4.81E-06
3	27.73	2.45	1.58E-07	IE_LOMC		1.00E+00
				A-PMCC-P8ABC-ME	COMMON CAUSE FAILURE OF ALL 3 AFW PUMPS P-8A/B/C TO START	5.45E-05
				H-ZZOA-OTC-INIT	OPERATOR FAILS TO INITIATE ONCE THROUGH COOLING	2.90E-03

Table A08-1: Top 100 Cutsets

Cut No.	% Total	% Cut Set	Prob.	Basic Event	Description	Event Prob.
4	29.14	1.41	9.06E-08	IE_LOMC		1.00E+00
				G-PMOE-P-55ABC	OPERATOR FAILS TO INITIATE CHARGING FLOW	1.10E-01
				/RVC	Pressurizer Safeties Closed	9.91E-01
				/RVO	Pressurizer Safeties Open	9.99E-01
				/RXC-ELEC-FAULTS	Electrical Scram Signal Faults	1.00E+00
				RXC-MECH-FAULTS	Mechanical Scram Faults	8.40E-07
				/TTF	Turbine Trip	9.90E-01
5	30.21	1.07	6.90E-08	IE_LOMC		1.00E+00
				A-AVOA-MISCALADJ	OPERATOR FAILS TO ADJUST AFW FLOW GIVEN FLOW INSTRUMENT MISC	1.45E-03
				A-ISOH-AFW-HDR3	MISCALIBRATION OF ALL FLOW INSTRUMENTS ON ALL HEADERS	1.30E-04
				H-ZZOA-OTC-CDTNL-HEP-2	COND HEP: A-AVOA-AFWFLADJ * B-XVOB-ADVS-MAN * H-ZZOA-OTC-INIT	3.66E-01
6	30.85	0.64	4.14E-08	IE_LOMC		1.00E+00
				RVC	Pressurizer Safeties Closed	8.61E-03
				/RVO	Pressurizer Safeties Open	9.99E-01
				RXC-ELEC-FAULTS	Electrical Scram Signal Faults	4.81E-06
7	31.48	0.63	4.06E-08	IE_LOMC		1.00E+00
				A-PMCC-P8ABC-ME	COMMON CAUSE FAILURE OF ALL 3 AFW PUMPS P-8A/B/C TO START	5.45E-05
				B-XVOB-ADVS-MAN	OPERATOR FAILS TO CLOSE MANUAL VALVES TO CLOSE ADV	4.03E-02
				H-ZZOA-OTC-CDTNL-HEP-4	COND HEP: B-XVOB-ADVS-MAN * H-ZZOA-OTC-INIT	1.85E-02
8	32.01	0.53	3.43E-08	IE_LOMC		1.00E+00
				B-RVMB-SRV-SGB	ONE SAFETY RELIEF VALVE ON SG B FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00

Table A08-1: Top 100 Cutsets

Cut No.	% Total	% Cut Set	Prob.	Basic Event	Description	Event Prob.
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01
				O-RVMA-PRV-1043B	PRV-1043B POWER OPERATED RELIEF VALVE FAILS TO OPEN	9.29E-03
				X-HSE-SGB-BLDN	SET TO 'T' - ESDE ON SG E-50B (House Event)	1.00E+00
9	32.54	0.53	3.43E-08	IE_LOMC		1.00E+00
				B-RVMB-SRV-SGA	ONE SAFETY RELIEF VALVE ON SG A FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01
				O-RVMA-PRV-1043B	PRV-1043B POWER OPERATED RELIEF VALVE FAILS TO OPEN	9.29E-03
				X-HSE-SGA-BLDN	SET TO 'T' - ESDE ON SG E-50A (House Event)	1.00E+00
10	33.04	0.5	3.24E-08	IE_LOMC		1.00E+00
				A-PMCC-P8ABC-ME	COMMON CAUSE FAILURE OF ALL 3 AFW PUMPS P-8A/B/C TO START	5.45E-05
				O-RVCC-PORVS-MA	COMMON CAUSE FAILURE OF BOTH PORVS TO NOT OPEN	5.95E-04
11	33.53	0.49	3.17E-08	IE_LOMC		1.00E+00
				G-PMOA-TRIP-PUMP	Operator fails to trip charging pump(s) prior to challenging PZR SRVs	6.80E-03
				U-FLCC-BS-1318&19&20-PLU	CCFAIL OF SWS DISCHARGE BASKET STRAINERS 1318 & 1319 & 1320 PLUGGING	4.66E-06
12	34.01	0.48	3.09E-08	IE_LOMC		1.00E+00
				A-CVCC-AFWPP3-MA	ALL 3 AFW PP CK VALVES CK-FW726	1.07E-05

Table A08-1: Top 100 Cutsets

Cut No.	% Total	% Cut Set	Prob.	Basic Event	Description	Event Prob.
				H-ZZOA-OTC-INIT	OPERATOR FAILS TO INITIATE ONCE THROUGH COOLING	2.90E-03
13	34.47	0.46	2.97E-08	IE_LOMC		1.00E+00
				A-PMMG-P-8B	AFW TURBINE PUMP P-8B FAILS TO RUN	5.82E-02
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				Y-PMCC-P8C66ABME	COMMON CAUSE FAILURE OF P-8C	5.10E-05
14	34.92	0.45	2.89E-08	IE_LOMC		1.00E+00
				A-AVOA-MISCALADJ	OPERATOR FAILS TO ADJUST AFW FLOW GIVEN FLOW INSTRUMENT MISC	1.45E-03
				A-PMCC-P8ABC-ME	COMMON CAUSE FAILURE OF ALL 3 AFW PUMPS P-8A/B/C TO START	5.45E-05
				H-ZZOA-OTC-CDTNL-HEP-2	COND HEP: A-AVOA-AFWFLADJ * B-XVOB-ADVS-MAN * H-ZZOA-OTC-INIT	3.66E-01
15	35.37	0.45	2.89E-08	IE_LOMC		1.00E+00
				A-AVOA-AFWFLADJ	OPERATOR FAILS TO ADJUST AFW FLOW GIVEN FAILURE OF ONE HDR	1.45E-03
				A-PMCC-P8ABC-ME	COMMON CAUSE FAILURE OF ALL 3 AFW PUMPS P-8A/B/C TO START	5.45E-05
				H-ZZOA-OTC-CDTNL-HEP-2	COND HEP: A-AVOA-AFWFLADJ * B-XVOB-ADVS-MAN * H-ZZOA-OTC-INIT	3.66E-01
16	35.76	0.39	2.51E-08	IE_LOMC		1.00E+00
				A-CVCC-AFWINJ-MA	ALL 4 AFW INJ CHECK VALVES FTO DUE TO COMMON CAUSE	8.65E-06
				H-ZZOA-OTC-INIT	OPERATOR FAILS TO INITIATE ONCE THROUGH COOLING	2.90E-03
17	36.14	0.38	2.45E-08	IE_LOMC		1.00E+00
				A-AVOA-MISCALADJ	OPERATOR FAILS TO ADJUST AFW FLOW GIVEN FLOW INSTRUMENT MISC	1.45E-03
				A-ISOH-AFW-HDR3	MISCALIBRATION OF ALL FLOW INSTRUMENTS ON ALL HEADERS	1.30E-04

Table A08-1: Top 100 Cutsets

Cut No.	% Total	% Cut Set	Prob.	Basic Event	Description	Event Prob.
				H-ZZOA-OTC-CDTNL-HEP-3	COND HEP: A-AVOA-MISCALADJ * M-OOOT-LPF-INIT * H-ZZOA-OTC-INIT	5.44E-01
				M-OOOT-LPF-CDTNL-HEP-1	COND HEP: A-AVOA-MISCALADJ * M-OOOT-LPF-INIT * H-AVOA-HPISUBCLG	2.39E-01
18	36.52	0.38	2.42E-08	IE_LOMC		1.00E+00
				A-PMCC-P8ABC-ME	COMMON CAUSE FAILURE OF ALL 3 AFW PUMPS P-8A/B/C TO START	5.45E-05
				Y-AVMD-CV-3056	AIR OPERATED VALVE CV-3056 FAILS TO REMAIN OPEN	4.44E-04
19	36.9	0.38	2.42E-08	IE_LOMC		1.00E+00
				A-PMCC-P8ABC-ME	COMMON CAUSE FAILURE OF ALL 3 AFW PUMPS P-8A/B/C TO START	5.45E-05
				Y-AVMD-CV-3027	AIR OPERATED VALVE CV-3027 FAILS TO REMAIN OPEN	4.44E-04
20	37.26	0.36	2.34E-08	IE_LOMC		1.00E+00
				A-AVCC-AFW-4-MA	ALL 4 AFW AOV'S CCAUSE FTO CV-0727/CV-0736/CV-0736A/CV-0749	8.06E-06
				H-ZZOA-OTC-INIT	OPERATOR FAILS TO INITIATE ONCE THROUGH COOLING	2.90E-03
21	37.6	0.34	2.20E-08	IE_LOMC		1.00E+00
				A-PMMG-P-8B	AFW TURBINE PUMP P-8B FAILS TO RUN	5.82E-02
				A-PSOH-AFWLOSUC	MISCALIBRATION OF ALL AFW LOW SUCTION PRESSURE SWITCHES	1.30E-04
				H-ZZOA-OTC-INIT	OPERATOR FAILS TO INITIATE ONCE THROUGH COOLING	2.90E-03
22	37.93	0.33	2.16E-08	IE_LOMC		1.00E+00
				B-RVMB-SRV-SGB	ONE SAFETY RELIEF VALVE ON SG B FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01

Table A08-1: Top 100 Cutsets

Cut No.	% Total	% Cut Set	Prob.	Basic Event	Description	Event Prob.
				O-MVMA-MO-1043A	MOTOR OPERATED VALVE MO-1043A FAILS TO OPEN	5.85E-03
				X-HSE-SGB-BLDN	SET TO 'T' - ESDE ON SG E-50B (House Event)	1.00E+00
23	38.26	0.33	2.16E-08	IE_LOMC		1.00E+00
				B-RVMB-SRV-SGA	ONE SAFETY RELIEF VALVE ON SG A FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01
				O-MVMA-MO-1043A	MOTOR OPERATED VALVE MO-1043A FAILS TO OPEN	5.85E-03
				X-HSE-SGA-BLDN	SET TO 'T' - ESDE ON SG E-50A (House Event)	1.00E+00
24	38.59	0.33	2.12E-08	IE_LOMC		1.00E+00
				A-OOOT-CSTMK-CDTNL-HEP-2	COND HEP: L-ZZOA-SDC-INIT * A-OOOT-CSTMKUP * P-CBOB-BUS1E	1.43E-01
				A-PMME-P-936	P-936 FAILS TO START	3.29E-03
				H-ZZOA-OTC-INIT	OPERATOR FAILS TO INITIATE ONCE THROUGH COOLING	2.90E-03
				L-ZZOA-SDC-INIT	OPERATOR FAILS TO INITIATE SDC	1.55E-02
25	38.89	0.3	1.96E-08	IE_LOMC		1.00E+00
				A-AVOA-AFWFLADJ	OPERATOR FAILS TO ADJUST AFW FLOW GIVEN FAILURE OF ONE HDR	1.45E-03
				B-RVMB-SRV-SGA	ONE SAFETY RELIEF VALVE ON SG A FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				H-ZZOA-OTC-CDTNL-HEP-2	COND HEP: A-AVOA-AFWFLADJ * B-XVOB-ADVS-MAN * H-ZZOA-OTC-INIT	3.66E-01

Table A08-1: Top 100 Cutsets

Cut No.	% Total	% Cut Set	Prob.	Basic Event	Description	Event Prob.
				X-HSE-SGA-BLDN	SET TO 'T' - ESDE ON SG E-50A (House Event)	1.00E+00
26	39.19	0.3	1.96E-08	IE_LOMC		1.00E+00
				A-AVOA-AFWFLADJ	OPERATOR FAILS TO ADJUST AFW FLOW GIVEN FAILURE OF ONE HDR	1.45E-03
				B-RVMB-SRV-SGB	ONE SAFETY RELIEF VALVE ON SG B FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				H-ZZOA-OTC-CDTNL-HEP-2	COND HEP: A-AVOA-AFWFLADJ * B-XVOB-ADVS-MAN * H-ZZOA-OTC-INIT	3.66E-01
				X-HSE-SGB-BLDN	SET TO 'T' - ESDE ON SG E-50B (House Event)	1.00E+00
27	39.48	0.29	1.89E-08	IE_LOMC		1.00E+00
				A-PMCC-P8ABC-MG	COMMON CAUSE FAILURE OF ALL 3 AFW PUMPS P-8A/B/C TO RUN	6.53E-06
				H-ZZOA-OTC-INIT	OPERATOR FAILS TO INITIATE ONCE THROUGH COOLING	2.90E-03
28	39.77	0.29	1.87E-08	IE_LOMC		1.00E+00
				G-PMOA-TRIP-PUMP	Operator fails to trip charging pump(s) prior to challenging PZR SRVs	6.80E-03
				U-FLCC-TRAV-SCRN	COMMON CAUSE FAILURE OF TRAVELING SCREENS	2.75E-06
29	40.05	0.28	1.81E-08	IE_LOMC		1.00E+00
				A-PMMG-P-8B	AFW TURBINE PUMP P-8B FAILS TO RUN	5.82E-02
				A-PMOO-P-8C	AFW PUMP P-8C OUT OF SERVICE	3.35E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				O-RVMA-PRV-1043B	PRV-1043B POWER OPERATED RELIEF VALVE FAILS TO OPEN	9.29E-03

Table A08-1: Top 100 Cutsets						
Cut No.	% Total	% Cut Set	Prob.	Basic Event	Description	Event Prob.
30	40.33	0.28	1.78E-08	IE_LOMC		1.00E+00
				G-PMOA-TRIP-PUMP	Operator fails to trip charging pump(s) prior to challenging PZR SRVs	6.80E-03
				U-PMCC-P-7ABC-MG	P-7A & P-7B & P-7C FAIL TO RUN DUE TO COMMON CAUSE	2.61E-06
31	40.59	0.26	1.67E-08	IE_LOMC		1.00E+00
				A-OOOT-CSTMK-CDTNL-HEP-2	COND HEP: L-ZZOA-SDC-INIT * A-OOOT-CSTMKUP * P-CBOB-BUS1E	1.43E-01
				H-ZZOA-OTC-INIT	OPERATOR FAILS TO INITIATE ONCE THROUGH COOLING	2.90E-03
				L-ZZOA-SDC-INIT	OPERATOR FAILS TO INITIATE SDC	1.55E-02
				P-B1MK-EA-13	FAULT ON BUS 1E	2.60E-03
32	40.85	0.26	1.66E-08	IE_LOMC		1.00E+00
				MTC1	PERCENTAGE OF TIME W/MTC NOT SUFFICIENTLY POSITIVE	2.00E-02
				/RVO	Pressurizer Safeties Open	9.99E-01
				/RXC-ELEC-FAULTS	Electrical Scram Signal Faults	1.00E+00
				RXC-MECH-FAULTS	Mechanical Scram Faults	8.40E-07
				/TTF	Turbine Trip	9.90E-01
33	41.1	0.25	1.64E-08	IE_LOMC		1.00E+00
				G-PMOA-TRIP-PUMP	Operator fails to trip charging pump(s) prior to challenging PZR SRVs	6.80E-03
				P-PAMK-EY-30	FAULT ON 120V PREFERRED AC BUS Y30	1.00E-01
				R-REMD-TX-4	RELAY TX-4 FAILS TO REMAIN DE-ENERGIZED	6.52E-03
				W-RVMB-RV-1039	PZR SAFETY VALVE RV-1039 FTC (GIVEN SPURIOUS DEMAND)	3.69E-03
34	41.35	0.25	1.64E-08	IE_LOMC		1.00E+00
				G-PMOA-TRIP-PUMP	Operator fails to trip charging pump(s) prior to challenging PZR SRVs	6.80E-03
				P-PAMK-EY-30	FAULT ON 120V PREFERRED AC BUS Y30	1.00E-01

Table A08-1: Top 100 Cutsets

Cut No.	% Total	% Cut Set	Prob.	Basic Event	Description	Event Prob.
				R-REMD-TVX-4	RELAY TVX-4 FAILS TO REMAIN DE-ENERGIZED	6.52E-03
				W-RVMB-RV-1039	PZR SAFETY VALVE RV-1039 FTC (GIVEN SPURIOUS DEMAND)	3.69E-03
35	41.6	0.25	1.64E-08	IE_LOMC		1.00E+00
				G-PMOA-TRIP-PUMP	Operator fails to trip charging pump(s) prior to challenging PZR SRVs	6.80E-03
				P-PAMK-EY-30	FAULT ON 120V PREFERRED AC BUS Y30	1.00E-01
				R-REMD-TX-4	RELAY TX-4 FAILS TO REMAIN DE-ENERGIZED	6.52E-03
				W-RVMB-RV-1040	PZR SAFETY VALVE RV-1040 FTC (GIVEN SPURIOUS DEMAND)	3.69E-03
36	41.85	0.25	1.64E-08	IE_LOMC		1.00E+00
				G-PMOA-TRIP-PUMP	Operator fails to trip charging pump(s) prior to challenging PZR SRVs	6.80E-03
				P-PAMK-EY-30	FAULT ON 120V PREFERRED AC BUS Y30	1.00E-01
				R-REMD-TVX-4	RELAY TVX-4 FAILS TO REMAIN DE-ENERGIZED	6.52E-03
				W-RVMB-RV-1040	PZR SAFETY VALVE RV-1040 FTC (GIVEN SPURIOUS DEMAND)	3.69E-03
37	42.1	0.25	1.64E-08	IE_LOMC		1.00E+00
				G-PMOA-TRIP-PUMP	Operator fails to trip charging pump(s) prior to challenging PZR SRVs	6.80E-03
				P-PAMK-EY-30	FAULT ON 120V PREFERRED AC BUS Y30	1.00E-01
				R-REMD-TX-4	RELAY TX-4 FAILS TO REMAIN DE-ENERGIZED	6.52E-03
				W-RVMB-RV-1041	PZR SAFETY VALVE RV-1041 FTC (GIVEN SPURIOUS DEMAND)	3.69E-03
38	42.35	0.25	1.64E-08	IE_LOMC		1.00E+00
				G-PMOA-TRIP-PUMP	Operator fails to trip charging pump(s) prior to challenging PZR SRVs	6.80E-03
				P-PAMK-EY-30	FAULT ON 120V PREFERRED AC BUS Y30	1.00E-01
				R-REMD-TVX-4	RELAY TVX-4 FAILS TO REMAIN DE-ENERGIZED	6.52E-03

Table A08-1: Top 100 Cutsets

Cut No.	% Total	% Cut Set	Prob.	Basic Event	Description	Event Prob.
				W-RVMB-RV-1041	PZR SAFETY VALVE RV-1041 FTC (GIVEN SPURIOUS DEMAND)	3.69E-03
39	42.6	0.25	1.63E-08	IE_LOMC		1.00E+00
				B-RVMB-SRV-SGB	ONE SAFETY RELIEF VALVE ON SG B FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01
				X-HSE-SGB-BLDN	SET TO 'T' - ESDE ON SG E-50B (House Event)	1.00E+00
				Y-AVMB-CV-3056	SIRWT RECIRC VALVE CV-3056 FTC	4.42E-03
40	42.85	0.25	1.63E-08	IE_LOMC		1.00E+00
				B-RVMB-SRV-SGA	ONE SAFETY RELIEF VALVE ON SG A FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01
				X-HSE-SGA-BLDN	SET TO 'T' - ESDE ON SG E-50A (House Event)	1.00E+00
				Y-AVMB-CV-3056	SIRWT RECIRC VALVE CV-3056 FTC	4.42E-03
41	43.07	0.22	1.45E-08	IE_LOMC		1.00E+00
				B-RVMB-SRV-SGA	ONE SAFETY RELIEF VALVE ON SG A FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01

Table A08-1: Top 100 Cutsets

Cut No.	% Total	% Cut Set	Prob.	Basic Event	Description	Event Prob.
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01
				X-HSE-SGA-BLDN	SET TO 'T' - ESDE ON SG E-50A (House Event)	1.00E+00
				Y-KVMB-SV-3056B	SIRWT RECIRC VALVE SOLENOID SV-3056B FTE	3.93E-03
42	43.29	0.22	1.45E-08	IE_LOMC		1.00E+00
				B-RVMB-SRV-SGB	ONE SAFETY RELIEF VALVE ON SG B FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01
				X-HSE-SGB-BLDN	SET TO 'T' - ESDE ON SG E-50B (House Event)	1.00E+00
				Y-KVMB-SV-3056B	SIRWT RECIRC VALVE SOLENOID SV-3056B FTE	3.93E-03
43	43.51	0.22	1.45E-08	IE_LOMC		1.00E+00
				B-RVMB-SRV-SGA	ONE SAFETY RELIEF VALVE ON SG A FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01
				X-HSE-SGA-BLDN	SET TO 'T' - ESDE ON SG E-50A (House Event)	1.00E+00
				Z-KVMB-SV-3029A	SUMP TO EAST ESS AIR SUPPLY SV-3029A FTE	3.93E-03
44	43.73	0.22	1.45E-08	IE_LOMC		1.00E+00
				B-RVMB-SRV-SGB	ONE SAFETY RELIEF VALVE ON SG B FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00

Table A08-1: Top 100 Cutsets

Cut No.	% Total	% Cut Set	Prob.	Basic Event	Description	Event Prob.
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01
				X-HSE-SGB-BLDN	SET TO 'T' - ESDE ON SG E-50B (House Event)	1.00E+00
				Z-KVMB-SV-3029B	SUMP TO EAST ESS AIR SUPPLY SV-3029B FTE	3.93E-03
45	43.95	0.22	1.45E-08	IE_LOMC		1.00E+00
				B-RVMB-SRV-SGA	ONE SAFETY RELIEF VALVE ON SG A FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01
				X-HSE-SGA-BLDN	SET TO 'T' - ESDE ON SG E-50A (House Event)	1.00E+00
				Z-KVMB-SV-3029B	SUMP TO EAST ESS AIR SUPPLY SV-3029B FTE	3.93E-03
46	44.17	0.22	1.45E-08	IE_LOMC		1.00E+00
				B-RVMB-SRV-SGB	ONE SAFETY RELIEF VALVE ON SG B FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01
				X-HSE-SGB-BLDN	SET TO 'T' - ESDE ON SG E-50B (House Event)	1.00E+00
				Z-KVMB-SV-3029A	SUMP TO EAST ESS AIR SUPPLY SV-3029A FTE	3.93E-03
47	44.39	0.22	1.45E-08	IE_LOMC		1.00E+00

Table A08-1: Top 100 Cutsets						
Cut No.	% Total	% Cut Set	Prob.	Basic Event	Description	Event Prob.
				B-RVMB-SRV-SGB	ONE SAFETY RELIEF VALVE ON SG B FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01
				X-HSE-SGB-BLDN	SET TO 'T' - ESDE ON SG E-50B (House Event)	1.00E+00
				Y-KVMB-SV-3056A	SIRWT RECIRC VALVE SOLENOID SV-3056A FTE	3.93E-03
48	44.61	0.22	1.45E-08	IE_LOMC		1.00E+00
				B-RVMB-SRV-SGA	ONE SAFETY RELIEF VALVE ON SG A FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01
				X-HSE-SGA-BLDN	SET TO 'T' - ESDE ON SG E-50A (House Event)	1.00E+00
				Y-KVMB-SV-3056A	SIRWT RECIRC VALVE SOLENOID SV-3056A FTE	3.93E-03
49	44.83	0.22	1.42E-08	IE_LOMC		1.00E+00
				A-PMCC-P8ABC-ME	COMMON CAUSE FAILURE OF ALL 3 AFW PUMPS P-8A/B/C TO START	5.45E-05
				Y-AVOB-RAS-VLVS	OPERATOR FAILS TO ENABLE ESS RECIRC VALVES TO CLOSE ON RAS	2.60E-04
50	45.05	0.22	1.40E-08	IE_LOMC		1.00E+00
				A-PMMG-P-8B	AFW TURBINE PUMP P-8B FAILS TO RUN	5.82E-02
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01

Table A08-1: Top 100 Cutsets						
Cut No.	% Total	% Cut Set	Prob.	Basic Event	Description	Event Prob.
				P-B1MK-EA-12	FAULT ON BUS 1D	2.40E-06
51	45.27	0.22	1.40E-08	IE_LOMC		1.00E+00
				A-PMMG-P-8B	AFW TURBINE PUMP P-8B FAILS TO RUN	5.82E-02
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				P-REMD-127-8-X1	RELAY 127-8-X1 FAILS TO REMAIN DE-ENERGIZED	2.40E-05
52	45.49	0.22	1.40E-08	IE_LOMC		1.00E+00
				A-PMMG-P-8B	AFW TURBINE PUMP P-8B FAILS TO RUN	5.82E-02
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				P-REMD-127-2-X2	RELAY 127-2-X2 FAILS TO REMAIN DE-ENERIZED	2.40E-05
53	45.71	0.22	1.40E-08	IE_LOMC		1.00E+00
				A-PMMG-P-8B	AFW TURBINE PUMP P-8B FAILS TO RUN	5.82E-02
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				P-REMD-162-154	RELAY 162-154 FAILS TO REMAIN DE-ENERGIZED	2.40E-05
54	45.93	0.22	1.40E-08	IE_LOMC		1.00E+00
				A-PMMG-P-8B	AFW TURBINE PUMP P-8B FAILS TO RUN	5.82E-02
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01

Table A08-1: Top 100 Cutsets

Cut No.	% Total	% Cut Set	Prob.	Basic Event	Description	Event Prob.
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				P-REMD-162-154X1	RELAY 162-154-X1 FAILS TO REMAIN DE-ENERGIZED	2.40E-05
55	46.15	0.22	1.40E-08	IE_LOMC		1.00E+00
				A-PMMG-P-8B	AFW TURBINE PUMP P-8B FAILS TO RUN	5.82E-02
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				R-REMD-194-211	LOAD SHED RELAY 194-211 FTRD	2.40E-05
56	46.36	0.21	1.34E-08	IE_LOMC		1.00E+00
				A-PMMG-P-8B	AFW TURBINE PUMP P-8B FAILS TO RUN	5.82E-02
				A-PMOO-P-8A	AFW PUMP P-8A OUT OF SERVICE	4.52E-03
				Y-PMCC-P8C66ABME	COMMON CAUSE FAILURE OF P-8C	5.10E-05
57	46.56	0.2	1.29E-08	IE_LOMC		1.00E+00
				A-PMMG-P-8B	AFW TURBINE PUMP P-8B FAILS TO RUN	5.82E-02
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-FUMK-D028-1	FUSE (FUZ/D028-1) TO PANEL D21A FAILED OPEN	2.21E-05
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
58	46.75	0.19	1.23E-08	IE_LOMC		1.00E+00
				A-REMA-SSX-3P8AB	AFW A/B INJECTION VALVES OPEN RELAY SSX-3/P8A/B FTD	2.41E-04
				Y-PMCC-P8C66ABME	COMMON CAUSE FAILURE OF P-8C	5.10E-05
59	46.94	0.19	1.20E-08	IE_LOMC		1.00E+00
				A-AVOA-CV-2010	OPERATOR FAILS TO OPEN CV-2010 FOR T-939 MAKEUP TO CST	2.59E-03

Table A08-1: Top 100 Cutsets

Cut No.	% Total	% Cut Set	Prob.	Basic Event	Description	Event Prob.
				A-OOOT-CSTMK-CDTNL-HEP-1	COND HEP: A-AVOA-CV-2010 * A-OOOT-CSTMKUP * Y-AVOB-RAS-VLVS	4.99E-01
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01
				O-RVMA-PRV-1043B	PRV-1043B POWER OPERATED RELIEF VALVE FAILS TO OPEN	9.29E-03
60	47.12	0.18	1.17E-08	IE_LOMC		1.00E+00
				B-RVMB-SRV-SGB	ONE SAFETY RELIEF VALVE ON SG B FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01
				O-LMMC-HS-1043A	LIMIT SWITCH POS-L FAILS TO REMAIN CLOSED	3.17E-03
				X-HSE-SGB-BLDN	SET TO 'T' - ESDE ON SG E-50B (House Event)	1.00E+00
61	47.3	0.18	1.17E-08	IE_LOMC		1.00E+00
				B-RVMB-SRV-SGA	ONE SAFETY RELIEF VALVE ON SG A FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01
				O-LMMC-HS-1043A	LIMIT SWITCH POS-L FAILS TO REMAIN CLOSED	3.17E-03
				X-HSE-SGA-BLDN	SET TO 'T' - ESDE ON SG E-50A (House Event)	1.00E+00

Table A08-1: Top 100 Cutsets

Cut No.	% Total	% Cut Set	Prob.	Basic Event	Description	Event Prob.
62	47.48	0.18	1.14E-08	IE_LOMC		1.00E+00
				A-PMMG-P-8B	AFW TURBINE PUMP P-8B FAILS TO RUN	5.82E-02
				A-PMOO-P-8C	AFW PUMP P-8C OUT OF SERVICE	3.35E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				O-MVMA-MO-1043A	MOTOR OPERATED VALVE MO-1043A FAILS TO OPEN	5.85E-03
63	47.65	0.17	1.13E-08	IE_LOMC		1.00E+00
				A-FLMK-F-P936	P-936 SUCTION STRAINER PLUGS	1.76E-03
				A-OOOT-CSTMK-CDTNL-HEP-2	COND HEP: L-ZZOA-SDC-INIT * A-OOOT-CSTMKUP * P-CBOB-BUS1E	1.43E-01
				H-ZZOA-OTC-INIT	OPERATOR FAILS TO INITIATE ONCE THROUGH COOLING	2.90E-03
				L-ZZOA-SDC-INIT	OPERATOR FAILS TO INITIATE SDC	1.55E-02
64	47.82	0.17	1.11E-08	IE_LOMC		1.00E+00
				G-PMOA-TRIP-PUMP	Operator fails to trip charging pump(s) prior to challenging PZR SRVs	6.80E-03
				W-RVMB-RV-1041	PZR SAFETY VALVE RV-1041 FTC (GIVEN SPURIOUS DEMAND)	3.69E-03
				Y-AVMD-CV-3056	AIR OPERATED VALVE CV-3056 FAILS TO REMAIN OPEN	4.44E-04
65	47.99	0.17	1.11E-08	IE_LOMC		1.00E+00
				G-PMOA-TRIP-PUMP	Operator fails to trip charging pump(s) prior to challenging PZR SRVs	6.80E-03
				W-RVMB-RV-1040	PZR SAFETY VALVE RV-1040 FTC (GIVEN SPURIOUS DEMAND)	3.69E-03
				Y-AVMD-CV-3056	AIR OPERATED VALVE CV-3056 FAILS TO REMAIN OPEN	4.44E-04
66	48.16	0.17	1.11E-08	IE_LOMC		1.00E+00
				G-PMOA-TRIP-PUMP	Operator fails to trip charging pump(s) prior to challenging PZR SRVs	6.80E-03

Table A08-1: Top 100 Cutsets

Cut No.	% Total	% Cut Set	Prob.	Basic Event	Description	Event Prob.
				W-RVMB-RV-1039	PZR SAFETY VALVE RV-1039 FTC (GIVEN SPURIOUS DEMAND)	3.69E-03
				Y-AVMD-CV-3056	AIR OPERATED VALVE CV-3056 FAILS TO REMAIN OPEN	4.44E-04
67	48.33	0.17	1.11E-08	IE_LOMC		1.00E+00
				G-PMOA-TRIP-PUMP	Operator fails to trip charging pump(s) prior to challenging PZR SRVs	6.80E-03
				W-RVMB-RV-1041	PZR SAFETY VALVE RV-1041 FTC (GIVEN SPURIOUS DEMAND)	3.69E-03
				Y-AVMD-CV-3027	AIR OPERATED VALVE CV-3027 FAILS TO REMAIN OPEN	4.44E-04
68	48.5	0.17	1.11E-08	IE_LOMC		1.00E+00
				G-PMOA-TRIP-PUMP	Operator fails to trip charging pump(s) prior to challenging PZR SRVs	6.80E-03
				W-RVMB-RV-1040	PZR SAFETY VALVE RV-1040 FTC (GIVEN SPURIOUS DEMAND)	3.69E-03
				Y-AVMD-CV-3027	AIR OPERATED VALVE CV-3027 FAILS TO REMAIN OPEN	4.44E-04
69	48.67	0.17	1.11E-08	IE_LOMC		1.00E+00
				G-PMOA-TRIP-PUMP	Operator fails to trip charging pump(s) prior to challenging PZR SRVs	6.80E-03
				W-RVMB-RV-1039	PZR SAFETY VALVE RV-1039 FTC (GIVEN SPURIOUS DEMAND)	3.69E-03
				Y-AVMD-CV-3027	AIR OPERATED VALVE CV-3027 FAILS TO REMAIN OPEN	4.44E-04
70	48.84	0.17	1.11E-08	IE_LOMC		1.00E+00
				B-RVMB-SRV-SGB	ONE SAFETY RELIEF VALVE ON SG B FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01
				O-OLMK-49-2625	THERMAL FUSE 49-2625 FAILS OPEN	3.01E-03

Table A08-1: Top 100 Cutsets

Cut No.	% Total	% Cut Set	Prob.	Basic Event	Description	Event Prob.
				X-HSE-SGB-BLDN	SET TO 'T' - ESDE ON SG E-50B (House Event)	1.00E+00
71	49.01	0.17	1.11E-08	IE_LOMC		1.00E+00
				B-RVMB-SRV-SGA	ONE SAFETY RELIEF VALVE ON SG A FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01
				O-OLMK-49-2625	THERMAL FUSE 49-2625 FAILS OPEN	3.01E-03
				X-HSE-SGA-BLDN	SET TO 'T' - ESDE ON SG E-50A (House Event)	1.00E+00
72	49.18	0.17	1.10E-08	IE_LOMC		1.00E+00
				B-RVMB-SRV-SGA	ONE SAFETY RELIEF VALVE ON SG A FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01
				X-HSE-SGA-BLDN	SET TO 'T' - ESDE ON SG E-50A (House Event)	1.00E+00
				Z-AVMA-CV-3029	CV-3029 AIR VALVE FAILS TO OPEN	2.99E-03
73	49.35	0.17	1.10E-08	IE_LOMC		1.00E+00
				B-RVMB-SRV-SGB	ONE SAFETY RELIEF VALVE ON SG B FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING	1.00E-01

Table A08-1: Top 100 Cutsets						
Cut No.	% Total	% Cut Set	Prob.	Basic Event	Description	Event Prob.
					VALUE)	
				X-HSE-SGB-BLDN	SET TO 'T' - ESDE ON SG E-50B (House Event)	1.00E+00
				Z-AVMA-CV-3029	CV-3029 AIR VALVE FAILS TO OPEN	2.99E-03
74	49.52	0.17	1.07E-08	IE_LOMC		1.00E+00
				B-RVMB-SRV-SGB	ONE SAFETY RELIEF VALVE ON SG B FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				H-ZZOA-OTC-INIT	OPERATOR FAILS TO INITIATE ONCE THROUGH COOLING	2.90E-03
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01
				X-HSE-SGB-BLDN	SET TO 'T' - ESDE ON SG E-50B (House Event)	1.00E+00
75	49.69	0.17	1.07E-08	IE_LOMC		1.00E+00
				B-RVMB-SRV-SGA	ONE SAFETY RELIEF VALVE ON SG A FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				H-ZZOA-OTC-INIT	OPERATOR FAILS TO INITIATE ONCE THROUGH COOLING	2.90E-03
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01
				X-HSE-SGA-BLDN	SET TO 'T' - ESDE ON SG E-50A (House Event)	1.00E+00
76	49.85	0.16	1.05E-08	IE_LOMC		1.00E+00
				A-PMMG-P-8B	AFW TURBINE PUMP P-8B FAILS TO RUN	5.82E-02
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01

Table A08-1: Top 100 Cutsets

Cut No.	% Total	% Cut Set	Prob.	Basic Event	Description	Event Prob.
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				Y-PMCC-P8C66A-ME	COMMON CAUSE FAILURE OF P-8C AND P-66A TO START	1.81E-05
77	50.01	0.16	1.03E-08	IE_LOMC		1.00E+00
				A-AVOA-MISCALADJ	OPERATOR FAILS TO ADJUST AFW FLOW GIVEN FLOW INSTRUMENT MISC	1.45E-03
				A-PMCC-P8ABC-ME	COMMON CAUSE FAILURE OF ALL 3 AFW PUMPS P-8A/B/C TO START	5.45E-05
				H-ZZOA-OTC-CDTNL-HEP-3	COND HEP: A-AVOA-MISCALADJ * M-OOOT-LPF-INIT * H-ZZOA-OTC-INIT	5.44E-01
				M-OOOT-LPF-CDTNL-HEP-1	COND HEP: A-AVOA-MISCALADJ * M-OOOT-LPF-INIT * H-AVOA-HPISUBCLG	2.39E-01
78	50.17	0.16	9.99E-09	IE_LOMC		1.00E+00
				B-RVMB-SRV-SGB	ONE SAFETY RELIEF VALVE ON SG B FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01
				O-C2MC-52-2625	CIRCUIT BREAKER 52-2625 (480V) FAILS TO REMAIN CLOSED	2.71E-03
				X-HSE-SGB-BLDN	SET TO 'T' - ESDE ON SG E-50B (House Event)	1.00E+00
79	50.33	0.16	9.99E-09	IE_LOMC		1.00E+00
				B-RVMB-SRV-SGA	ONE SAFETY RELIEF VALVE ON SG A FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01

Table A08-1: Top 100 Cutsets

Cut No.	% Total	% Cut Set	Prob.	Basic Event	Description	Event Prob.
				O-C2MC-52-2625	CIRCUIT BREAKER 52-2625 (480V) FAILS TO REMAIN CLOSED	2.71E-03
				X-HSE-SGA-BLDN	SET TO 'T' - ESDE ON SG E-50A (House Event)	1.00E+00
80	50.48	0.15	9.79E-09	IE_LOMC		1.00E+00
				A-PMMG-P-8B	AFW TURBINE PUMP P-8B FAILS TO RUN	5.82E-02
				P-PAMK-EY-10	FAULT ON 120V PREFERRED AC BUS Y10	3.30E-02
				P-PAMK-EY-30	FAULT ON 120V PREFERRED AC BUS Y30	1.00E-01
				Y-PMCC-P8C66ABME	COMMON CAUSE FAILURE OF P-8C	5.10E-05
81	50.63	0.15	9.69E-09	IE_LOMC		1.00E+00
				B-RVMB-SRV-SGB	ONE SAFETY RELIEF VALVE ON SG B FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				H-PMOO-P-66A	HPSI PUMP P-66A OUT OF SERVICE FOR MAINTENANCE	2.63E-03
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01
				X-HSE-SGB-BLDN	SET TO 'T' - ESDE ON SG E-50B (House Event)	1.00E+00
82	50.78	0.15	9.69E-09	IE_LOMC		1.00E+00
				B-RVMB-SRV-SGA	ONE SAFETY RELIEF VALVE ON SG A FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				H-PMOO-P-66A	HPSI PUMP P-66A OUT OF SERVICE FOR MAINTENANCE	2.63E-03
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01

Table A08-1: Top 100 Cutsets

Cut No.	% Total	% Cut Set	Prob.	Basic Event	Description	Event Prob.
				X-HSE-SGA-BLDN	SET TO 'T' - ESDE ON SG E-50A (House Event)	1.00E+00
83	50.92	0.14	9.27E-09	IE_LOMC		1.00E+00
				A-PMCC-P8ABC-ME	COMMON CAUSE FAILURE OF ALL 3 AFW PUMPS P-8A/B/C TO START	5.45E-05
				O-MVCC-BLKVLV-MA	COMMON CAUSE FAILURE OF BOTH ISOLATION VALVES TO OPEN	1.70E-04
84	51.06	0.14	9.05E-09	IE_LOMC		1.00E+00
				A-PMME-P-936	P-936 FAILS TO START	3.29E-03
				U-FLCC-TRAV-SCRN	COMMON CAUSE FAILURE OF TRAVELING SCREENS	2.75E-06
85	51.2	0.14	8.98E-09	IE_LOMC		1.00E+00
				A-PMMG-P-8B	AFW TURBINE PUMP P-8B FAILS TO RUN	5.82E-02
				E-DGCC-K-6A&B&NSR-MG	EDG1-1 EDG1-2 AND NSR COMMON CAUSE FAILURE TO RUN	3.44E-04
				E-HSE-EDG11-RUN	SET TO 'T' -EDG11 RUN FAILURES ARE MODELED (House Event)	1.00E+00
				E-HSE-EDG12-RUN	SET TO 'T' -EDG12 RUN FAILURES ARE MODELED (House Event)	1.00E+00
				P-LOOP-24HR	LOOP COINCIDENT WITH ANOTHER IEVENT (24 HR MISSION TIME)	4.48E-04
86	51.34	0.14	8.93E-09	IE_LOMC		1.00E+00
				A-PMME-P-8C	AFW PUMP P-8C FAILS TO START	1.65E-03
				A-PMMG-P-8B	AFW TURBINE PUMP P-8B FAILS TO RUN	5.82E-02
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				O-RVMA-PRV-1043B	PRV-1043B POWER OPERATED RELIEF VALVE FAILS TO OPEN	9.29E-03
87	51.48	0.14	8.71E-09	IE_LOMC		1.00E+00

Table A08-1: Top 100 Cutsets						
Cut No.	**% Total**	**% Cut Set**	**Prob.**	**Basic Event**	**Description**	**Event Prob.**
				A-C2MB-152-209	AFW PUMP P-8C CIRCUIT BREAKER 152-209 FAILS TO CLOSE	1.61E-03
				A-PMMG-P-8B	AFW TURBINE PUMP P-8B FAILS TO RUN	5.82E-02
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				O-RVMA-PRV-1043B	PRV-1043B POWER OPERATED RELIEF VALVE FAILS TO OPEN	9.29E-03
88	51.61	0.13	8.67E-09	IE_LOMC		1.00E+00
				A-PMMG-P-8B	AFW TURBINE PUMP P-8B FAILS TO RUN	5.82E-02
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-CBMC-72-403	DC CIRCUIT BREAKER 72-403 FAILS TO REMAIN CLOSED	1.49E-05
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
89	51.74	0.13	8.63E-09	IE_LOMC		1.00E+00
				A-PMMG-P-8B	AFW TURBINE PUMP P-8B FAILS TO RUN	5.82E-02
				A-PMOO-P-8C	AFW PUMP P-8C OUT OF SERVICE	3.35E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				Y-AVMB-CV-3056	SIRWT RECIRC VALVE CV-3056 FTC	4.42E-03
90	51.87	0.13	8.47E-09	IE_LOMC		1.00E+00
				B-HCMA-HIC-0780A	SDCR CONTROLLER HIC-0780A FAILS TO DE-ENERGIZE	1.14E-02
				B-XVOB-ADVS-MAN	OPERATOR FAILS TO CLOSE MANUAL VALVES TO CLOSE ADV	4.03E-02

Table A08-1: Top 100 Cutsets

Cut No.	% Total	% Cut Set	Prob.	Basic Event	Description	Event Prob.
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				H-ZZOA-OTC-CDTNL-HEP-4	COND HEP: B-XVOB-ADVS-MAN * H-ZZOA-OTC-INIT	1.85E-02
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01
				X-HSE-SGB-BLDN	SET TO 'T' - ESDE ON SG E-50B (House Event)	1.00E+00
91	52	0.13	8.47E-09	IE_LOMC		1.00E+00
				B-HCMA-HIC-0780A	SDCR CONTROLLER HIC-0780A FAILS TO DE-ENERGIZE	1.14E-02
				B-XVOB-ADVS-MAN	OPERATOR FAILS TO CLOSE MANUAL VALVES TO CLOSE ADV	4.03E-02
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				H-ZZOA-OTC-CDTNL-HEP-4	COND HEP: B-XVOB-ADVS-MAN * H-ZZOA-OTC-INIT	1.85E-02
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01
				X-HSE-SGA-BLDN	SET TO 'T' - ESDE ON SG E-50A (House Event)	1.00E+00
92	52.12	0.12	7.95E-09	IE_LOMC		1.00E+00
				A-CVCC-AFWPP3-MA	ALL 3 AFW PP CK VALVES CK-FW726	1.07E-05
				B-XVOB-ADVS-MAN	OPERATOR FAILS TO CLOSE MANUAL VALVES TO CLOSE ADV	4.03E-02
				H-ZZOA-OTC-CDTNL-HEP-4	COND HEP: B-XVOB-ADVS-MAN * H-ZZOA-OTC-INIT	1.85E-02
93	52.24	0.12	7.81E-09	IE_LOMC		1.00E+00
				A-PMME-P-8B	AFW TURBINE PUMP P-8B FAILS TO START	1.53E-02
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00

Table A08-1: Top 100 Cutsets

Cut No.	% Total	% Cut Set	Prob.	Basic Event	Description	Event Prob.
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				Y-PMCC-P8C66ABME	COMMON CAUSE FAILURE OF P-8C	5.10E-05
94	52.36	0.12	7.68E-09	IE_LOMC		1.00E+00
				B-RVMB-SRV-SGB	ONE SAFETY RELIEF VALVE ON SG B FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01
				Q-FVMD-FCV-3029B	FLOW CONTROL VLV FCV-3029B FAILS TO REMAIN OPEN	2.08E-03
				X-HSE-SGB-BLDN	SET TO 'T' - ESDE ON SG E-50B (House Event)	1.00E+00
95	52.48	0.12	7.68E-09	IE_LOMC		1.00E+00
				B-RVMB-SRV-SGA	ONE SAFETY RELIEF VALVE ON SG A FTC	3.69E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				I-CMOE-IA-COMPS	OPERATOR FAILS TO START A COMPRESSOR (SCREENING VALUE)	1.00E-01
				Q-FVMD-FCV-3029B	FLOW CONTROL VLV FCV-3029B FAILS TO REMAIN OPEN	2.08E-03
				X-HSE-SGA-BLDN	SET TO 'T' - ESDE ON SG E-50A (House Event)	1.00E+00
96	52.6	0.12	7.67E-09	IE_LOMC		1.00E+00
				A-PMMG-P-8B	AFW TURBINE PUMP P-8B FAILS TO RUN	5.82E-02
				A-PMOO-P-8C	AFW PUMP P-8C OUT OF SERVICE	3.35E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00

Table A08-1: Top 100 Cutsets

Cut No.	% Total	% Cut Set	Prob.	Basic Event	Description	Event Prob.
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				Z-KVMB-SV-3029A	SUMP TO EAST ESS AIR SUPPLY SV-3029A FTE	3.93E-03
97	52.72	0.12	7.67E-09	IE_LOMC		1.00E+00
				A-PMMG-P-8B	AFW TURBINE PUMP P-8B FAILS TO RUN	5.82E-02
				A-PMOO-P-8C	AFW PUMP P-8C OUT OF SERVICE	3.35E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				Z-KVMB-SV-3029B	SUMP TO EAST ESS AIR SUPPLY SV-3029B FTE	3.93E-03
98	52.84	0.12	7.67E-09	IE_LOMC		1.00E+00
				A-PMMG-P-8B	AFW TURBINE PUMP P-8B FAILS TO RUN	5.82E-02
				A-PMOO-P-8C	AFW PUMP P-8C OUT OF SERVICE	3.35E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01
				Y-KVMB-SV-3056B	SIRWT RECIRC VALVE SOLENOID SV-3056B FTE	3.93E-03
99	52.96	0.12	7.67E-09	IE_LOMC		1.00E+00
				A-PMMG-P-8B	AFW TURBINE PUMP P-8B FAILS TO RUN	5.82E-02
				A-PMOO-P-8C	AFW PUMP P-8C OUT OF SERVICE	3.35E-03
				D-BCMT-ED-15	BATTERY CHARGER #1 FAILS TO FUNCTION	1.00E+00
				D-BCMT-ED-17	BATTERY CHARGER #3 FAILS TO FUNCTION	1.00E-01
				D-HSMC-HS-72-01	HAND SWITCH 72-01 FAILS TO REMAIN CLOSED	1.00E-01

Table A08-1: Top 100 Cutsets

Cut No.	% Total	% Cut Set	Prob.	Basic Event	Description	Event Prob.
				Y-KVMB-SV-3056A	SIRWT RECIRC VALVE SOLENOID SV-3056A FTE	3.93E-03
100	53.08	0.12	7.61E-09	IE_LOMC		1.00E+00
				A-PMCC-P8ABC-ME	COMMON CAUSE FAILURE OF ALL 3 AFW PUMPS P-8A/B/C TO START	5.45E-05
				Y-AVCC-3027-56MB	BOTH SIRWT RECIRC VALVES CV-3027 & CV-3056 COMMON CAUSE FTC	1.40E-04

Attachment 09 Sequences

Table A09-1: Sequence Results				
Event tree	**Sequence**	**CCDP**	**Count**	**End State**
TR-MCND	20	1.95E-06	2126	CORE-DAMAGE
TR-MCND	18	1.30E-06	1913	CORE-DAMAGE
TR-MCND	22-15	1.11E-06	1	CORE-DAMAGE
TR-MCND	22-13	5.26E-07	6	CORE-DAMAGE
TR-MCND	19	3.44E-07	397	CORE-DAMAGE
TR-MCND	8	3.35E-07	669	CORE-DAMAGE
TR-MCND	21-09	1.46E-07	76	CORE-DAMAGE
TR-MCND	21-02	1.42E-07	156	CORE-DAMAGE
TR-MCND	6	1.26E-07	291	CORE-DAMAGE
TR-MCND	21-10	1.21E-07	262	CORE-DAMAGE
TR-MCND	21-15	1.05E-07	77	CORE-DAMAGE
TR-MCND	22-03	9.09E-08	3	CORE-DAMAGE
TR-MCND	7	4.63E-08	119	CORE-DAMAGE
TR-MCND	22-14	4.14E-08	1	CORE-DAMAGE
TR-MCND	5	4.10E-08	72	CORE-DAMAGE
TR-MCND	22-05	1.66E-08	1	CORE-DAMAGE
TR-MCND	22-04	7.15E-09	1	CORE-DAMAGE
TR-MCND	22-16	4.73E-09	1	CORE-DAMAGE
TR-MCND	21-20	3.99E-09	16	CORE-DAMAGE
TR-MCND	22-10	1.93E-09	1	CORE-DAMAGE
TR-MCND	21-19	1.10E-09	6	CORE-DAMAGE
TR-MCND	22-08	9.15E-10	1	CORE-DAMAGE
TR-MCND	22-06	8.18E-10	1	CORE-DAMAGE
TR-MCND	17	6.75E-10	5	CORE-DAMAGE
TR-MCND	21-07	6.67E-10	5	CORE-DAMAGE
TR-MCND	21-18	2.22E-10	2	CORE-DAMAGE

Sequence Key:

XX	Transient with Loss of Main Condenser (TR-MCND)
21-XX	LOCA via Pressurizer Safety Relief Valve(s) (XFR-SBLOCA-SRV)
22-XX	Anticipated Transient Without SCRAM (XFR-ATWS)

Attachment 10: Auxiliary Feedwater Flow Rate to Steam Generators E-50A and E-50B Following the Failure of Panel ED-11-2 on September 25, 2011

1.0 PURPOSE

Flow rate indication from the P-8A and P-8B auxiliary feedwater (AFW) pump train was lost for a period of time following the failure of dc panel ED-11-2 on September 25, 2011. It was known that the P-8C pump train was providing relatively equal flow to both steam generators and its associated flow control valves were functioning normally. Pump P-8B started automatically due to the loss of dc power, which also caused its flow control valves to fully open. The P-8B flow rate to the steam generators for this configuration was not known, and the reason for steam generator E-50A level increasing (40% to 90%) significantly more than E-50B (35% to 60%) was not understood. (Note: E-50A and E-50B levels were observed at 40% and 35% during EOP-1.0 (~1515).)

This evaluation utilizes the AFW system Pipe-Flo hydraulic model to establish AFW flow rates to the steam generators as a function of time and dome pressure for input to the Modular Accident Analysis Program (MAAP) model.

2.0 INPUT

2.1 Hydraulic Model

The Pipe-Flo Professional 2007 base-deck hydraulic model of the Auxiliary Feedwater system, as developed in EA-PSA-PIPEFLO-AFW-08-06 [1], was used for the evaluation. Pipe-Flo is classified level "A" (safety related software) in accordance with EN-IT-104. The software quality assurance plan is found in [1].

2.2 Condensate Storage Tank Temperature

The condensate storage tank (T-2) temperature was 87°F as recorded in the electronic operator rounds (eSOMS) at 0752 on 9-25-2011.

2.3 Steam Generator Pressure and P-8C Flow Rate Data

Steam generator pressures were obtained from the PI data archive. PI is classified as SQA category "C" (important to business) in accordance with Entergy procedure EN-IT-104. The plant process computer (PPC) is classified as SQA category "B" system (regulatory commitments). The PPC is the PI data source. Most PPC points are calibrated via technical specification surveillance procedure or preventive maintenance and controlled calibration sheets.

Part of the PI server system runs on the PPC. This portion monitors selected points every second to test against the exception threshold change value. If the change value is exceeded, the data is passed to the PI server and recorded. The PI server also compares the new value against previous values to see if it still fits on a line within the compression limit. If yes, the data is discarded, otherwise it is added to the archive. For pump starts, the compression limit is simply a change in state (on-off or start-stopped).If 8 hours have passed without an archive update, one is made regardless. PI generally provides accurate long term values and greater amounts of data when events are changing rapidly.

For this analysis, PI server tags PT0751B (Steam Generator E-50A Pressure), PT0752B (Steam Generator E-50B Pressure), FT0737 (AFW Flow to Steam Generator E-50A) and FT0736 (AFW Flow to

Steam Generator E-50B) were used to extract sampled data from the PI archive for the period in which P-8B AFW pump was in service on 9-25-2011 (Per Attachment 01 of this analysis P-8C was in service from 15:06 – 15:44). Values shown in Table 2.3-1 are averages over each time period.

Table 2.3-1: PI Archive Average Steam Generator Pressure and P-8C Flow Rate Data

	15:06 – 15:20		15:21 – 15:29		15:30-15:39		15:40-16:03	
	Pressure (psig)	P-8C Flow Rate (gpm)	Pressure (psig)	P-8C Flow Rate (gpm)	Pressure (psig)	P-8C Flow Rate (gpm)	Pressure (psig)	P-8C Flow Rate (gpm)
E-50A	948.3	163.4	923.4	164.8	896.9	152.1	859.9	0
E-50B	945.0	162.5	955.7	159.8	969.4	161.7	958.2	163.4

3.0 ASSUMPTIONS

3.1 Major Assumptions

3.1.1 Auxiliary feedwater system flow control valves CV-0727 and CV-0749 are fully open from event initiation at 15:06 until steam was isolated to the P-8B steam turbine at an estimated time of 16:03.

Basis: A review of electrical schematics by system experts and operations staff found the flow control valves fail in the fully open position on loss of dc power. Steam isolation to the P-8B turbine driver occurred at approximately 16:03 based on a review of operator logs and interviews. See Attachment 01 for the event time line.

Bias: This assumption is neutral as it represents a realistic event based on the best available information.

3.2 Minor Assumptions

3.2.1 For the purpose of establishing the pump suction pressure and recirculation boundary conditions, condensate storage tank (T-2) level is assumed to remain at 82% level. This equates to a level of 274" above the tank bottom [2] (approximately 9.9 psig at the 590 elevation). With respect to the modeled P-8B recirculation node, this would equate to 13.8 psig as it's elevation is at 581 feet. The P-8C recirculation node is at 583 feet, so its boundary pressure is 12.9 psig.

Basis: This level was recorded in the electronic operator rounds (SOMS) database at 10:41 on the day of the event. During the event, level indication was lost.

Bias: This assumption is neutral and has a negligible impact on calculated flow rates. Pump flow rate is normally set by the flow control valves, but it is primarily a function of steam generator pressure when the flow control valves are fully open.

3.2.2 All pump curves used in the model are assumed to be nominal (e.g. the pumps have no performance degradation from typical surveillance test results). Pipe-Flo model pump curve data points were obtained from [1].

Basis: Palisades' pump in-service test (IST) data has consistently demonstrated that all pumps in the AFW system perform slightly below manufacturer's factory test data. This can be demonstrated by a review of EA-EC82841-02 Rev. 0, "Auxiliary Feedwater System Capacity", Appendix A. The pump curve data plotted in this analysis illustrates consistent pump performance over several years. Although

some degradation of the pumps is allowed by the IST procedure, which is accounted for in design basis analyses, the actual pump performance has been consistently nominal.

Bias: This assumption is neutral as it results in a realistic evaluation of the pump condition.

3.2.3 Dynamic head loss from the steam generator dome to the main steam safety valves is neglected.

Basis: Reference [4] calculates the dynamic head loss between the steam dome and the main steam safety valves to be 19.9 psid. This analysis accounts for safety valve accumulation and piping losses based on a steam flow rate shortly after a plant trip. Application of this additional pressure to the steam generator boundary condition is deemed overly conservative as it considers the main steam safety valves are fully open for the duration of the event and applies a constant decay heat value for steaming. Realistically, the safety valves are only open for short periods of time, or in an intermediate throttle position for longer periods, and decay heat decreases over time.

Bias: This assumption is neutral. Applying the dynamic head loss value would be overly conservative and unrealistically reduce the P-8B flow rate to the steam generators.

4.0 ANALYSIS

4.1 Pipe-Flo Model Balancing to Test Data with Fully Open Flow Control Valves

Typically, the AFW system is operated by setting the flow control valves to a specific flow rate. To account for line losses and the pressure drop through the flow control valves in the wide open position, flow elements based on Special Test T-202 [3] were developed here.

The T-202 test was performed to determine the system flow rate to a single steam generator with a flow control valve in the full open position and flow to the other steam generator isolated. Although the test was performed using only P-8A, the P-8A/P-8B pump train share common discharge piping and flow control valves. The pumps are also adjacent to each other in the AFW pump room; therefore, any variations in line losses between the two are negligible.

To determine system the pressure drop under the test conditions, simulated flow control valves were inserted into the Pipe-Flo model [1] at pipelines 180 and 210 and set at the test measured flow rate.

Table 4.1-1: Special Test T-202 Test Results

Flow Rate to E-50A (gpm)	E-50A Dome Pressure (psia)	Flow Rate to E-50B (gpm)	E-50B Dome Pressure (psia)	T-2 Level (ft)	T-2 Temperature (F)
418.6	889.7	427.3	856.3	608.14	85

With the Pipe-Flo model aligned per the test configuration and boundary conditions established as shown in Table 4.0-1, the modeled flow control valves calculated a pressure drop of 68.89 psid in line 210 (flow to E-50A) and 83.73 psid in line 180 (flow to E-50B) would be required to establish the measured flow rate [1].

Using the calculated differential pressure and measured flow rate from T-202, reference [1] calculated fixed loss coefficients (K) in the pipelines as shown in Table 4.0-2.

Table 4.0-2: Pipe-Flo Model Flow Elements Based on T-202 Data			
Loss Coefficient "CV-0749" Inserted in Pipeline 210		Loss Coefficient "CV-0727" Inserted in Pipeline 180	
Differential Pressure (psid)	Equivalent K	Differential Pressure (psid)	Equivalent K
83.7	87.4	68.9	75.1

This approach allows the model to calculate the head loss through the open flow control valve component for flow rates other than those measured in the test.

4.2 Auxiliary Feedwater Pump P-8C Flow Control Valve Modeling

Flow rate data was recorded from the P-8C AFW pump to both E-50A and E-50B for the duration of the event as shown in Table 2.3-1. To model these flow rates, Pipe-Flo flow control valves were inserted in the model at node 34 (CV-0737A) and node 29 (CV-0736A). The Pipe-Flo flow control valves establish a differential pressure in the model pipeline to match the user entered flow rate.

5.0 CONCLUSION

Using the inputs and boundary conditions presented above, four Pipe-Flo model cases were developed. Each case represents a time segment from event initiation to the estimated time steam to the P-8B turbine was isolated. Boundary conditions and Pipe-Flo analysis results are presented in Table 5.0-1. The Pipe-Flo calculated values are for flow rates from P-8B and total flow to each steam generator.

Table 5.0-1: AFW System Flow Rates Following D11-2 Failure Event										
Time	T-2 Pressure (psig)	T-2 (system) Temp. (F)	E-50A Pressure (psig)	E-50B Pressure (psig)	P-8B Flow Rate to E-50A (gpm)	P-8B Flow Rate to E-50B (gpm)	P-8C Flow Rate to E-50A (gpm)	P-8C Flow Rate to E-50B (gpm)	Total Flow Rate to E-50A (gpm)	Total Flow Rate to E-50B (gpm)
15:06-15:20	9.9	87	948.3	945	178.7	187.2	163.4	162.5	342.1	349.7
15:21-15:29	9.9	87	923.4	955.7	254.3	113.5	164.8	159.8	419.1	273.3
15:30-15:39	9.9	87	896.9	969.4	342.7	23.4	152.1	161.7	494.8	185.1
15:40-16:03	9.9	87	859.9	958.2	379.4	0	0	163.4	379.4	163.4

6.0 REFERENCES:

[1] EA-PSA-PIPEFLO-AFW-08-06 Rev. 0, "Pipe-Flo Professional 2007a Hydraulic Model of the Auxiliary Feedwater System and Software Quality Assurance Documentation".

[2] M-398 Sh. 20, "Level Setting Diagram Condensate Storage Tank T-2".

[3] Test Report, Palisades Special Test T-202, "Auxiliary Feedwater P-8A and P-8C System Flow Characteristics", Test Performed on December 2, 1986, report dated 3/5/87 (7613/2206).

[4] EA-EC82841-02, Revision 0, "Auxiliary Feedwater System Capacity".

7.0 APPENDICES

Att. 10 - App. A.pdf

[A] Pipe-Flo Lineup Report and Flo-Sheet for Case 15:06 – 15:20 (7 pages)

Att. 10 - App. B.pdf

[B] Pipe-Flo Lineup Report and Flo-Sheet for Case 15:21 – 15:29 (7 pages)

Att. 10 - App. C.pdf

[C] Pipe-Flo Lineup Report and Flo-Sheet for Case 15:30 – 15:39 (7 pages)

Att. 10 - App. D.pdf

[D] Pipe-Flo Lineup Report and Flo-Sheet for Case 15:40 – 16:03 (7 pages)

System: EA-PSA-SDP-D11-2-11-07
Lineup: 1506-1520
rev: 11/15/11 10:34 am

System created: 01/29/08 7:04 am
with Design file: standard

Atm pressure: 14.7 psi a

11/15/11 10:39 am

Company: Entergy
Project: EA-PSA-SDP-D11-2-11-07
by: sjm

Total System Volume: 19974 gallons
Pressure drop calculations: Darcy-Weisbach method, laminar cutoff Re = 2100
Calculated: 7 iterations Avg Deviation: 0.000205 %

Specifications

Specification	Material / Schedule	Roughness	Sizing	Design Limits
AFWS @ 120 deg	Steel A53-B36.10 / 40	0.0018 in	8 ft/sec	0 to 12 ft/sec
	Valves: standard	C: 140		0 to 1200 psi g
AFWS @ 120 deg{sch40}	Steel A53-B36.10 / 40	0.0018 in	8 ft/sec	0 to 12 ft/sec
	Valves: standard	C: 140		0 to 1200 psi g
AFWS @ 120 deg{sch80}	Steel A53-B36.10 / 80	0.00181 in	8 ft/sec	0 to 12 ft/sec
	Valves: standard	C: 140		0 to 1200 psi g
FPS Header Pipe	Stainless Pipe IPS / 40S	0.0018 in	8 ft/sec	0 to 12 ft/sec
	Valves: standard	C: 140		0 to 1200 psi g

Fluid Zones

Fluid Zone	Fluid	Temp °F	Pressure psi g	Density lb/ft³	Viscosity cP	Pv / Pc or k psi a
AFWS @ 87 deg	Water	87	0	62.32	0.7884	0.6355 / 3198
FPS_FEED_AFW	Water	85	0	62.32	0.807	0.5962 / 3198

Pipelines

Pipeline	From	To	Status	Flow US gpm	Velocity ft/sec	dP psi	HL ft
005 sch40 to Bypass	~CST(N-002)	~Node 01		783.9	8.713	(0.316)	0.029
010 CST OUT	CST	~CST(N-002)		783.9	9.657	(1.058)	0.553
015 Bypass	~Node 01	~Node 02		272.4	3.027	(1.239)	0.456
020	~Node 01	~Node 02		511.5	5.686	(1.239)	0.456
030 CST To AFWP	~Node 02	~Node 03		783.9	8.713	(0.291)	0.027
040 CST To P8A&B	~Node 03	~Node 04		425.9	4.734	0.132	1.525
045	~Node 04	~Node 05		168.8	1.876	0.073	0.169
050	~Node 04	~Node 05		257.1	2.858	0.073	0.169
060	~Node 05	~Node 06		425.9	4.734	0.139	0.322
065 From FireSys	~Node FpS 07	~Node 06	X Closed	---	---	---	---
070 To P-8A&B	~Node 06	~Node 07		425.9	4.734	(1.474)	0.592
080 P-8A IN	~Node 07	P-8A Deg	X Closed	---	---	---	---
100 P-8A Out	P-8A Deg	~Node 10	X Closed	---	---	---	---
1010 P-41 Discharge	~P-41	~Node FPS 01	X Closed	---	---	---	---
1030 FPS Header 1	~Node FPS 02	~Node FPS 03	X Closed	---	---	---	---
1040 FPS Header 2	~Node FPS 03	~Node FPS 04	X Closed	---	---	---	---
105 P8A RECIRC	~Node 10	~Node A Recirc	X Closed	---	---	---	---
1050 FPS Header 3	~Node FPS 04	~Node FPS 05	X Closed	---	---	---	---
1060 FPS Vert	~Node FPS 05	~Node FPS 06	X Closed	---	---	---	---
1070 UdrGrnd from FPS	~Node FPS 06	~Node FpS 07	X Closed	---	---	---	---
1090 FPS P-9B Disch	~P-9B	~Node FPS 08	X Closed	---	---	---	---
110 P-8A to Tee	~Node 10	~Node 11		0	0	4.2	0
1110 P-9A Disch	~P-9A	~Node FPS 09	X Closed	---	---	---	---
120 P-8B IN	~Node 07	P-8B Nom		425.9	4.734	(1.473)	0.426
140 P-8B Out	P-8B Nom	~Node 14		425.9	5.247	1.574	3.019
145 P-8B RECIRC	~Node 14	~Node B Recirc		60.04	6.529	995.3	2294
150 P-8B to Tee	~Node 14	~Node 11		365.9	4.507	4.381	0.419
160 8A&B To SG'S	~Node 11	~Node 15		365.9	4.507	(2.001)	0.624
170 8A&B To SG'S	~Node 15	~Node 16		365.9	4.507	8.685	0.828
180 8A&B To E50B	~Node 16	~Node 17		187.2	5.228	18.7	41.24
190 8A&B To E50B	~Node 17	~Node 18		187.2	4.721	2.15	1.47
200 To E-50B	~Node 18	~NODE 19(E-50B		349.7	8.82	28.72	14.56
210 8A&B To E50A	~Node 16	~Node 20		178.7	4.991	15.15	33.53
220 8A&B To E50A	~Node 20	~Node 21		178.7	4.508	4.471	1.327
230 To E-50A	~Node 21	~Node 22(E-50A		342.1	8.629	26.8	15.13
240 To P-8C	~Node 03	~Node 23		358	3.979	1.577	5.535
250 P-8C IN	~Node 23	P-8C Nom		358	3.979	(3.609)	0.526
270 P-8C Out	P-8C Nom	~Node 26		358	4.41	0.873	2.148
275 P-8C RECIRC	~Node 26	~Node C Recirc		32.08	3.489	1124	2587
280 P-8C TO TEE	~Node 26	~Node 27		325.9	4.015	0.806	1.194
290 P8C TO E50B	~Node 27	~Node 28		162.5	2.002	0.237	0.797
300	~Node 28	~Node 29		162.5	2.002	(0.24)	0.026
310 CV-0736A	~Node 29	~Node 30		162.5	4.099	9.293	20.91
315 CV-0736	~Node 28	~Node 30	X Closed	---	---	---	---
320 MO-0748/0755	~Node 30	~Node 31		162.5	4.099	4.372	0.399
330 CK-FW703	~Node 31	~Node 32		162.5	1.806	9.457	0.326
340 To E-50B TEE	~Node 32	~Node 18		162.5	4.099	0.062	0.143
350 P-8C To E50A	~Node 27	~Node 33		163.4	2.013	0.352	0.814
360	~Node 33	~Node 34		163.4	2.013	0.009	0.02
370 CV-0737A	~Node 34	~Node 35		163.4	4.122	7.16	16.55
375 CV-0737	~Node 33	~Node 35	X Closed	---	---	---	---
380 MO-0754/0759	~Node 35	~Node 36		163.4	4.122	5.732	0.792

Pipelines

Pipeline	From	To	Status	Flow US gpm	Velocity ft/sec	dP psi	HL ft
390	~Node 36	~Node 37		163.4	2.013	8.078	0.067
400 CK-FW704	~Node 37	~Node 38		163.4	1.816	2.185	0.113
410 To E-50A TEE	~Node 38	~Node 21		163.4	4.122	0.069	0.161
430	~NODE 19(E-50B	~Node E-50B	Limit	349.7	15.19	3.496	7.832
440	~Node 22(E-50A	908	Limit	342.1	14.86	3.343	7.478
700 Header B8-1	~Node SWS 001x	~Node 23	X Closed	---	---	---	---
Pipe{001}	~Lake1	~P-41	X Closed	---	---	---	---
Pipe{002}	~Lake 2	~P-9B	X Closed	---	---	---	---
Pipe{003}	~Lake 3	~P-9A	X Closed	---	---	---	---

Nodes

Node	Elev ft	Status	Pressure psi g	Grade ft
~CST(N-002)	587		10.96	612.3
~Node 01	586.24		11.27	612.3
~Node 02	582.92		12.51	611.8
~Node 03	582.22		12.8	611.8
~Node 04	581		12.67	610.3
~Node 05	581		12.6	610.1
~Node 06	581		12.46	609.8
~Node 07	577		13.93	609.2
~Node 10	573.79		1009	2906
~Node 11	583.5		1005	2906
~Node 14	573.79		1009	2907
~Node 15	578.25		1007	2906
~Node 16	597.5		998.1	2905
~Node 17	599.5		979.4	2864
~Node 18	603		977.2	2862
~NODE 19(E-50B	654.83		948.5	2848
~Node 20	599		982.9	2871
~Node 21	608.01		978.4	2870
~Node 22(E-50A	654.83		951.6	2855
~Node 23	580.33		11.23	606.3
~Node 26	571.33		1137	3200
~Node 27	572		1136	3199
~Node 28	571.75		1136	3198
~Node 30	571.75		991.1	2863
~Node 31	581.46		986.7	2863
~Node 32	603		977.3	2862
~Node 33	572		1136	3198
~Node 35	572		994.5	2871
~Node 36	584.46		988.8	2871
~Node 37	603.07		980.7	2870
~Node 38	608.01		978.5	2870

Pumps

Pump	Flow US gpm	Status	Total head ft	dP psi	Speed rpm	NPSHa ft	Suction psi g	Discharge psi g	Suction ft	Discharge ft
P-8B Nom	425.9		(2301)	(995.3)	3475	68.22	15.41	1011	573.17	573.17
P-8C Nom	358		(2596)	(1123)	3600	66.82	14.84	1138	571.46	571.46

Controls

Control	Set Value	Elev ft	Flow US gpm	Status	dP psi	HL ft	Inlet psi g	Outlet psi g
~Node 29	FCV: 162.5	571.17	162.5		135.8	313.9	1136	1000
~Node 34	FCV: 163.4	572	163.4		134.2	310.2	1136	1002

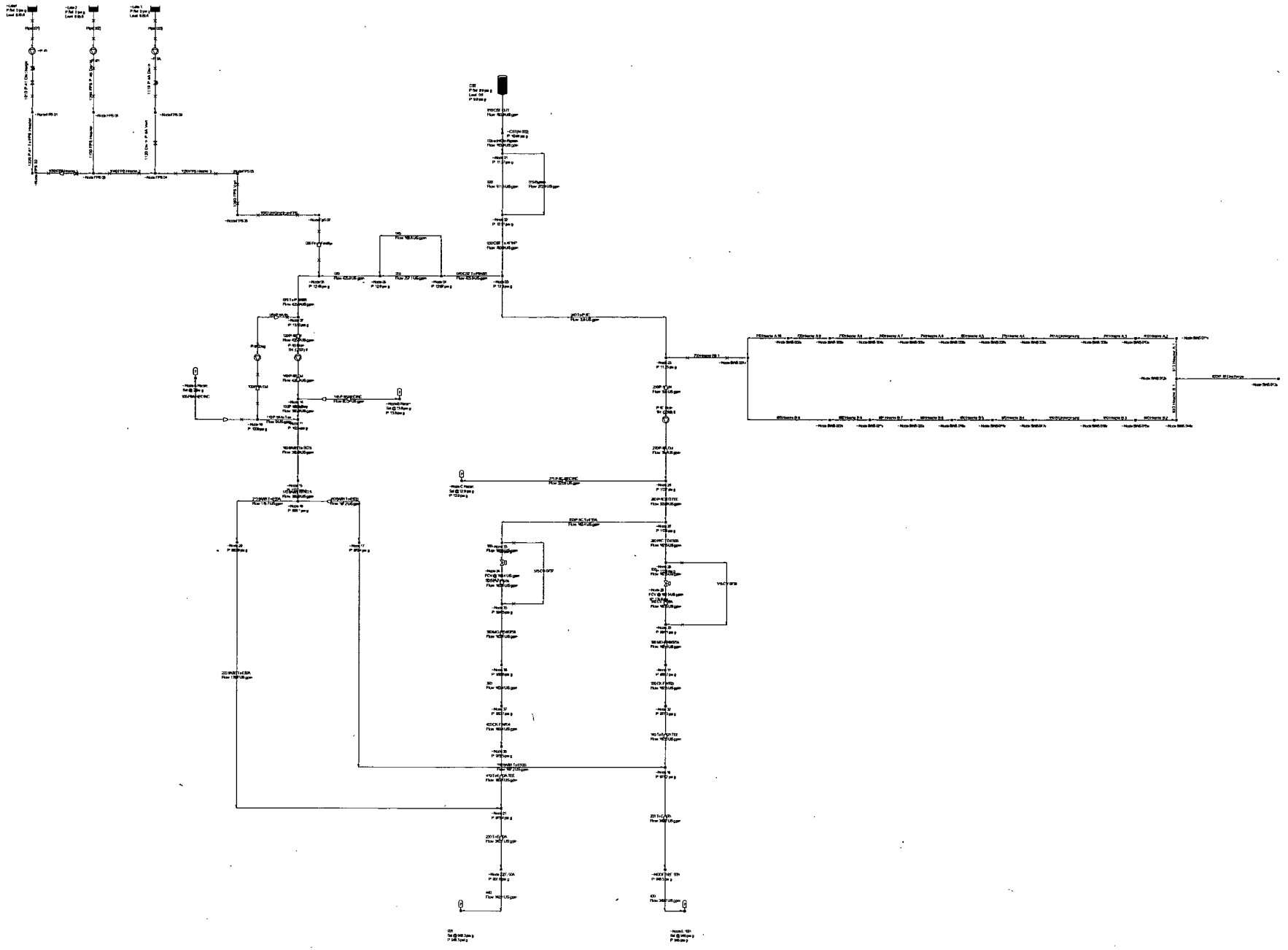
Tanks

Tank	Surface Pressure psi g	Level ft	Bottom Elevation ft	Status	Flow US gpm	Pressure psi g	Grade ft
CST	9.9	0	590		-783.9	9.9	612.9

Connecting pipelines	Flow (US gpm)	Pressure (psi g)	Grade (ft)
010 CST OUT @ 0 ft	783.9	9.9	612.9

Demands

Demand	Set Value	Flow Rate US gpm	Pressure psi g	Elev ft	Status	Grade ft
~Node B Recirc	Boundary pressure	60.04	13.8	581		612.9
~Node C Recirc	Boundary pressure	32.08	12.9	583		612.8
~Node E-50B	Boundary pressure	349.7	945	655.08		2840
908	Boundary pressure	342.1	948.3	655.08		2847



Lineup:	1506-1520	Darcy-Weisbach	PIPE-FLO 2007
System:	EA-PSA-SDP-D11-2-11-07		Flow: US gpm
Date:	11/15/11 10:40 am		Pressure: psi g
Company:	Entergy		Size: in
Project:	EA-PSA-SDP-D11-2-11-07		Elevation: ft
by:	sjm		Velocity: ft/sec
	Attachment 10, Appendix A		Length: ft
			Volume: gallons

List Report

System: EA-PSA-SDP-D11-2-11-07
Lineup: 1521-1529
rev: 11/15/11 10:34 am
System created: 01/29/08 7:04 am
with Design file: standard
Atm pressure: 14.7 psi a

11/15/11 10:40 am
Company: Entergy
Project: EA-PSA-SDP-D11-2-11-07
by: sjm

Total System Volume: 19974 gallons
Pressure drop calculations: Darcy-Weisbach method, laminar cutoff Re = 2100
Calculated: 7 iterations Avg Deviation: 0.0002108 %

Specifications

Specification	Material / Schedule	Roughness	Sizing	Design Limits
AFWS @ 120 deg	Steel A53-B36.10 / 40	0.0018 in	8 ft/sec	0 to 12 ft/sec
	Valves: standard	C: 140		0 to 1200 psi g
AFWS @ 120 deg{sch40}	Steel A53-B36.10 / 40	0.0018 in	8 ft/sec	0 to 12 ft/sec
	Valves: standard	C: 140		0 to 1200 psi g
AFWS @ 120 deg{sch80}	Steel A53-B36.10 / 80	0.00181 in	8 ft/sec	0 to 12 ft/sec
	Valves: standard	C: 140		0 to 1200 psi g
FPS Header Pipe	Stainless Pipe IPS / 40S	0.0018 in	8 ft/sec	0 to 12 ft/sec
	Valves: standard	C: 140		0 to 1200 psi g

Fluid Zones

Fluid Zone	Fluid	Temp °F	Pressure psi g	Density lb/ft³	Viscosity cP	Pv / Pc or k psi a
AFWS @ 87 deg	Water	87	0	62.32	0.7884	0.6355 / 3198
FPS_FEED_AFW	Water	85	0	62.32	0.807	0.5962 / 3198

Pipelines

Pipeline	From	To	Status	Flow US gpm	Velocity ft/sec	dP psi	HL ft
005 sch40 to Bypass	~CST(N-002)	~Node 01		784.3	8.717	(0.316)	0.029
010 CST OUT	CST	~CST(N-002)		784.3	9.662	(1.058)	0.554
015 Bypass	~Node 01	~Node 02		272.5	3.029	(1.239)	0.457
020	~Node 01	~Node 02		511.8	5.688	(1.239)	0.457
030 CST To AFWP	~Node 02	~Node 03		784.3	8.717	(0.291)	0.027
040 CST To P8A&B	~Node 03	~Node 04		427.7	4.754	0.137	1.537
045	~Node 04	~Node 05		169.5	1.884	0.074	0.17
050	~Node 04	~Node 05		258.2	2.87	0.074	0.17
060	~Node 05	~Node 06		427.7	4.754	0.14	0.324
065 From FireSys	~Node FpS 07	~Node 06	X Closed	---	---	---	---
070 To P-8A&B	~Node 06	~Node 07		427.7	4.754	(1.472)	0.597
080 P-8A IN	~Node 07	P-8A Deg	X Closed	---	---	---	---
100 P-8A Out	P-8A Deg	~Node 10	X Closed	---	---	---	---
1010 P-41 Discharge	~P-41	~Node FPS 01	X Closed	---	---	---	---
1030 FPS Header 1	~Node FPS 02	~Node FPS 03	X Closed	---	---	---	---
1040 FPS Header 2	~Node FPS 03	~Node FPS 04	X Closed	---	---	---	---
105 P8A RECIRC	~Node 10	~Node A Recirc	X Closed	---	---	---	---
1050 FPS Header 3	~Node FPS 04	~Node FPS 05	X Closed	---	---	---	---
1060 FPS Vert	~Node FPS 05	~Node FPS 06	X Closed	---	---	---	---
1070 UdrGrnd from FPS	~Node FPS 06	~Node FpS 07	X Closed	---	---	---	---
1090 FPS P-9B Disch	~P-9B	~Node FPS 08	X Closed	---	---	---	---
110 P-8A to Tee	~Node 10	~Node 11		0	0	4.2	0
1110 P-9A Disch	~P-9A	~Node FPS 09	X Closed	---	---	---	---
120 P-8B IN	~Node 07	P-8B Nom		427.7	4.754	(1.471)	0.429
140 P-8B Out	P-8B Nom	~Node 14		427.7	5.269	1.585	3.043
145 P-8B RECIRC	~Node 14	~Node B Recirc		59.9	6.514	990.7	2283
150 P-8B to Tee	~Node 14	~Node 11		367.8	4.531	4.383	0.423
160 8A&B To SG'S	~Node 11	~Node 15		367.8	4.531	(1.998)	0.631
170 8A&B To SG'S	~Node 15	~Node 16		367.8	4.531	8.689	0.837
180 8A&B To E50B	~Node 16	~Node 17		113.5	3.17	7.433	15.18
190 8A&B To E50B	~Node 17	~Node 18		113.5	2.863	1.752	0.549
200 To E-50B	~Node 18	~NODE 19(E-50B		273.3	6.894	26.32	9.01
210 8A&B To E50A	~Node 16	~Node 20		254.3	7.102	29.98	67.81
220 8A&B To E50A	~Node 20	~Node 21		254.3	6.414	5.051	2.667
230 To E-50A	~Node 21	~Node 22(E-50A		419.1	10.57	29.99	22.51
240 To P-8C	~Node 03	~Node 23		356.6	3.964	1.559	5.495
250 P-8C IN	~Node 23	P-8C Nom		356.6	3.964	(3.61)	0.522
270 P-8C Out	P-8C Nom	~Node 26		356.6	4.394	0.866	2.132
275 P-8C RECIRC	~Node 26	~Node C Recirc		32.04	3.484	1121	2579
280 P-8C TO TEE	~Node 26	~Node 27		324.6	3.999	0.802	1.185
290 P8C TO E50B	~Node 27	~Node 28		159.8	1.969	0.225	0.771
300	~Node 28	~Node 29		159.8	1.969	(0.24)	0.025
310 CV-0736A	~Node 29	~Node 30		159.8	4.031	8.995	20.22
315 CV-0736	~Node 28	~Node 30	X Closed	---	---	---	---
320 MO-0748/0755	~Node 30	~Node 31		159.8	4.031	4.367	0.386
330 CK-FW703	~Node 31	~Node 32		159.8	1.776	9.453	0.315
340 To E-50B TEE	~Node 32	~Node 18		159.8	4.031	0.06	0.138
350 P-8C To E50A	~Node 27	~Node 33		164.8	2.03	0.358	0.828
360	~Node 33	~Node 34		164.8	2.03	0.009	0.021
370 CV-0737A	~Node 34	~Node 35		164.8	4.157	7.283	16.84
375 CV-0737	~Node 33	~Node 35	X Closed	---	---	---	---
380 MO-0754/0759	~Node 35	~Node 36		164.8	4.157	5.738	0.805

Pipelines

Pipeline	From	To	Status	Flow US gpm	Velocity ft/sec	dP psi	HL ft
390	~Node 36	~Node 37		164.8	2.03	8.079	0.068
400 CK-FW704	~Node 37	~Node 38		164.8	1.832	2.186	0.115
410 To E-50A TEE	~Node 38	~Node 21		164.8	4.157	0.071	0.163
430	~NODE 19(E-50B	~Node E-50B		273.3	11.87	2.18	4.789
440	~Node 22(E-50A	908	Limit	419.1	18.2	4.959	11.21
700 Header B8-1	~Node SWS 001x	~Node 23	X Closed	---	---	---	---
Pipe{001}	~Lake1	~P-41	X Closed	---	---	---	---
Pipe{002}	~Lake 2	~P-9B	X Closed	---	---	---	---
Pipe{003}	~Lake 3	~P-9A	X Closed	---	---	---	---

Nodes

Node	Elev ft	Status	Pressure psi g	Grade ft
~CST(N-002)	587		10.96	612.3
~Node 01	586.24		11.27	612.3
~Node 02	582.92		12.51	611.8
~Node 03	582.22		12.8	611.8
~Node 04	581		12.67	610.3
~Node 05	581		12.59	610.1
~Node 06	581		12.45	609.8
~Node 07	577		13.93	609.2
~Node 10	573.79		1004	2895
~Node 11	583.5		1000	2895
~Node 14	573.79		1004	2896
~Node 15	578.25		1002	2895
~Node 16	597.5		993.4	2894
~Node 17	599.5		985.9	2879
~Node 18	603		984.2	2878
~NODE 19(E-50B	654.83		957.9	2869
~Node 20	599		963.4	2826
~Node 21	608.01		958.3	2824
~Node 22(E-50A	654.83		928.4	2801
~Node 23	580.33		11.24	606.3
~Node 26	571.33		1134	3192
~Node 27	572		1133	3191
~Node 28	571.75		1133	3190
~Node 30	571.75		998.1	2879
~Node 31	581.46		993.7	2879
~Node 32	603		984.3	2879
~Node 33	572		1132	3190
~Node 35	572		974.4	2825
~Node 36	584.46		968.7	2824
~Node 37	603.07		960.6	2824
~Node 38	608.01		958.4	2824

Pumps

Pump	Flow US gpm	Status	Total head ft	dP psi	Speed rpm	NPSHa ft	Suction psi g	Discharge psi g	Suction ft	Discharge ft
P-8B Nom	427.7		(2290)	(990.6)	3475	68.2	15.4	1006	573.17	573.17
P-8C Nom	356.6		(2589)	(1120)	3600	66.86	14.86	1134	571.46	571.46

Controls

Control	Set Value	Elev ft	Flow US gpm	Status	dP psi	HL ft	Inlet psi g	Outlet psi g
~Node 29	FCV: 159.8	571.17	159.8		125.8	290.7	1133	1007
~Node 34	FCV: 164.8	572	164.8		150.7	348.5	1132	981.7

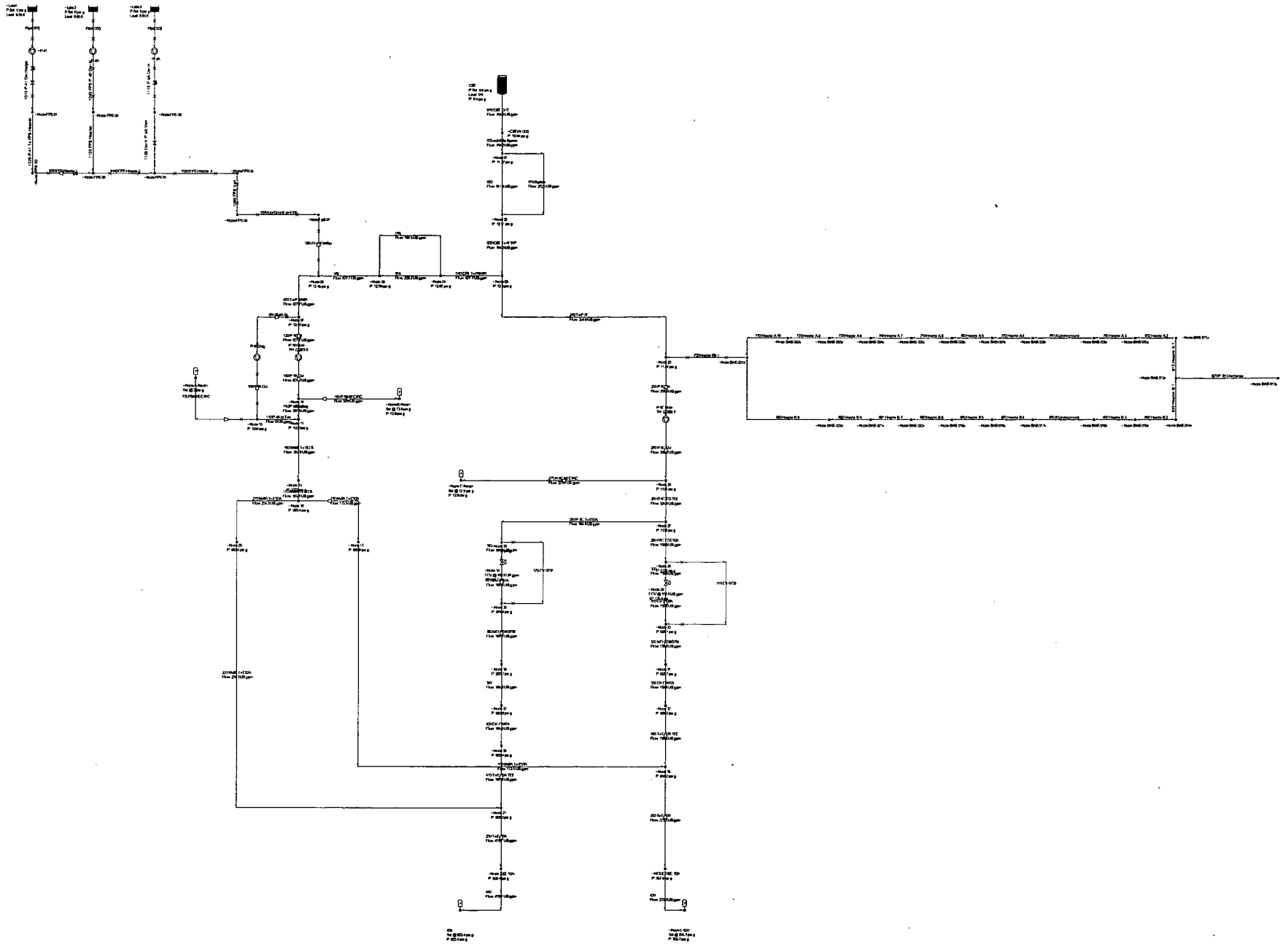
Tanks

Tank	Surface Pressure psi g	Level ft	Bottom Elevation ft	Status	Flow US gpm	Pressure psi g	Grade ft
CST	9.9	0	590		-784.3	9.9	612.9

Connecting pipelines	Flow (US gpm)	Pressure (psi g)	Grade (ft)
010 CST OUT @ 0 ft	784.3	9.9	612.9

Demands

Demand	Set Value	Flow Rate US gpm	Pressure psi g	Elev ft	Status	Grade ft
~Node B Recirc	Boundary pressure	59.9	13.8	581		612.9
~Node C Recirc	Boundary pressure	32.04	12.9	583		612.8
~Node E-50B	Boundary pressure	273.3	955.7	655.08		2864
908	Boundary pressure	419.1	923.4	655.08		2790



Lineup:	1521-1529	Darcy-Weisbach	PIPE-FLO 2007
System:	EA-PSA-SDP-D11-2-11-07		Flow: US gpm
Date:	11/15/11 10:40 am		Pressure: psi g
Company:	Entergy		Size: in
Project:	EA-PSA-SDP-D11-2-11-07		Elevation: ft
by:	sjm		Velocity: ft/sec
	Attachment 10, Appendix B		Length: ft
			Volume: gallons

List Report

System: EA-PSA-SDP-D11-2-11-07
Lineup: 1530-1539
rev: 11/15/11 10:34 am

System created: 01/29/08 7:04 am
with Design file: standard

Atm pressure: 14.7 psi a

11/15/11 10:41 am

Company: Entergy
Project: EA-PSA-SDP-D11-2-11-07
by: sjm

Total System Volume: 19974 gallons
Pressure drop calculations: Darcy-Weisbach method, laminar cutoff Re = 2100
Calculated: 7 iterations Avg Deviation: 0.0003269 %

Specifications

Specification	Material / Schedule	Roughness	Sizing	Design Limits
AFWS @ 120 deg	Steel A53-B36.10 / 40 Valves: standard	0.0018 in C: 140	8 ft/sec	0 to 12 ft/sec 0 to 1200 psi g
AFWS @ 120 deg{sch40}	Steel A53-B36.10 / 40 Valves: standard	0.0018 in C: 140	8 ft/sec	0 to 12 ft/sec 0 to 1200 psi g
AFWS @ 120 deg{sch80}	Steel A53-B36.10 / 80 Valves: standard	0.00181 in C: 140	8 ft/sec	0 to 12 ft/sec 0 to 1200 psi g
FPS Header Pipe	Stainless Pipe IPS / 40S Valves: standard	0.0018 in C: 140	8 ft/sec	0 to 12 ft/sec 0 to 1200 psi g

Fluid Zones

Fluid Zone	Fluid	Temp °F	Pressure psi g	Density lb/ft³	Viscosity cP	Pv / Pc or k psi a
AFWS @ 87 deg	Water	87	0	62.32	0.7884	0.6355 / 3198
FPS_FEED_AFW	Water	85	0	62.32	0.807	0.5962 / 3198

Pipelines

Pipeline	From	To	Status	Flow US gpm	Velocity ft/sec	dP psi	HL ft
005 sch40 to Bypass	~CST(N-002)	~Node 01		771.6	8.576	(0.317)	0.028
010 CST OUT	CST	~CST(N-002)		771.6	9.505	(1.066)	0.536
015 Bypass	~Node 01	~Node 02		268.1	2.98	(1.245)	0.442
020	~Node 01	~Node 02		503.5	5.596	(1.245)	0.442
030 CST To AFWP	~Node 02	~Node 03		771.6	8.576	(0.292)	0.026
040 CST To P8A&B	~Node 03	~Node 04		426.2	4.737	0.133	1.527
045	~Node 04	~Node 05		168.9	1.877	0.073	0.169
050	~Node 04	~Node 05		257.3	2.86	0.073	0.169
060	~Node 05	~Node 06		426.2	4.737	0.139	0.322
065 From FireSys	~Node FpS 07	~Node 06	X Closed	---	---	---	---
070 To P-8A&B	~Node 06	~Node 07		426.2	4.737	(1.474)	0.593
080 P-8A IN	~Node 07	P-8A Deg	X Closed	---	---	---	---
100 P-8A Out	P-8A Deg	~Node 10	X Closed	---	---	---	---
1010 P-41 Discharge	~P-41	~Node FPS 01	X Closed	---	---	---	---
1030 FPS Header 1	~Node FPS 02	~Node FPS 03	X Closed	---	---	---	---
1040 FPS Header 2	~Node FPS 03	~Node FPS 04	X Closed	---	---	---	---
105 P8A RECIRC	~Node 10	~Node A Recirc	X Closed	---	---	---	---
1050 FPS Header 3	~Node FPS 04	~Node FPS 05	X Closed	---	---	---	---
1060 FPS Vert	~Node FPS 05	~Node FPS 06	X Closed	---	---	---	---
1070 UdrGrnd from FPS	~Node FPS 06	~Node FpS 07	X Closed	---	---	---	---
1090 FPS P-9B Disch	~P-9B	~Node FPS 08	X Closed	---	---	---	---
110 P-8A to Tee	~Node 10	~Node 11		0	0	4.2	0
1110 P-9A Disch	~P-9A	~Node FPS 09	X Closed	---	---	---	---
120 P-8B IN	~Node 07	P-8B Nom		426.2	4.737	(1.472)	0.426
140 P-8B Out	P-8B Nom	~Node 14		426.2	5.25	1.575	3.022
145 P-8B RECIRC	~Node 14	~Node B Recirc		60.02	6.527	994.7	2292
150 P-8B to Tee	~Node 14	~Node 11		366.2	4.511	4.382	0.419
160 8A&B To SG'S	~Node 11	~Node 15		366.2	4.511	(2)	0.625
170 8A&B To SG'S	~Node 15	~Node 16		366.2	4.511	8.686	0.829
180 8A&B To E50B	~Node 16	~Node 17		23.44	0.655	1.147	0.653
190 8A&B To E50B	~Node 17	~Node 18		23.44	0.591	1.525	0.026
200 To E-50B	~Node 18	~NODE 19(E-50B		185.1	4.67	24.25	4.236
210 8A&B To E50A	~Node 16	~Node 20		342.7	9.573	53.89	123.1
220 8A&B To E50A	~Node 20	~Node 21		342.7	8.645	5.983	4.822
230 To E-50A	~Node 21	~Node 22(E-50A	Limit	494.8	12.48	33.74	31.18
240 To P-8C	~Node 03	~Node 23		345.4	3.84	1.418	5.169
250 P-8C IN	~Node 23	P-8C Nom		345.4	3.84	(3.624)	0.491
270 P-8C Out	P-8C Nom	~Node 26		345.4	4.255	0.809	2.002
275 P-8C RECIRC	~Node 26	~Node C Recirc		31.63	3.44	1093	2514
280 P-8C TO TEE	~Node 26	~Node 27		313.8	3.866	0.769	1.109
290 P8C TO E50B	~Node 27	~Node 28		161.7	1.992	0.233	0.789
300	~Node 28	~Node 29		161.7	1.992	(0.24)	0.026
310 CV-0736A	~Node 29	~Node 30		161.7	4.079	9.204	20.7
315 CV-0736	~Node 28	~Node 30	X Closed	---	---	---	---
320 MO-0748/0755	~Node 30	~Node 31		161.7	4.079	4.371	0.395
330 CK-FW703	~Node 31	~Node 32		161.7	1.797	9.456	0.322
340 To E-50B TEE	~Node 32	~Node 18		161.7	4.079	0.061	0.142
350 P-8C To E50A	~Node 27	~Node 33		152.1	1.874	0.305	0.706
360	~Node 33	~Node 34		152.1	1.874	0.008	0.018
370 CV-0737A	~Node 34	~Node 35		152.1	3.837	6.204	14.34
375 CV-0737	~Node 33	~Node 35	X Closed	---	---	---	---
380 MO-0754/0759	~Node 35	~Node 36		152.1	3.837	5.687	0.689

Pipelines

Pipeline	From	To	Status	Flow US gpm	Velocity ft/sec	dP psi	HL ft
390	~Node 36	~Node 37		152.1	1.874	8.074	0.058
400 CK-FW704	~Node 37	~Node 38		152.1	1.691	2.179	0.098
410 To E-50A TEE	~Node 38	~Node 21		152.1	3.837	0.06	0.139
430	~NODE 19(E-50B	~Node E-50B		185.1	8.042	1.06	2.202
440	~Node 22(E-50A	908	Limit	494.8	21.49	6.868	15.63
700 Header B8-1	~Node SWS 001x	~Node 23	X Closed	---	---	---	---
Pipe{001}	~Lake1	~P-41	X Closed	---	---	---	---
Pipe{002}	~Lake 2	~P-9B	X Closed	---	---	---	---
Pipe{003}	~Lake 3	~P-9A	X Closed	---	---	---	---

Nodes

Node	Elev ft	Status	Pressure psi g	Grade ft
~CST(N-002)	587		10.97	612.4
~Node 01	586.24		11.28	612.3
~Node 02	582.92		12.53	611.9
~Node 03	582.22		12.82	611.9
~Node 04	581		12.69	610.3
~Node 05	581		12.61	610.2
~Node 06	581		12.47	609.8
~Node 07	577		13.95	609.2
~Node 10	573.79		1008	2905
~Node 11	583.5		1004	2905
~Node 14	573.79		1008	2905
~Node 15	578.25		1006	2904
~Node 16	597.5		997.4	2903
~Node 17	599.5		996.2	2903
~Node 18	603		994.7	2903
~NODE 19(E-50B	654.83		970.5	2898
~Node 20	599		943.5	2780
~Node 21	608.01		937.5	2775
~Node 22(E-50A	654.83		903.8	2744
~Node 23	580.33		11.4	606.7
~Node 26	571.33		1106	3127
~Node 27	572		1105	3126
~Node 28	571.75		1105	3125
~Node 30	571.75		1009	2904
~Node 31	581.46		1004	2903
~Node 32	603		994.8	2903
~Node 33	572		1104	3125
~Node 35	572		953.5	2777
~Node 36	584.46		947.8	2776
~Node 37	603.07		939.7	2776
~Node 38	608.01		937.6	2776

Pumps

Pump	Flow US gpm	Status	Total head ft	dP psi	Speed rpm	NPSHa ft	Suction psi g	Discharge psi g	Suction ft	Discharge ft
P-8B Nom	426.2		(2299)	(994.6)	3475	68.25	15.42	1010	573.17	573.17
P-8C Nom	345.4		(2523)	(1091)	3600	67.26	15.03	1106	571.46	571.46

Controls

Control	Set Value	Elev ft	Flow US gpm	Status	dP psi	HL ft	Inlet psi g	Outlet psi g
~Node 29	FCV: 161.7	571.17	161.7		86.94	201	1105	1018
~Node 34	FCV: 152.1	572	152.1		144.7	334.6	1104	959.7

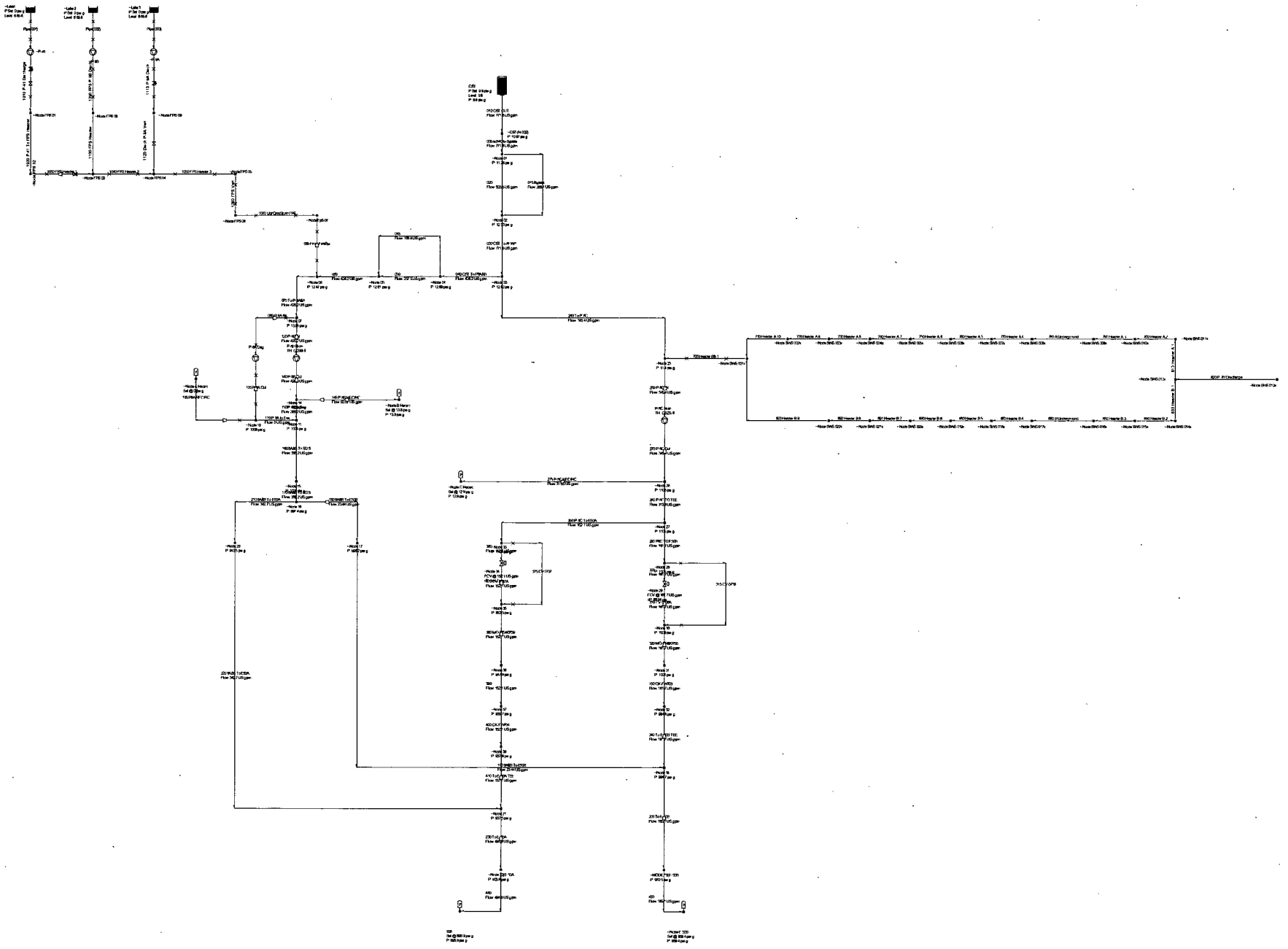
Tanks

Tank	Surface Pressure psi g	Level ft	Bottom Elevation ft	Status	Flow US gpm	Pressure psi g	Grade ft
CST	9.9	0	590		-771.6	9.9	612.9

Connecting pipelines	Flow (US gpm)	Pressure (psi g)	Grade (ft)
010 CST OUT @ 0 ft	771.6	9.9	612.9

Demands

Demand	Set Value	Flow Rate US gpm	Pressure psi g	Elev ft	Status	Grade ft
~Node B Recirc	Boundary pressure	60.02	13.8	581		612.9
~Node C Recirc	Boundary pressure	31.63	12.9	583		612.8
~Node E-50B	Boundary pressure	185.1	969.4	655.08		2896
908	Boundary pressure	494.8	896.9	655.08		2729



Lineup:	1530-1539	Darcy-Weisbach	PIPE-FLO 2007
System:	EA-PSA-SDP-D11-2-11-07		Flow: US gpm
Date:	11/15/11 10:41 am		Pressure: psi g
Company:	Entergy		Size: in
Project:	EA-PSA-SDP-D11-2-11-07		Elevation: ft
by:	sjm		Velocity: ft/sec
	Attachment 10, Appendix C		Length: ft
			Volume: gallons

System: EA-PSA-SDP-D11-2-11-07
Lineup: 1540-1603
rev: 11/15/11 10:34 am

System created: 01/29/08 7:04 am
with Design file: standard

Atm pressure: 14.7 psi a

11/15/11 10:41 am

Company: Entergy
Project: EA-PSA-SDP-D11-2-11-07
by: sjm

Total System Volume: 19974 gallons
Pressure drop calculations: Darcy-Weisbach method, laminar cutoff Re = 2100
Calculated: 7 iterations Avg Deviation: 0.004365 %

Specifications

Specification	Material / Schedule	Roughness	Sizing	Design Limits
AFWS @ 120 deg	Steel A53-B36.10 / 40 Valves: standard	0.0018 in C: 140	8 ft/sec	0 to 12 ft/sec 0 to 1200 psi g
AFWS @ 120 deg{sch40}	Steel A53-B36.10 / 40 Valves: standard	0.0018 in C: 140	8 ft/sec	0 to 12 ft/sec 0 to 1200 psi g
AFWS @ 120 deg{sch80}	Steel A53-B36.10 / 80 Valves: standard	0.00181 in C: 140	8 ft/sec	0 to 12 ft/sec 0 to 1200 psi g
FPS Header Pipe	Stainless Pipe IPS / 40S Valves: standard	0.0018 in C: 140	8 ft/sec	0 to 12 ft/sec 0 to 1200 psi g

Fluid Zones

Fluid Zone	Fluid	Temp °F	Pressure psi g	Density lb/ft³	Viscosity cP	Pv / Pc or k psi a
AFWS @ 87 deg	Water	87	0	62.32	0.7884	0.6355 / 3198
FPS_FEED_AFW	Water	85	0	62.32	0.807	0.5962 / 3198

Pipelines

Pipeline	From	To	Status	Flow US gpm	Velocity ft/sec	dP psi	HL ft
005 sch40 to Bypass	~CST(N-002)	~Node 01		634.6	7.053	(0.32)	0.019
010 CST OUT	CST	~CST(N-002)		634.6	7.817	(1.14)	0.364
015 Bypass	~Node 01	~Node 02		220.4	2.45	(1.306)	0.3
020	~Node 01	~Node 02		414.1	4.603	(1.306)	0.3
030 CST To AFWP	~Node 02	~Node 03		634.6	7.053	(0.295)	0.018
040 CST To P8A&B	~Node 03	~Node 04		438.5	4.874	0.17	1.613
045	~Node 04	~Node 05		173.7	1.931	0.077	0.179
050	~Node 04	~Node 05		264.7	2.943	0.077	0.179
060	~Node 05	~Node 06		438.5	4.874	0.148	0.341
065 From FireSys	~Node FpS 07	~Node 06	X Closed	---	---	---	---
070 To P-8A&B	~Node 06	~Node 07		438.5	4.874	(1.459)	0.627
080 P-8A IN	~Node 07	P-8A Deg	X Closed	---	---	---	---
100 P-8A Out	P-8A Deg	~Node 10	X Closed	---	---	---	---
1010 P-41 Discharge	~P-41	~Node FPS 01	X Closed	---	---	---	---
1030 FPS Header 1	~Node FPS 02	~Node FPS 03	X Closed	---	---	---	---
1040 FPS Header 2	~Node FPS 03	~Node FPS 04	X Closed	---	---	---	---
105 P8A RECIRC	~Node 10	~Node A Recirc	X Closed	---	---	---	---
1050 FPS Header 3	~Node FPS 04	~Node FPS 05	X Closed	---	---	---	---
1060 FPS Vert	~Node FPS 05	~Node FPS 06	X Closed	---	---	---	---
1070 UdrGrnd from FPS	~Node FPS 06	~Node FpS 07	X Closed	---	---	---	---
1090 FPS P-9B Disch	~P-9B	~Node FPS 08	X Closed	---	---	---	---
110 P-8A to Tee	~Node 10	~Node 11		0	0	4.2	0
1110 P-9A Disch	~P-9A	~Node FPS 09	X Closed	---	---	---	---
120 P-8B IN	~Node 07	P-8B Nom		438.5	4.874	(1.462)	0.451
140 P-8B Out	P-8B Nom	~Node 14		438.5	5.402	1.651	3.198
145 P-8B RECIRC	~Node 14	~Node B Recirc		59.02	6.418	961.9	2217
150 P-8B to Tee	~Node 14	~Node 11		379.4	4.675	4.395	0.45
160 8A&B To SG'S	~Node 11	~Node 15		379.4	4.675	(1.981)	0.671
170 8A&B To SG'S	~Node 15	~Node 16		379.4	4.675	8.712	0.89
180 8A&B To E50B	~Node 16	~Node 17		0	0	0.865	0
190 8A&B To E50B	~Node 17	~Node 18	X Closed	---	---	---	---
200 To E-50B	~Node 18	~NODE 19(E-50B		163.4	4.121	23.86	3.33
210 8A&B To E50A	~Node 16	~Node 20		379.4	10.6	65.9	150.9
220 8A&B To E50A	~Node 20	~Node 21		379.4	9.572	6.451	5.902
230 To E-50A	~Node 21	~Node 22(E-50A		379.4	9.572	28.27	18.53
240 To P-8C	~Node 03	~Node 23		196.1	2.18	(0.058)	1.755
250 P-8C IN	~Node 23	P-8C Nom		196.1	2.18	(3.767)	0.161
270 P-8C Out	P-8C Nom	~Node 26		196.1	2.416	0.226	0.652
275 P-8C RECIRC	~Node 26	~Node C Recirc		32.71	3.557	1168	2689
280 P-8C TO TEE	~Node 26	~Node 27		163.4	2.013	0.424	0.311
290 P8C TO E50B	~Node 27	~Node 28		163.4	2.013	0.24	0.806
300	~Node 28	~Node 29		163.4	2.013	(0.24)	0.026
310 CV-0736A	~Node 29	~Node 30		163.4	4.122	9.394	21.14
315 CV-0736	~Node 28	~Node 30	X Closed	---	---	---	---
320 MO-0748/0755	~Node 30	~Node 31		163.4	4.122	4.374	0.404
330 CK-FW703	~Node 31	~Node 32		163.4	1.816	9.459	0.329
340 To E-50B TEE	~Node 32	~Node 18		163.4	4.122	0.063	0.145
350 P-8C To E50A	~Node 27	~Node 33		0	0	0	0
360	~Node 33	~Node 34		0	0	0	0
370 CV-0737A	~Node 34	~Node 35		0	0	0	0
375 CV-0737	~Node 33	~Node 35	X Closed	---	---	---	---
380 MO-0754/0759	~Node 35	~Node 36		0	0	5.389	0

Pipelines

Pipeline	From	To	Status	Flow US gpm	Velocity ft/sec	dP psi	HL ft
390	~Node 36	~Node 37		0	0	8.049	0
400 CK-FW704	~Node 37	~Node 38		0	0	2.137	0
410 To E-50A TEE	~Node 38	~Node 21		0	0	0	0
430	~NODE 19(E-50B	~Node E-50B		163.4	7.097	0.85	1.716
440	~Node 22(E-50A	908	Limit	379.4	16.48	4.086	9.197
700 Header B8-1	~Node SWS 001x	~Node 23	X Closed	---	---	---	---
Pipe{001}	~Lake1	~P-41	X Closed	---	---	---	---
Pipe{002}	~Lake 2	~P-9B	X Closed	---	---	---	---
Pipe{003}	~Lake 3	~P-9A	X Closed	---	---	---	---

Nodes

Node	Elev ft	Status	Pressure psi g	Grade ft
~CST(N-002)	587		11.04	612.5
~Node 01	586.24		11.36	612.5
~Node 02	582.92		12.67	612.2
~Node 03	582.22		12.96	612.2
~Node 04	581		12.79	610.6
~Node 05	581		12.71	610.4
~Node 06	581		12.57	610.1
~Node 07	577		14.03	609.4
~Node 10	573.79		975.5	2829
~Node 11	583.5		971.3	2829
~Node 14	573.79		975.7	2830
~Node 15	578.25		973.3	2828
~Node 16	597.5		964.6	2828
~Node 17	599.5		963.7	2828
~Node 18	603		982.9	2875
~NODE 19(E-50B	654.83		959.1	2872
~Node 20	599		898.7	2677
~Node 21	608.01		892.3	2671
~Node 22(E-50A	654.83		864	2652
~Node 23	580.33		13.02	610.4
~Node 26	571.33		1181	3301
~Node 27	572		1180	3301
~Node 28	571.75		1180	3300
~Node 30	571.75		996.8	2876
~Node 31	581.46		992.4	2876
~Node 32	603		983	2876
~Node 33	572		1180	3301
~Node 35	572		907.8	2671
~Node 36	584.46		902.4	2671
~Node 37	603.07		894.4	2671
~Node 38	608.01		892.3	2671

Pumps

Pump	Flow US gpm	Status	Total head ft	dP psi	Speed rpm	NPSHa ft	Suction psi g	Discharge psi g	Suction ft	Discharge ft
P-8B Nom	438.5		(2224)	(961.9)	3475	68.41	15.49	977.4	573.17	573.17
P-8C Nom	196.1		(2692)	(1164)	3600	71.33	16.79	1181	571.46	571.46

Controls

Control	Set Value	Elev ft	Flow US gpm	Status	dP psi	HL ft	Inlet psi g	Outlet psi g
~Node 29	FCV: 163.4	571.17	163.4		174.2	402.7	1180	1006
~Node 34	FCV: 0	572	0		---	---	1180	907.8

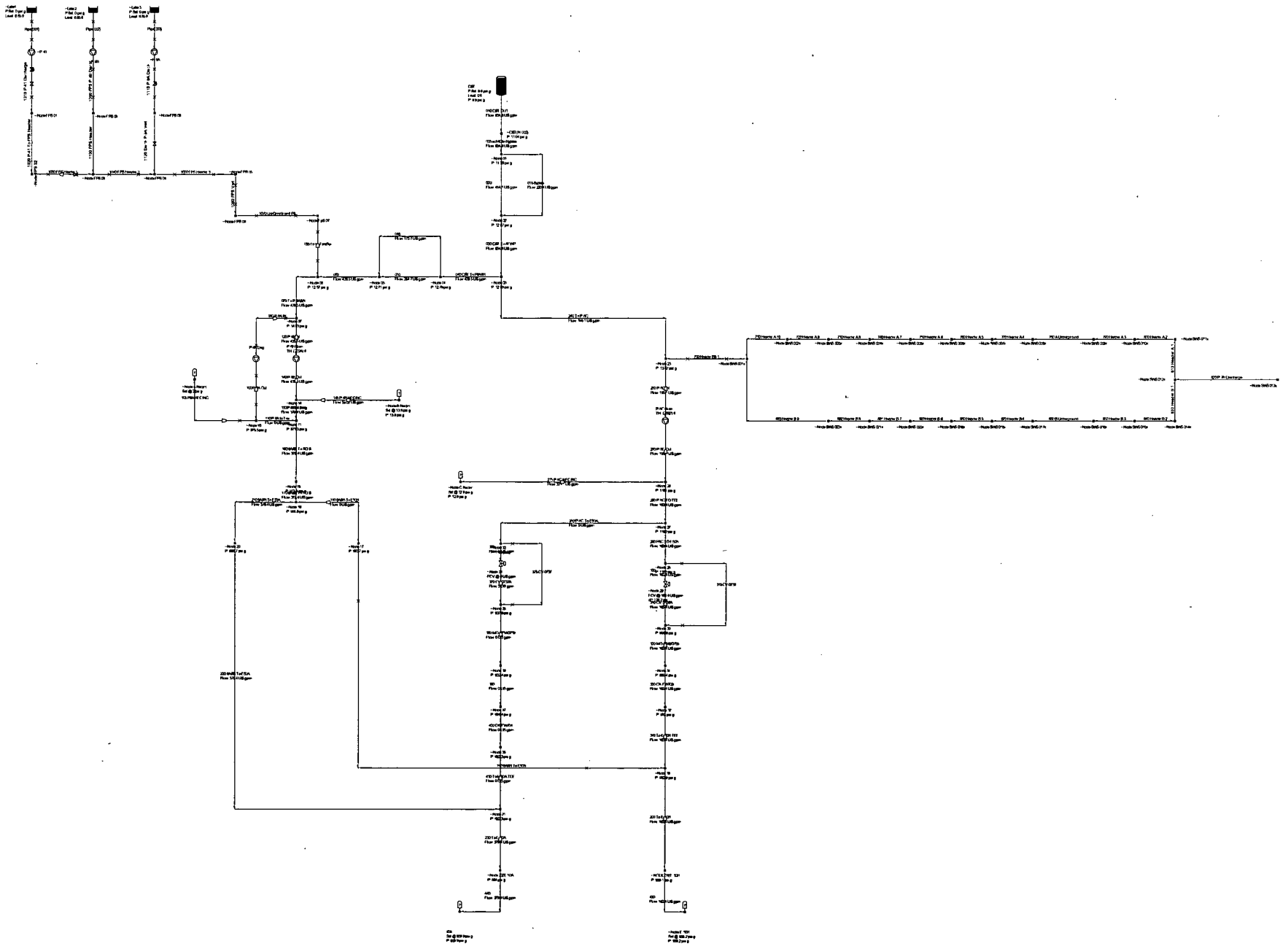
Tanks

Tank	Surface Pressure psi g	Level ft	Bottom Elevation ft	Status	Flow US gpm	Pressure psi g	Grade ft
CST	9.9	0	590		-634.6	9.9	612.9

Connecting pipelines	Flow (US gpm)	Pressure (psi g)	Grade (ft)
010 CST OUT @ 0 ft	634.6	9.9	612.9

Demands

Demand	Set Value	Flow Rate US gpm	Pressure psi g	Elev ft	Status	Grade ft
~Node B Recirc	Boundary pressure	59.02	13.8	581		612.9
~Node C Recirc	Boundary pressure	32.71	12.9	583		612.8
~Node E-50B	Boundary pressure	163.4	958.2	655.08		2870
908	Boundary pressure	379.4	859.9	655.08		2643



Lineup:	1540-1603	Darcy-Weisbach	PIPE-FLO 2007
System:	EA-PSA-SDP-D11-2-11-07		Flow: US gpm
Date:	11/15/11 10:41 am		Pressure: psi g
Company:	Entergy		Size: in
Project:	EA-PSA-SDP-D11-2-11-07		Elevation: ft
by:	sjm		Velocity: ft/sec
	Attachment 10, Appendix D		Length: ft
			Volume: gallons

Attachment 12 HRA Calculator Output for Developed HEPs

This attachment contains the EPRI HRA Calculator output for the failure to trip charging pump HEP and failure to align EY-10 to the bypass regulator, as discussed in Section 6.3.

References

[1] EPRI HRA Calculator™, Version 4.0, Electric Power Software Center, 9625 Research Drive, Charlotte, NC 28262.

CVC-PMOA-P55-TRIP-S, OP FAILS TO STOP CHARGING PUMP OPERATION (HEP)

Cognitive Method	Date	Analyst - Reviewer
CBDTM/ASEP/THERP	12/07/11	FJY - BAB
Analysis File	**File Date**	**File Size (Bytes)**
Pal_Post_HEPs_r3 1-5-11.HRA	12/07/11	5935104

Table 1: CVC-PMOA-P55-TRIP-S SUMMARY

Analysis Method:	CBDTM/ASEP Combination (Sum)	
Analysis Database:	Pal_Post_HEPs_r3 1-5-11.HRA (12/07/11, 5935104 Bytes)	
Analysis Results:	without Recovery	with Recovery
$P_{cog-CBDTM}$	6.8e-03	3.1e-04
$P_{cog-ASEP}$	1.9e-03	1.9e-03
P_{exe}	2.0e-02	4.6e-03
Total HEP		6.8e-03
Error Factor		5

Identification and Definition

This HEP is modified from the base case to replicate the conditions of the 9/25/2011 loss of dc event. As a result of the loss of dc and preferred ac power in this event an additional charging pump started on a right channel safety injection signal. Letdown was isolated when CV-2009 closed due a right channel containment high radiation signal. Consequently the event results in a charging letdown flow mismatch which results in a continuous rise in pressurizer level. This condition requires the operator action to control charging to regain control of pressurizer level prior to challenging a pressurizer safety. The timing regarding this action is provided under the time window description. This action is the same as the base case action under different conditions with the same indications
and alternate timing as described in the 'Time Window' discussion.

In response to annunciator LETDOWN HT EX TUBE INLET HI-LO PRESS, EK-0704 operators would observe charging and letdown flow and place all 3 orifice valve control switches to CLOSE per ARP-4. The ARP then directs restoring charging and letdown when desired per SOP-2A. If P-55A is not stopped, PZR level will continue rising.

a. SOP-2A Section 7.3.9 TO RESTORE LETDOWN provides direction for restoring letdown flow. There is no stated procedural link between the ARPs and SOP-2A Section 7.3.8 ISOLATE LETDOWN AT RATED CONDITIONS. However, this section does provide direction to successfully mitigate this condition and may be referred to as the title describes the existing condition.

b. In the event action is not taken to manually control charging flow, PZR level will continue rising and the PRESSURIZER LEVEL HI-LO, EK-0761 annunciator will alarm at 62.75% level, and then annunciator PRESSURIZER HIGH LEVEL, EK-0769 will alarm at 75% level. ARP response for these annunciators directs the operator to SHIFT level level control to the channel not in service. Additionally direction is provided that manual control may be necessary.

On reactor trip the operators enter EOP-1.0 STANDARD POST-TRIP ACTIONS. Immediate Actions Step 5 directs the operator to manually control charging and letdown to maintain PZR level between 42% and 57%, at which time they take manual control of the charging pumps.

1. Initial Conditions: Steady state, full power operations

2. Initiating Event: Malfunction occurs spuriously isolating letdown.

3. Accident Sequence (preceding functional failures and successes):

LETDOWN HT EX TUBE OUTLET HI-LO PRESS EK-0704 annunciators alarms.

ARP-4 provides guidance that the operator may have to to manually control pressure and RESTORE Charging and Letdown in a controlled manner per SOP-2A.

In this scenario, failure to trip charging pump(s) would challenge pressurizer safeties.

4. Preceding operator errors or successes in sequence: No operator errors or additional successes noted.

5. Operator action success criterion: Success is tripping charging pumps P-55B, C and/or A as necessary to restore level to the normal operating band .

6. Consequences of failure: SORV, LOCA, and potential for core damage.

Assigned Basic Events

Cues and Indications	
Initial Cue	EK-0704, LETDOWN HT EX TUBE OUTLET HI-LO PRESS
Recovery Cue	Pump breaker status indicating lights on panel EC-02. Charging flow indication FIC-0202 on panel EC-02. Pressurizer level indication LIC-0101A/B (narrow range on EC-02), LI-0103A (wide range, on EC-02) and LIA-0102A (wide range on panel EC-12).
Cue/s	In response to annunciator LETDOWN HT EX TUBE INLET HI-LO PRESS, EK-0704 operators would observe charging and letdown flow and place all 3 orifice valve control switches to CLOSE per ARP-4. The ARP then directs restoring charging and letdown when desired per SOP-2A. If P-55A is not stopped, PZR level will continue rising. In the event action is not taken to manually control charging flow, PZR level will continue rising and the PRESSURIZER LEVEL HI-LO, EK-0761 annunciator will alarm at 62.75% level, and then annunciator PRESSURIZER HIGH LEVEL, EK-0769 will alarm at 75% level. Additional indication available: LI-0103B on panel EC-33 in the Auxiliary Building 590 elevation LI-0102B on panel EC-150 in the Turbine Building 607 elevation
Degree of Clarity	Very Good

Procedures and Training	
Cognitive Procedure	ARP-4 TILE 4 (Revision: 58)
Cognitive Step Number	OPERATOR ACTION
Cognitive Instruction	CHECK Charging flow and Letdown flow matched.
Execution Procedure	ARP-4 TILE 4 (Revision: 58)
Other Procedure	SOP-2A (Revision: 69)
Job Performance Measure	PL-OPS-CVC-005J
Classroom Training	Frequency: 0.5 per year
Simulator Training	Frequency: 0.5 per year

Notes

Procedures applicable to this action

EOP-1.0 STANDARD POST-TRIP ACTIONS REV 12
ARP-4 PRIMARY COOLANT PUMP STEAM GENERATOR AND ROD DRIVES SCHEME EK-07 (EC-12) REV 58
SOP-2A CHEMICAL AND VOLUME CONTROL SYSTEM REV 70

In response to annunciator LETDOWN HT EX TUBE INLET HI-LO PRESS, EK-0704 operators would observe charging and letdown flow and place all 3 orifice valve control switches to CLOSE per ARP-4. The ARP then directs restoring charging and letdown when desired per SOP-2A. If P-55A is not stopped, PZR level will continue rising.

TRAINING:
Initial training and is included in 2 year training plan.
JPM PL-OPS-CVC-005J, MANUALLY LOWER CHARGING AND LETDOWN FLOW includes an action to manually stop P-55B or P-55C when desired to reduce letdown flow. Stopping P-55A would be a similar action.

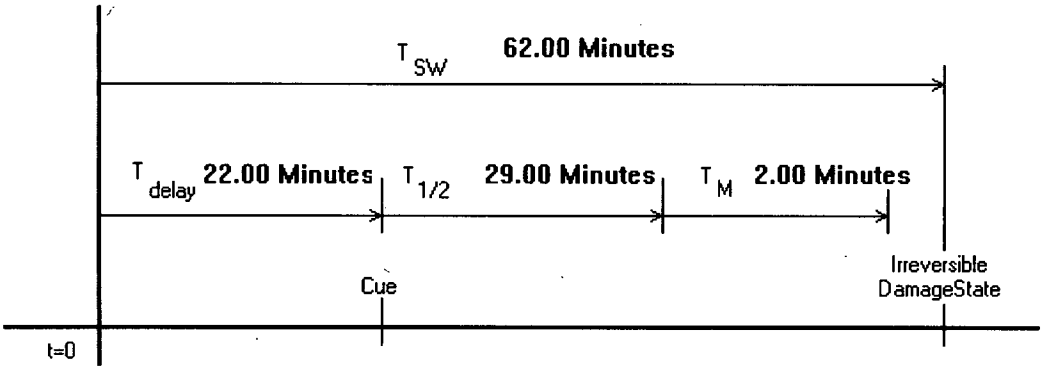
Manpower Requirements			
		Default	**Actual**
Operations:	Shift Manager	1	0
	Shift Supervisor	1	1
	STA	1	0
	Reactor Operators	2	1
	Plant Operators	4	0
Maintenance	Mechanics	0	0
	Electricians	0	0
	I&C Technicians	0	0
Health Physics	Technicians	1	0
Chemistry	Technicians	1	0

Dependencies (Related Human Interactions)
CVC-AVOB-CV-2001 OP FAILS TO CLOSE CV-2001 ON HIGH TEMP AT LETDOWN HX E-58 (HEP) CVC-AVOA-CV-2003 OPERATOR FAILS TO CLOSE LETDOWN ORIFICE STOP VALVE CV-2003 (HEP) CVC-AVOA-CV-2122 OP FAILS TO OPEN LETDOWN INTERMEDIATE PRESSURE CONTROL (HEP) CVC-PMOA-P55-TRIP OP FAILS TO STOP CHARGING PUMP OPERATION (HEP) CVC-PMOE-P-55-2 OP FAILS TO START ADDITIONAL CHARGING PUMPS FOR 2 IN SERVICE CVC-MVOA-SUCT-SRCE OP FAILS TO TRANSITION SUCTION SOURCE TO SIRWT (HEP)

Key Assumptions

Operator Interview Insights

Timing Analysis



Timing Analysis	
T_{sw}	62.00 Minutes
T_{delay}	22.00 Minutes
$T_{1/2}$	29.00 Minutes
T_M	2.00 Minutes
Time available for recovery	9.00 Minutes
SPAR-H Available time (cognitive)	38.00 Minutes
SPAR-H Available time (execution) ratio	5.50
Minimum level of dependence for recovery	HD

Notes

Regarding Tsw : The time for Tsw is based on the 9/25/2011 loss of dc event that led to increasing pressurizer level. The rising pressurizer level was consequence the loss dc power that caused isolation of letdown flow and a right channel safety injection signal. The right channel safety injection signal resulted in the start of an additional charging pump. The excess charging flow with no letdown flow caused the rise in pressurizer level and pressure. Based on the event timeline and additional information provided in the EA-PSA-SDP-D11-2-11-07, the time to the consequential condition that pressurizer safety would be challenged without operator intervention was determined to be 62 minutes. Additional details regarding the event response are discussed in the EA.

The time to the indication of high pressurizer pressure and increasing level was 22 minutes. The median (actual) response time was 29 minutes. The response time was a result of operator action to verify boration requirements were met prior throttling injection flow.

The base version of the HEP assumed a bounding condition and was based on three charging pumps operating with nominal letdown and assumed the consequential failure occurs when 100% level is reached and ignored the volume above 100%. The base version with three charging pumps operating predicted the time to consequential failure to be 30 minutes. The base version with only two charging pumps operating operating predicts consequential failure at 64 minutes similar to the Tsw for 9/25/2011 event.

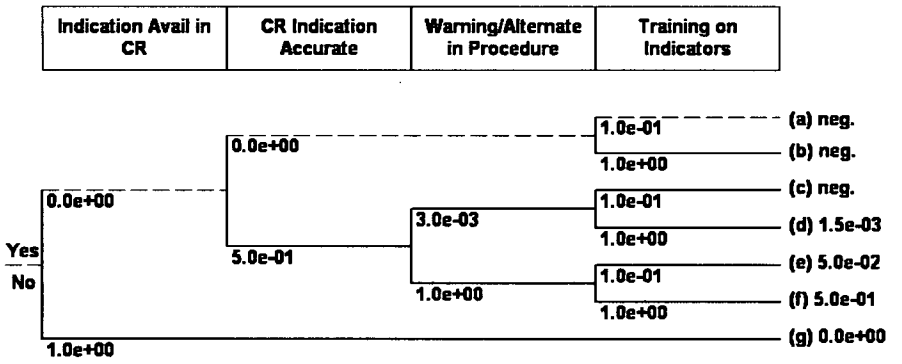
The execution time is unchanged as the actions in this version are the same actions used in the base case.

Per P-IOAQ (RMassa, 12/21/2010):

> Tm: It would take ~2 minutes to complete the action once the need is identified.
>
> NOTE: Currently, actions to open the additional letdown valves are not credited as part of this action.

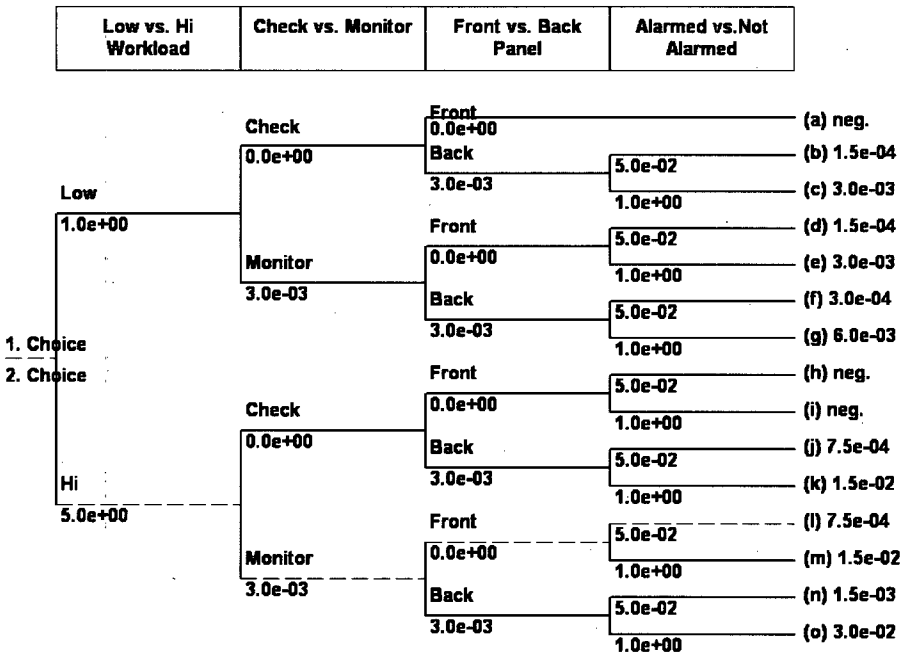
Cognitive Analysis		
Pc Failure Mechanism	**Branch**	**HEP**
P_{ca}: Availability of Information	a	neg.
Notes: Indicators available, accurate. Crew trained.		
P_{cb}: Failure of Attention	I	7.5e-04
Notes: Workload expected to be high (multiple alarms). Operators monitor pressurizer conditions, using instruments located on a front panel. Indicators are alarmed.		
P_{cc}: Misread/miscommunicate data	a	neg.
Notes: The applicable indications are easy to locate and they do not have human engineering deficiencies. The Palisades operators use formal communications.		
P_{cd}: Information misleading	a	neg.
Notes: Cues as stated.		
P_{ce}: Skip a step in procedure	g	6.0e-03
Notes: The steps concerning pressurizer control and leak isolation are not hidden in any way although they are not graphically distinct. The operators are in multiple procedures. The ONPs and the ARPs are Continuous Use procedures and the operators are required to mark off steps as they are completed via the circle/slash method of placekeeping.		
P_{cf}: Misinterpret Instructions	a	neg.
Notes: The procedure steps involving pressurizer control use standard wording and the operators have all the information they need to complete this action.		
P_{cg}: Misinterpret decision logic	I	neg.
Notes: There are no NOT, AND or OR statements in the decision logic for pressurizer control. The operators have practiced pressurizer control, however, the scenarios postulated for this action are do not clearly link the symptoms to the action of controlling the charging pumps.		
P_{ch}: Deliberate violation	a	neg.
Notes: The operators believe that the instructions contained in their procedures are accurate and adequate.		
Initial P_c(without recovery credited)		6.8e-03
Notes		
Cognitive Complexity	Complex	
Equipment Accessibility	Control Room (Panel C-12): Accessible	

pca: Availability of information



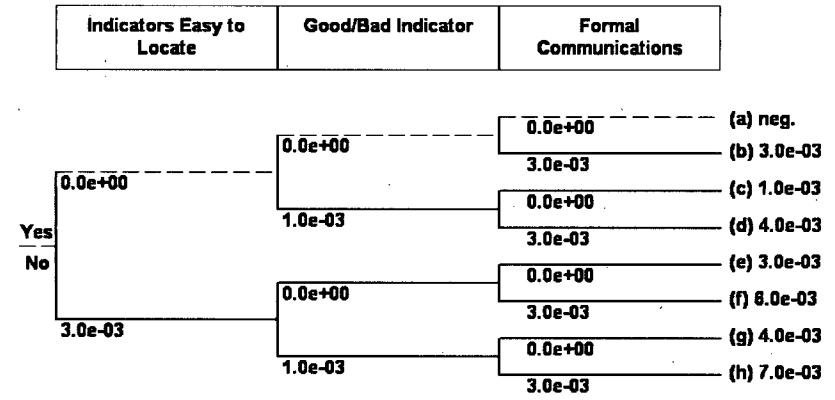
Indicators available, accurate. Crew trained.

pcb: Failure of attention



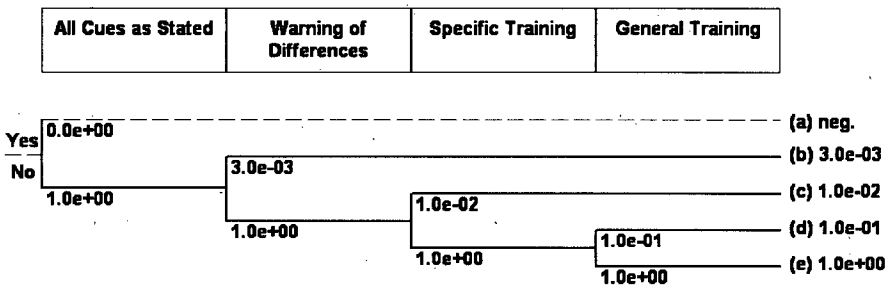
Workload expected to be high (multiple alarms). Operators monitor pressurizer conditions, using instruments located on a front panel. Indicators are alarmed.

pcc: Misread/miscommunicate data



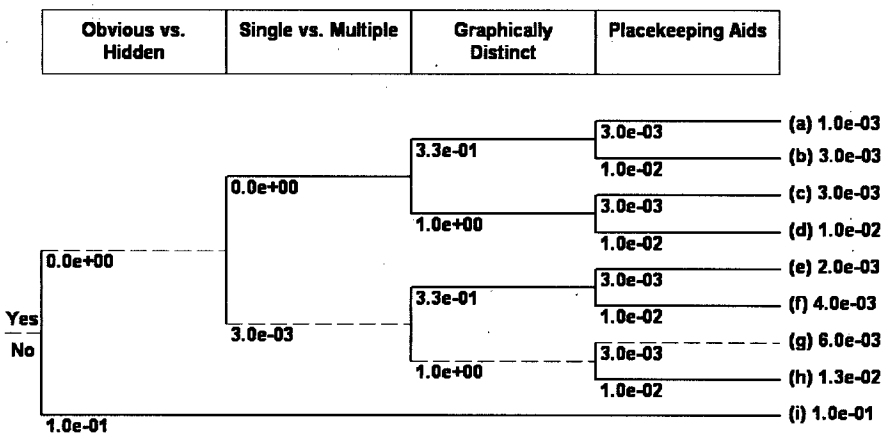
The applicable indications are easy to locate and they do not have human engineering deficiencies. The Palisades operators use formal communications.

pcd: Information misleading



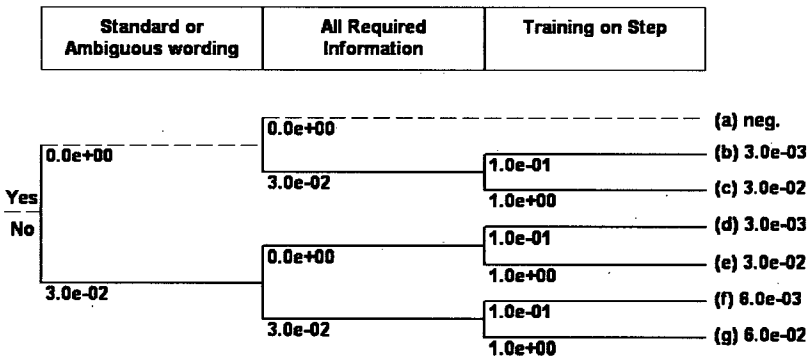
Cues as stated.

pce: Skip a step in procedure



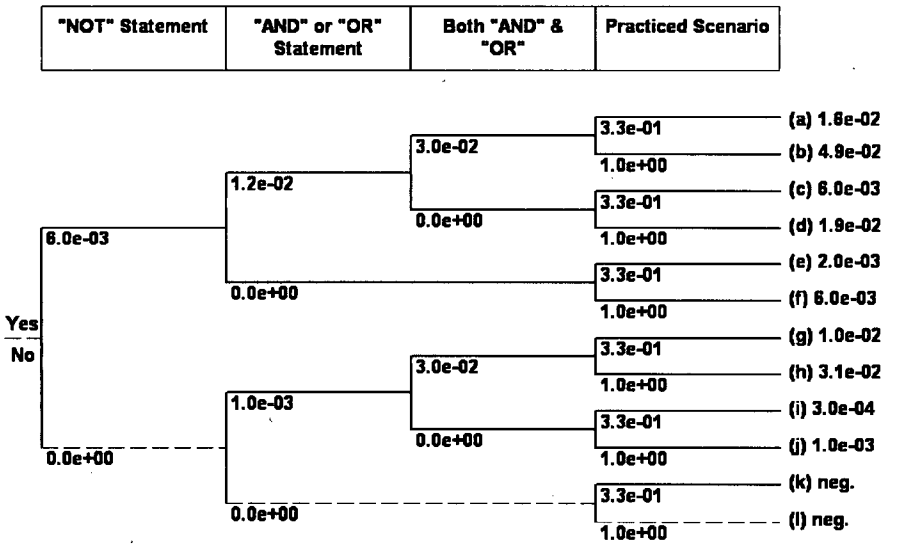
The steps concerning pressurizer control and leak isolation are not hidden in any way although they are not graphically distinct. The operators are in multiple procedures. The ONPs and the ARPs are Continuous Use procedures and the operators are required to mark off steps as they are completed via the circle/slash method of placekeeping.

pcf: Misinterpret instruction



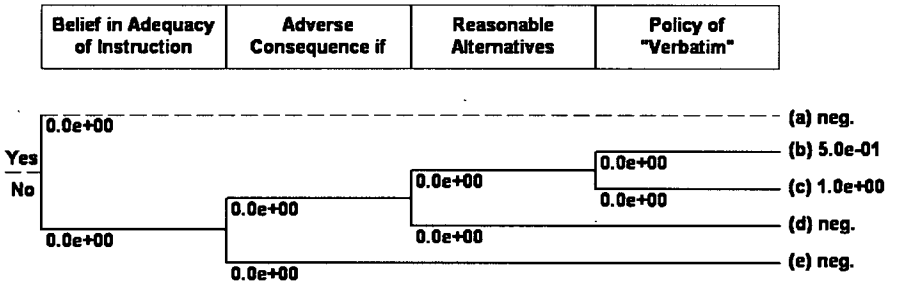
The procedure steps involving pressurizer control use standard wording and the operators have all the information they need to complete this action.

pcg: Misinterpret decision logic



There are no NOT, AND or OR statements in the decision logic for pressurizer control. The operators have practiced pressurizer control, however, the scenarios postulated for this action are do not clearly link the symptoms to the action of controlling the charging pumps.

pch: Deliberate violation



The operators believe that the instructions contained in their procedures are accurate and adequate.

Cognitive Recovery											
	Initial HEP	Self Review	Extra Crew	STA Review	Shift Change	ERF Review	Recovery Matrix	Dependency Level	Multiply HEP By	Override Value	Final Value
Pc_a	neg.	-	-	-	-	-	N/A	-	1.0e+00		
Pc_b	7.5e-04	X	-	X	-	-	N/A	-	1.0e-02		7.5e-06
Pc_c	neg.	-	-	-	-	-	N/A	-	1.0e+00		
Pc_d	neg.	-	-	-	-	-	N/A	-	1.0e+00		
Pc_e	6.0e-03	X	X	-	-	-	N/A	-	5.0e-02		3.0e-04
Pc_f	neg.	-	-	-	-	-	N/A	-	1.0e+00		
Pc_g	neg.	-	-	-	-	-	N/A	-	1.0e+00		
Pc_h	neg.	-	-	-	-	-	N/A	-	1.0e+00		
Final Pc (with recovery credited)											3.1e-04
Notes											
Pc uses "extra crew" as a surrogate for shift supervisor credit (Control Room Supervisor). Control room actions would be peer checked as they are performed by the other Reactor Operator, Shift Engineer or Control Room Supervisor.											

Pc ASEP Nominal Diagnosis Model
In order to compensate for possible non-conservative estimates produced by the cause-based method for short term actions (Time available for recovery <1 hour), the cognitive failure probability for short term actions is taken to be the sum of the cause-based and ASEP results; longer term actions do not include the ASEP component.

Use Nominal HEP because the event is not a "well-recognized classic", but it is trained on.

Actual Time	Error Factor	Median HEP	Mean	Upper Bound	Lower Bound
29.0 minutes	**10**	4.6e-04	**1.9e-03**	6.7e-03	3.1e-05

Execution Performance Shaping Factors		
Environment	Lighting	Normal
	Heat	Normal
	Radiation	Background
	Atmosphere	Normal
Equipment Accessibility	Control Room (Panel EC-02)	Accessible
Stress	**Moderate**	
	Plant Response As Expected:	Yes
	Workload:	High
	Performance Shaping Factors:	Optimal
Notes		
Following recognition of the need for the action (Pcognitive), the operator workload is assessed as high due to the number actions required as a consequence of the event. The PSFs are not negative for this action which is executed in the control room.		
Execution Complexity	Simple	

Execution Unrecovered							
Procedure: ARP 4 TILE 4, PRIMARY SYSTEM VOLUME LEVEL PRESSURE SCHEME EK-07 (C-12)		Comment				Stress Factor	Over Ride
Step No.	Instruction/Comment	Error Type	THERP Table	THERP Item	HEP		
EOP-1 Step 5.1 a	IF PLCS does NOT respond, THEN RESTORE AND MAINTAIN PZR level between 42% and 57%: a. OPERATE PZR Level Control System (PLCS).					2	
	--	EOM	20-7b	2	1.3E-3		
		EOC	20-12	2	3.8E-3		
					Total Step HEP		1.0e-02
EOP-1 Step 5.1 b	IF PLCS does NOT respond, THEN RESTORE AND MAINTAIN PZR level between 42% and 57%:b. MANUALLY OPERATE Charging and Letdown					2	
	--	EOM	20-7b	2	1.3E-3		
		EOC	20-12	2	3.8E-3		
					Total Step HEP		1.0e-02
EXEC RECOV - ICR	Execution recovery provided by independent personnel	See Section 4.3 of the HRA Notebook for further information. This execution recovery factor is applied to the individual execution steps with a dependence factor based on the time available for recovery. Note that the execution stress factors applied to the execution subtasks are not applied to the execution recovery factor. The EOM does not apply.				2	0.1
					Total Step HEP		1.0e-01

Execution Recovered							
Critical Step No.	Recovery Step No.	Action	HEP (Crit)	HEP (Rec)	Dep.	Cond. HEP (Rec)	Total for Step
EOP-1 Step 5.1 a		IF PLCS does NOT respond, THEN RESTORE AND MAINTAIN PZR level between 42% and 57%: a. OPERATE PZR Level Control System (PLCS).	1.0e-02				2.3e-03
	EXEC RECOV - ICR	Execution recovery provided by independent personnel		1.0e-01	MD	2.3e-01	
EOP-1 Step 5.1 b		IF PLCS does NOT respond, THEN RESTORE AND MAINTAIN PZR level between 42% and 57%:b. MANUALLY OPERATE Charging and Letdown	1.0e-02				2.3e-03
	EXEC RECOV - ICR	Execution recovery provided by independent personnel		1.0e-01	MD	2.3e-01	
		Total Unrecovered:	2.0e-02			**Total Recovered:**	4.6e-03

ACP-CBOB-BYREG-2, OPERATOR FAILS TO ALIGN BUS Y-01 THROUGH BYPASS REGULATOR TO SUPPLY A DE-ENERGIZED PFAC BUS (HEP)

Analyst:	FJY
Rev. Date:	12/08/11
Reviewer:	BAB
Cognitive Method:	CBDTM/THERP
Analysis Database:	Pal_Post_HEPs_r3 1-5-11.HRA (12/08/11, 5967872 Bytes)

Table 2: ACP-CBOB-BYREG-2 SUMMARY

Analysis Results:	without Recovery	with Recovery
P_{cog}	1.2e-02	6.0e-04
P_{exe}	6.5e-02	3.3e-02
Total HEP		3.3e-02
Error Factor		5

Assigned Basic Events:

Related Human Interactions:
Although Y20 is modeled in this calculation, the analysis applies equally to the alignment of any of the remaining preferred AC busses.

Initial Cue:
Loss of Preferred AC Bus Y10, Y20, Y30, or Y40

Recovery Cue:

Cue:
Multiple procedures (as listed in the "Procedures" section) direct the operators to verify that AC busses are energized. For the preferred AC busses, the contingency action directs OPS to:

ONP-24.1, LOSS OF PREFERRED AC BUS Y10
ONP-24.2, LOSS OF PREFERRED AC BUS Y20
ONP-24.3, LOSS OF PREFERRED AC BUS Y30
ONP-24.4, LOSS OF PREFERRED AC BUS Y40

Degree of Clarity of Cues & Indications:
Very Good

Procedures:
Cognitive: ONP-24.2 (LOSS OF PREFERRED BUS Y20) Revision: 23
Execution: SOP-30 (STATION POWER) Revision: 53
Other: EOP-9.0 (FUNCTIONAL RECOVERY PROCEDURE) Revision: 19

Cognitive Procedure:
Step: 4.17
Instruction: IF a fault does NOT exist on Y20, THEN REFER TO SOP-30 AND PLACE Y20 on the Bypass Regulator.

Procedure Notes:
EOP-1.0, STANDARD POST-TRIP ACTIONS step 4.4.6) states: VERIFY 3 of 4 Preferred AC buses are energized.

EOP-2.0, REACTOR TRIP RECOVERY, step 4.9 directs the operators to verify that the given AC buses are energized. The contingency action for the preferred AC busses directs the operators to ONP-24.1 through ONP-24.4, LOSS OF PREFERRED AC BUS Y10 / Y20 / Y30 / Y40.

The following procedures contain this action:

EOP-2.0 REACTOR TRIP RECOVERY
EOP-9.0 FUNCTIONAL RECOVERY PROCEDURE MV-AE-DC-1
ONP-2.3 LOSS OF DC POWER
ONP-24.1, 24.2, 24.3, 24.4 LOSS OF PREFERRED BUS Y-10, Y-20, Y-30, Y-40
ARP-3 WINDOWS 34, 44, 45, 46 PREFERRED AC BUS NO. 1, 2, 3, 4 TROUBLE
ARP-3 WINDOW 48 125V DC BUS UNDERVOLTAGE/TROUBLE
SOP-30, STATION POWER, Section 7.6.2, To Supply a Preferred AC Bus With the Bypass Regulator

This is an Auxiliary Operator action, and the following JPMs are available:

(Licensed Operators) JPMPL-OPS-EPS-001(PLACE PREFERRED AC BUS, Y-20 ON BYPASS REGULATOR)

Training:

Simulator, Frequency: 0.5 per year

JPM Procedure:
JPM ISBA-JPM-04 (PLACE PREFERRED AC BUS, Y-20 ON BYPASS REGULATOR) Revision: 6

Identification and Definition:

This action aligns power from bus Y-01 via the bypass regulator to a preferred AC power bus (Y-10, Y-20, Y-30 or Y-40) which has failed due to a failure of its power source, i.e. MCC-1 or MCC-2. As stated earlier, although Y20 is modeled here, the analysis applies to the alignment of any of the remaining preferred AC busses.

1. Initial Conditions: Steady state, full power operations

2. Initiating Event: LODC (bus ED-10)

3. Accident Sequence (preceding functional failures and successes):

Loss of DC power to DC bus ED10-R and ED10-L.
Reactor Trip

Turbine Trip
OPS enters EOP-1.0 and performs the standard post-trip actions.

The operators would continue in EOP-1.0 and enter ONP-24.1 and ONP-24.3 For post trip actions and indications of loss of preferred ac panels EY-10 and EY-30.
ARP-3, alarm response refers the operators to ONP-24.1 and ONP-24.3 for alternatives to power the preferred AC panel loads.
EOP-1.0 event diagnostic directs the operator to EOP 9.0 if 3 of 4 preferred AC busses are not energized. Given the safety function criteria (SF) are not met (2 or more preferred AC busses NOT energized), then the operators would transition to EOP-9.0 Functional Recovery Procedure and start working through success path MV-AE-DC-1 since it is the only "jeopardized" SF. MV-AE-DC-1 step 6 directs operators to verify at least 3 preferred AC busses are energized. If less than 3 are available, step 6.1 directs operators to ENERGIZE ALL available preferred AC Buses per ONP-24.1, 2, 3, 4 as applicable.
ONP-24.2 step 4.17 directs: IF a fault does NOT exist on Y20, THEN REFER TO SOP-30 AND PLACE Y20 on the Bypass Regulator.
SOP-30, STATION POWER, Section 7.6.2, To Supply a Preferred AC Bus With the Bypass Regulator.

4. Preceding operator errors or successes in sequence: No operator errors or additional successes noted.

5. Operator action success criterion: Success is restoring Y20 prior to battery depletion.

6. Consequences of failure: Loss of TD AF pump and AF valve control

Key Assumptions:
Current modeling assumes only Y-20 can be backed up by the bypass regulator. Any single preferred AC bus can be backed up.

Operator Interview Insights:
EOP-2.0, REACTOR TRIP RECOVERY, would only be entered if the scenario was an "uncomplicated" trip. If a LOOP is in progress, the operators would transition from EOP-1.0 to EOP-8.0 LOSS OF OFFSITE POWER/NATURAL CIRCULATION RECOVERY. EOP-8.0 safety function status checks require 3 of 4 preferred AC busses to be energized. So if only one is not energized, the function is met and NO corrective action is directed.

If the safety function criteria (SF) are not met (2 or more preferred AC busses NOT energized), then the operators would transition to EOP-9.0, Functional Recovery Procedure, and start working through success path MV-AE-DC-1 since it is the only "jeopardized" SF. MV-AE-DC-1 step 6 directs operators to verify at least 3 preferred AC busses are energized. If less than 3 are available, step 6.1 directs operators to ENERGIZE ALL available preferred AC Buses per ONP-24.1, 2, 3, or 4 as applicable.

In summary, for loss of 1 preferred bus with any other single event in progress procedures do not direct any action being taken with exception of annunciator response procedure ARP-3.

Manpower Requirements:

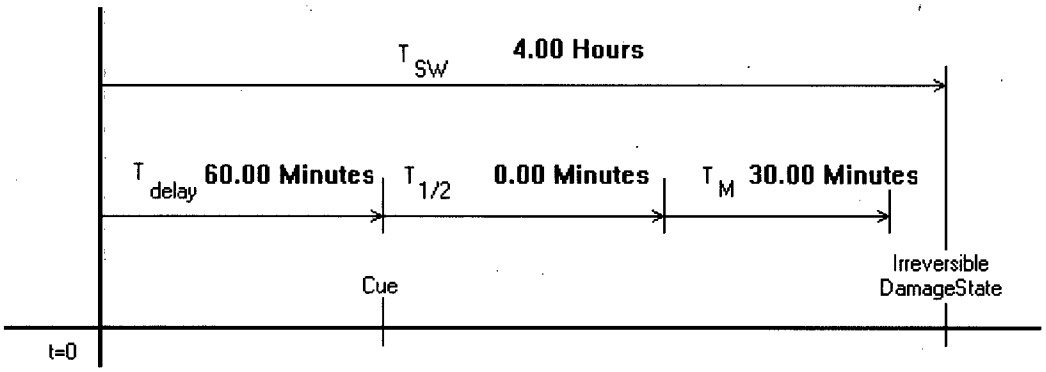
Operations:	Shift Manager	1	0
	Shift Supervisor:	1	1
	STA:	1	1
	Reactor operators:	2	1
	Plant operators:	4	2
Maintenance:	Mechanics:	0	0
	Electricians:	0	0
	I&C Technicians:	0	0
Health Physics:	Technicians:	1	0
Chemistry:	Technicians:	1	0

Execution Performance Shaping Factors:

Environment:	Lighting	Normal
	Heat/Humidity	Normal
	Radiation	Background
	Atmosphere	Normal
Special Requirements:		
Complexity of Response:	Cognitive	Simple
	Execution	Complex
Equipment Accessibility:	Control Room	Accessible
	Cable Spreading Room (AB 607')	Accessible
Stress:	**Moderate**	
	Plant Response As Expected:	Yes
	Workload:	Low
	Performance Shaping Factors:	Negative

Performance Shaping Factor Notes:
Because of the relatively long system window, the workload is not high. While the PSFs could be assigned as "negative" due to the emergency lighting in service for a LOOP case, operator interviews conducted in August 2009 confirmed that there is sufficient emergency lighting available for both access and execution. The PSFs are therefore not assessed as negative. Additionally, a second AO would do peer checking on a "not to delay basis." However, there is more than sufficient time to complete this action as the SPAR execution ratio is 6.

Timing:



Timing Analysis:
The system window is based on battery depletion time. As given in the EOP-3.0 basis document (rev 11) [47], the battery depletion time is 4 hours per DBD Chapter 4.01, Section 3.2.2, and FSAR Chapter 8.

According to an OPS estimate, it will take the operators 20 minutes to complete EOP-1.0. For a LOOP event, the crew will then transition to EOP-8.0 LOSS OF OFFSITE POWER/NATURAL CIRCULATION RECOVERY. EOP-8.0 safety function status checks require 3 of 4 preferred AC busses to be energized. If the safety function criteria (SF) are not met (2 or more preferred AC busses NOT energized), then the operators would transition to EOP-9.0 Functional Recovery Procedure and start working through success path MV-AE-DC-1 since it is the only "jeopardized" SF. MV-AE-DC-1 step 6 directs operators to verify at least 3 preferred AC busses are energized. If less than 3 are available, contingency action step 6.1 directs operators to ENERGIZE ALL available preferred AC Buses per ONP-24.1, 2, 3, 4 as applicable. Reaching this step is expected to take another 40 minutes per OPS estimates (08/26/09). Therefore, the time to reach the direction for this action is expected to take a total of 60 minutes. (Tdelay)

The manipulation time estimate for this action is 30 minutes. (OPS estimate 08/26/09)

Time available for recovery: 150.00 Minutes

SPAR-H Available time (cognitive): 150.00 Minutes

SPAR-H Available time (execution) ratio: 6.00

Minimum level of dependence for recovery: ZD

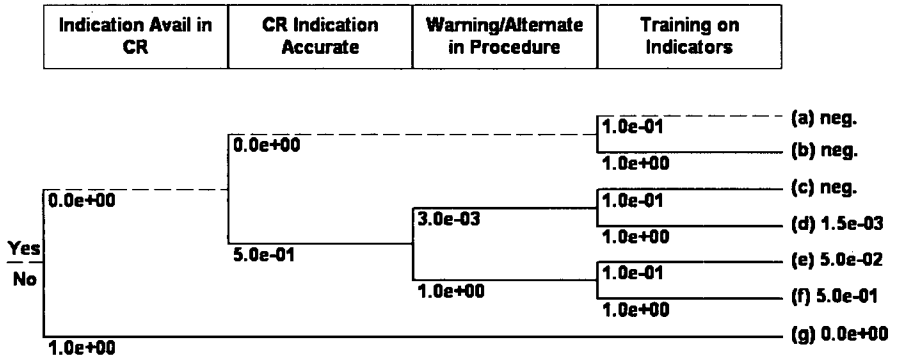
Cognitive Unrecovered

ACP-CBOB-BYREG-2

Table 3: ACP-CBOB-BYREG-2 COGNITIVE UNRECOVERED

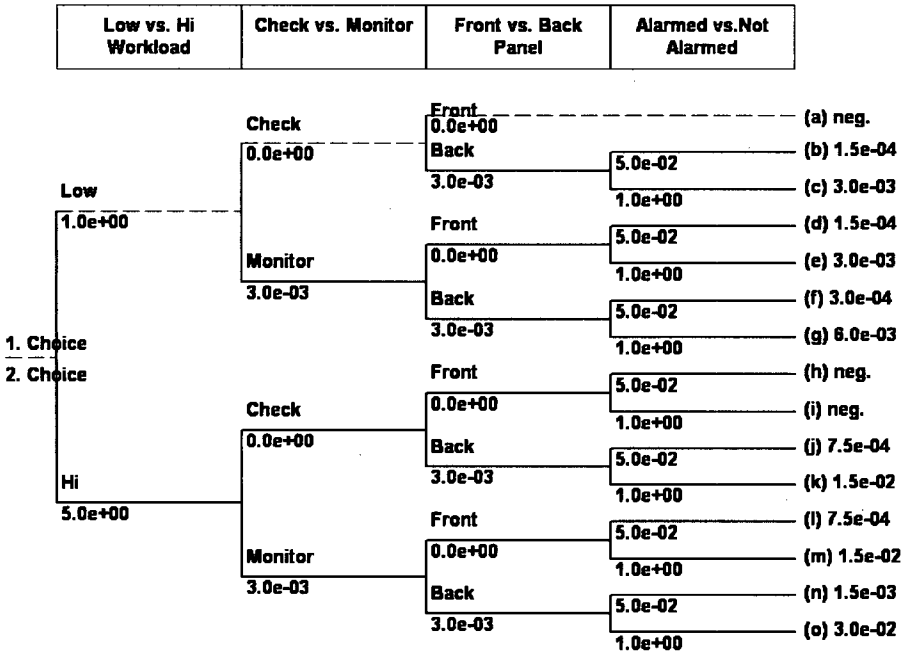
Pc Failure Mechanism	Branch	HEP
Pc_a: Availability of Information	a	neg.
Pc_b: Failure of Attention	a	neg.
Pc_c: Misread/miscommunicate data	a	neg.
Pc_d: Information misleading	a	neg.
Pc_e: Skip a step in procedure	g	6.0e-03
Pc_f: Misinterpret instruction	a	neg.
Pc_g: Misinterpret decision logic	c	6.0e-03
Pc_h: Deliberate violation	a	neg.
Sum of Pc_a through Pc_h = Initial Pc =		1.2e-02

pca: Availability of information



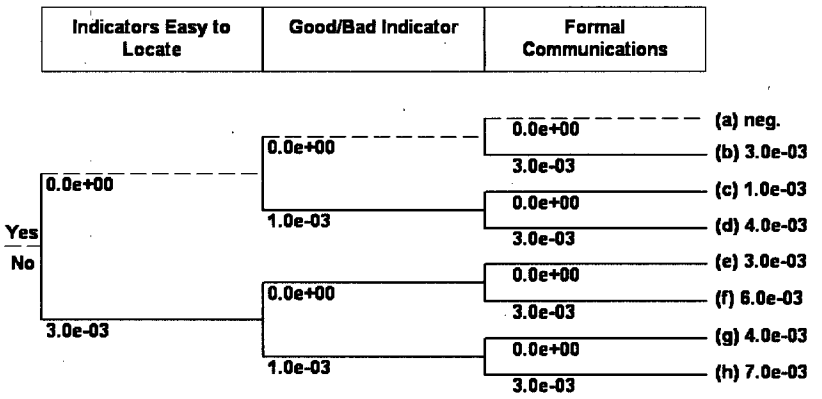
Preferred AC bus indications are available in the CR and they are accurate. The operators have been trained on all CR indications.

pcb: Failure of attention



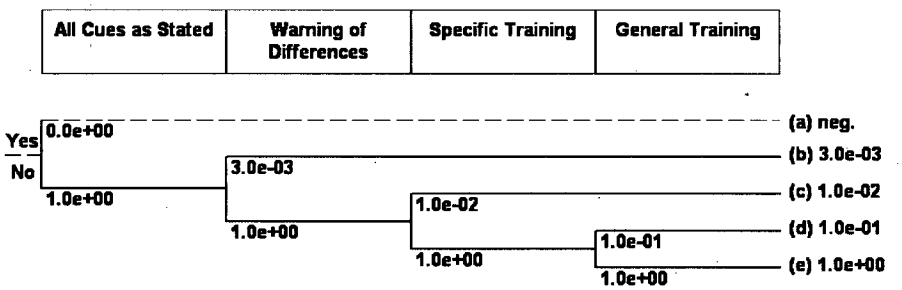
The operator workload would not be high in view of the long system window. The operator would only need to check preferred AC bus status, located on a front panel, to recognize the need for this action.

pcc: Misread/miscommunicate data



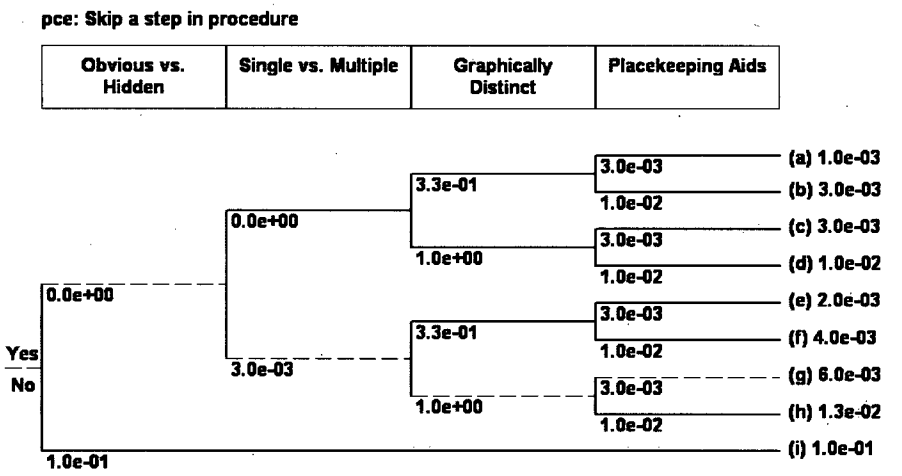
The AC bus indications are easy to locate and they do not have human engineering deficiencies. The Palisades operators use formal communications.

pcd: Information misleading



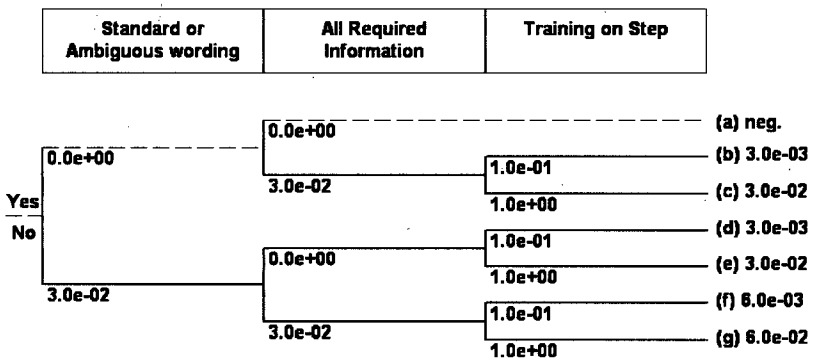
All cues are as stated.

pce: Skip a step in procedure



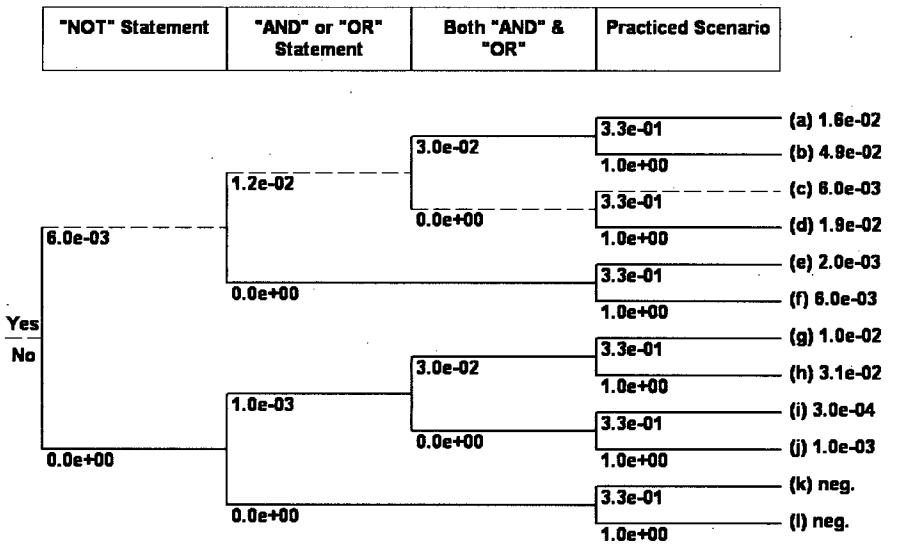
The applicable procedure steps are not hidden in any way although they are not graphically distinct. The operators are potentially in multiple procedures. The EOPs have placekeeping aids and the Palisades operators use the circle/slash method of placekeeping for the SOPs.

pcf: Misinterpret instruction



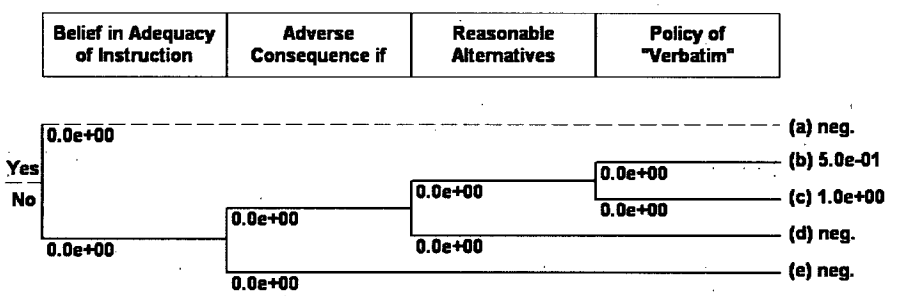
The applicable procedure steps use standard wording and the operators have all the information they need to complete this action.

pcg: Misinterpret decision logic



There are implied NOT and AND statements in the decision logic for this action. There are no OR statements. The operators have practiced loss of preferred AC bus restoration actions in the simulator.

pch: Deliberate violation



The Palisades operators believe in the adequacy of their instruction.

Cognitive Recovery

ACP-CBOB-BYREG-2

Table 4: ACP-CBOB-BYREG-2 COGNITIVE RECOVERY

	Initial HEP	Self-Review	Extra Crew	STA Review	Shift Change	ERF Review	DF	Multiply HEP By	Override Value	Final Value
Pc_a	neg.	-	-	-	-	-	-	1.0e+00		
Pc_b	neg.	-	-	-	-	-	-	1.0e+00		
Pc_c	neg.	-	-	-	-	-	-	1.0e+00		
Pc_d	neg.	-	-	-	-	-	-	1.0e+00		
Pc_e	6.0e-03	X	X	-	-	-	-	5.0e-02		3.0e-04
Pc_f	neg.	-	-	-	-	-	-	1.0e+00		
Pc_g	6.0e-03	-	X	X	-	-	-	5.0e-02		3.0e-04
Pc_h	neg.	-	-	-	-	-	-	1.0e+00		
								Sum of Pc_a through Pc_h = Initial Pc =		6.0e-04

Notes:
"Extra crew" is used as a surrogate for "Shift Supervisor" (Control Room Supervisor) credit.

Execution Unrecovered

ACP-CBOB-BYREG-2

Table 5: ACP-CBOB-BYREG-2 EXECUTION UNRECOVERED

Procedure: SOP-30, STATION POWER		Comment				Stress Factor	Over Ride
Step No.	Instruction/Comment	Error Type	THERP Table	THERP Item	HEP		
ONP-24.2 NOTE	CHECK for fault per Note located prior to step 4.17 in ONP-24.2	NOTE located prior to step 4.17 in ONP-24.2: NOTE: If the loss of the preferred AC bus is due to the Inverter DC input breaker opening and the Inverter AC output breaker did NOT trip, it is unlikely that there is a fault on the preferred AC bus itself.				2	
	--	EOM	20-7b	2	1.3E-3		
		EOC	20-9	2	1.3E-3		
		EOC	20-11	7	neg.		
						Total Step HEP	5.2e-03
SOP-30 - 7.6.2.c	IF the Preferred AC Bus is to be restored on the Bypass Regulator following an Inverter failure, THEN PLACE the Manual Bypass Switch in the BYPASS SOURCE position.					2	
	--	EOM	20-7b	2	1.3E-3		
		EOC	20-12	4	1.3E-3		
		EOC	20-12	8a	2.7E-4		
						Total Step HEP	5.8e-03
SOP-30 - 7.6.2.d	CLOSE (ON) Breaker 41 on Instrument AC Bus Y01					2	
	--	EOM	20-7b	2	1.3E-3		
		EOC	20-12	12	3.8E-3		
		EOC	20-12	8a	2.7E-4		
						Total Step HEP	1.1e-02
SOP-30 - 7.6.2.e	PLACE the Kirk interlock key (SS key #234) into the breaker lock for Preferred AC Bus to be transferred. (Located in Bypass Regulator)	selection error is negligible				2	
	--	EOM	20-7b	2	1.3E-3		
	used as a surrogate	EOC	20-12	8a	2.7E-4		
						Total Step HEP	3.1e-03
SOP 30 - 7.6.2.f	PLACE the breaker lock to OPEN position (this allows permissive closing of associated breaker).					2	
	--	EOM	20-7b	2	1.3E-3		
		EOC	20-12	3	1.3E-3		
		EOC	20-12	8a	2.7E-4		
						Total Step HEP	5.8e-03

SOP 30 - 7.6.2.g	CLOSE (ON) the Bypass Regulator Breaker to the Inverter to be spared.						
	--	EOM	20-7b	2	1.3E-3	2	
		EOC	20-12	4	1.3E-3		
		EOC	20-12	8a	2.7E-4		
						Total Step HEP	5.8e-03
SOP 30 - 7.6.2.h.	PERFORM the following to transfer loads from the Inverter to the Bypass Regulator						
	--	EOM	20-7b	2	1.3E-3	2	
	selection error - CLOSE Bypass Source AC Input Breaker.	EOC	20-12	4	1.3E-3		
	manipulation error - CLOSE Bypass Source AC Input Breaker.	EOC	20-12	8a	2.7E-4		
	VERIFY In Sync light is ON.	EOC	20-9	1	neg.		
	VERIFY In Sync light is ON.	EOC	20-11	7	neg.		
	PUSH "Bypass Source To Load" pushbutton.	EOC	20-12	4	1.3E-3		
	PUSH "Bypass Source To Load" pushbutton.	EOC	20-12	8a	2.7E-4		
	VERIFY "Bypass Source Supplying Load" light is ON.	EOC	20-9	2	1.3E-3		
	VERIFY "Bypass Source Supplying Load" light is ON.	EOC	20-11	7	neg.		
	ENSURE Manual Bypass Switch in BYPASS SOURCE position.	EOC	20-9	2	1.3E-3		
	ENSURE Manual Bypass Switch in BYPASS SOURCE position. Used as a surrogate.	EOC	20-11	7	neg.		
	OPEN Inverter Output breaker.	EOC	20-12	4	1.3E-3		
	OPEN Inverter Output breaker.	EOC	20-12	8a	2.7E-4		
	OPEN Bypass Source AC Input breaker.	EOC	20-12	4	1.3E-3		
	OPEN Bypass Source AC Input breaker.	EOC	20-12	8a	2.7E-4		
	DEPRESS ALARM RESET to clear Inverter alarms.	EOC	20-12	3	1.3E-3		
	DEPRESS ALARM RESET to clear Inverter alarms.	EOC	20-12	8a	2.7E-4		
						Total Step HEP	2.3e-02
SOP 30 - 7.6.2.6	OPEN Inverter Output breaker.	SHOULD I ADD THE STEPS OMITTED? If not - change to short list					
	--	EOM	20-7b	2	1.3E-3	2	
		EOC	20-12	4	1.3E-3		
		EOC	20-12	8a	2.7E-4		
						Total Step HEP	5.8e-03
EXEC RECOV - OCR	Execution recovery provided by independent personnel	See Section 4.3 of the HRA Notebook for further information. This execution recovery factor is applied to the individual execution steps with a dependence factor based on the time available for recovery. Note that the execution stress factors applied to the execution subtasks are not applied to the execution recovery factor. The EOM does not apply. Although the execution occurs in both the control room and in the cable spreading room, the "outside control room" execution recovery factor is applied.				2	0.5
						Total Step HEP	5.0e-01

Execution Recovery

ACP-CBOB-BYREG-2

Table 6: ACP-CBOB-BYREG-2 EXECUTION RECOVERY

Critical Step No.	Recovery Step No.	Action	HEP (Crit)	HEP (Rec)	Dep.	Cond. HEP (Rec)	Total for Step
ONP-24.2 NOTE		**CHECK for fault per Note located prior to step 4.17 in ONP-24.2**	**5.2e-03**				**2.6e-03**
	EXEC RECOV - OCR	Execution recovery provided by independent personnel		5.0e-01	ZD	5.0e-01	
SOP-30 - 7.6.2.c		**IF the Preferred AC Bus is to be restored on the Bypass Regulator following an Inverter failure, THEN PLACE the Manual Bypass Switch in the BYPASS SOURCE position.**	**5.8e-03**				**2.9e-03**
	EXEC RECOV - OCR	Execution recovery provided by independent personnel		5.0e-01	ZD	5.0e-01	
SOP-30 - 7.6.2.d		**CLOSE (ON) Breaker 41 on Instrument AC Bus Y01**	**1.1e-02**				**5.5e-03**
	EXEC RECOV - OCR	Execution recovery provided by independent personnel		5.0e-01	ZD	5.0e-01	
SOP-30 - 7.6.2.e		**PLACE the Kirk interlock key (SS key #234) into the breaker lock for Preferred AC Bus to be transferred. (Located in Bypass Regulator)**	**3.1e-03**				**1.6e-03**
	EXEC RECOV - OCR	Execution recovery provided by independent personnel		5.0e-01	ZD	5.0e-01	
SOP 30 - 7.6.2.f		**PLACE the breaker lock to OPEN position (this allows permissive closing of associated breaker).**	**5.8e-03**				**2.9e-03**
	EXEC RECOV - OCR	Execution recovery provided by independent personnel		5.0e-01	ZD	5.0e-01	
SOP 30 - 7.6.2.g		**CLOSE (ON) the Bypass Regulator Breaker to the Inverter to be spared.**	**5.8e-03**				**2.9e-03**
	EXEC RECOV - OCR	Execution recovery provided by independent personnel		5.0e-01	ZD	5.0e-01	
SOP 30 - 7.6.2.h.		**PERFORM the following to transfer loads from the Inverter to the Bypass Regulator**	**2.3e-02**				**1.2e-02**
	EXEC RECOV - OCR	Execution recovery provided by independent personnel		5.0e-01	ZD	5.0e-01	
SOP 30 - 7.6.2.6		**OPEN Inverter Output breaker.**	**5.8e-03**				**2.9e-03**
	EXEC RECOV - OCR	Execution recovery provided by independent personnel		5.0e-01	ZD	5.0e-01	
		Total Unrecovered:	**6.5e-02**			**Total Recovered:**	**3.3e-02**

Attachment 13 Procedure Use Evaluation for DC Panel ED-11-2 Fault Event

This attachment contains the following:

- Event procedure use in narrative format
- Event procedure use in flow chart format (Figure A13-1)

Note: the narrative and flow chart provide an overview of procedure usage during the ED-11-2 event. They are not all inclusive, i.e. they do not include all procedures referenced/used during the event.

Procedure Use Narrative

I. Procedure Use Expectations

During the ED-11-2 event multiple procedures were concurrently in use, including Emergency Operating Procedures (EOPs), Off Normal Procedures (ONPs), Annunciator Response Procedures (ARPs), General Operating Procedures (GOPs) and System Operating Procedures (SOPs). EOP and ONP procedure steps are written in the order the writer expects the plant to respond. Since the plant may not respond exactly as predicted, performance of steps out of sequence may be necessary. To avoid masking event symptoms and complicating diagnosis, additional actions to those stated in the EOP-1.0 Immediate Actions are not permitted until EOP-1.0 event diagnosis completion, except as directed as an immediate action of an applicable ONP, or are otherwise immediately essential for personnel safety, plant safety, equipment protection or safety of the public.

II. EOP-1.0 Standard Post-Trip Actions

Operators enter EOP-1.0 Standard Post-Trip Actions and perform Immediate and Operator Actions. The loss of dc and preferred ac buses precluded verification of some required conditions. For example, main generator breaker, atmospheric steam dump valve, and auxiliary feedwater pump P-8B and associated flow control valve indications were not available. Operators performed contingency action 2.b.1 to open the main generator breakers after verifying their status with International Transmission Control (ITC). The loss of dc panels ED-11-1 and ED-11-2 and preferred ac buses EY-10 and EY-30 were identified.

EOP-1.0 Operator Actions include performing GOP-10 Balance of Plant Actions Following A Reactor Trip and event diagnosis using the diagnostic flow chart. Due to not having at least 3 preferred ac buses energized, the operators were directed to EOP-9.0 Functional Recovery Procedure. GOP-10 checklist GCL-10.1 Post Trip Checklist Inside Control Room directs review of control panel annunciators and referencing associated ARPs. The unavailability of ED-11-1 and ED-11-2 noted previously and annunciator EK-0548 125V DC UNDERVOLTAGE ARP-3 Electrical Auxiliaries and Diesel Generator Scheme EK-05 (EC-11) direction provided cues for ONP-2.3 Loss of DC Power entry. Operators entered both EOP-9.0 and ONP-2.3.

III. EOP-9.0 Functional Recovery Procedure

Operators enter EOP-9.0 and perform Operator Actions including referring to Site Emergency Plan (SEP) EI-1, verifying emergency boration in progress and identifying in use safety function success paths. It was determined that SEP implementation was not required.

The following safety function success paths were selected based on EOP-9.0 Resource Assessment Tree 'conditions' criteria:

1. Reactivity Control: RC-3 Boration Using SIS (due to SIAS activated)
2. Maintenance of Vital Auxiliaries Electric DC: MVAE-DC-1 Battery Chargers/Station Batteries
3. Maintenance of Vital Auxiliaries Electric AC: MVAE-AC-1 Offsite Power
4. Inventory Control: IC-2 Safety Injection (due to SIAS activated)
5. Pressure Control: PC-3 Saturated Pressure Control (due to SIAS activated)
6. Heat Removal: HR-2 S/G with SI Operating (due to SIAS activated)
7. Containment Integrity: CI-1 Automatic/Manual Isolation
8. Containment Atmosphere Control: CA-1 Containment Air coolers (Normal Mode*)
9. Maintenance of Vital Auxiliaries Water: MVAW-1 Service Water and CCW
10. Maintenance of Vital Auxiliaries Air: MVAA-1 Instrument Air Compressors

*Note: Although containment air coolers were operating in the Emergency Mode, CA-1 was selected based on meeting plant conditions criteria, i.e. containment temperature < 125oF and containment pressure < 0.85 psig.

Operators identified MVAE-DC-1 as the only jeopardized safety function and proceeded completing appropriate actions while monitoring other safety functions by performing periodic safety function status checks (SFSCs).

The MVAE-DC-1 instruction column Step 6 condition requiring at least 3 preferred ac buses energized was not met. This required operators to perform the contingency action ('ENERGIZE ALL available Preferred AC Buses'), referring to applicable ONPs (ONP-24.1 Loss of Preferred AC Bus Y-10 and ONP-24.3 Loss of Preferred AC Bus Y-30). After verification of bus EY-30 being fault-free, operators energized EY-30 from the bypass regulator per ONP-24.3 and SOP-30 Station Power Section 7.6.2.

Pressurizer (PZR) pressure and level controllers and the heater select switch were placed in channel B during performance of ONP-24.3. This action enabled the PZR spray valves (lowered PCS pressure), reduced P-55A charging pump speed from 53 gpm to 33 gpm and opened the letdown orifice isolation valves. Opening the orifice valves resulted in RV-2006 lifting and annunciator EK-0702 RELIEF VALVE 2006 RELIEF VALVE DISCH HI TEMP alarming. Operators isolated flow to RV-2006 by placing the orifice valve handswitches to close per ARP-4 Primary System Volume Level Pressure Scheme EK-07 (C-12).

Due to observed high PZR level, in use success paths Inventory Control IC-2 and Heat Removal HR-2 were referenced for direction to stop PCS inventory addition. Emergency boration requirements were verified per HR-2 Step 6 and safety injection throttling criteria verified per IC-2 Step 10. Operators then throttled safety injection, including stopping both operating charging pumps.

IV. ONP-2.3 Loss of DC Power

Due to observed steam generator E-50A high level, operators identified the need to stop AFW pump P-8B. ONP-2.3 Step 2.b directs stopping P-8B by closing steam supply valve CV-0522B per SOP-12 Feedwater System Section 7.2.3 and Attachment 9. Operators dispatched a plant operator to close CV-0522B using EOP Supplement 19 Alternate Auxiliary Feedwater Methods Section 4 Steps 2.a and 2.b, which is equivalent to SOP-12 for the necessary actions.

After verifying dc buses ED-10L and ED-10R fault free, operators energized them from station battery ED-01 per ONP-2.3 Step 11 and placed #3 battery charger ED-17 in service per SOP-30 Step 7.8.2. After verifying bus EY-10 fault-free, and due to its normal power supply (inverter ED-06) not being available (dc input breaker tripped open), operators energized EY-30 from its normal power supply (inverter ED-08) per SOP-30 Step 7.6.3 and energized EY-10 from the bypass regulator per SOP-30 Step 7.6.2.

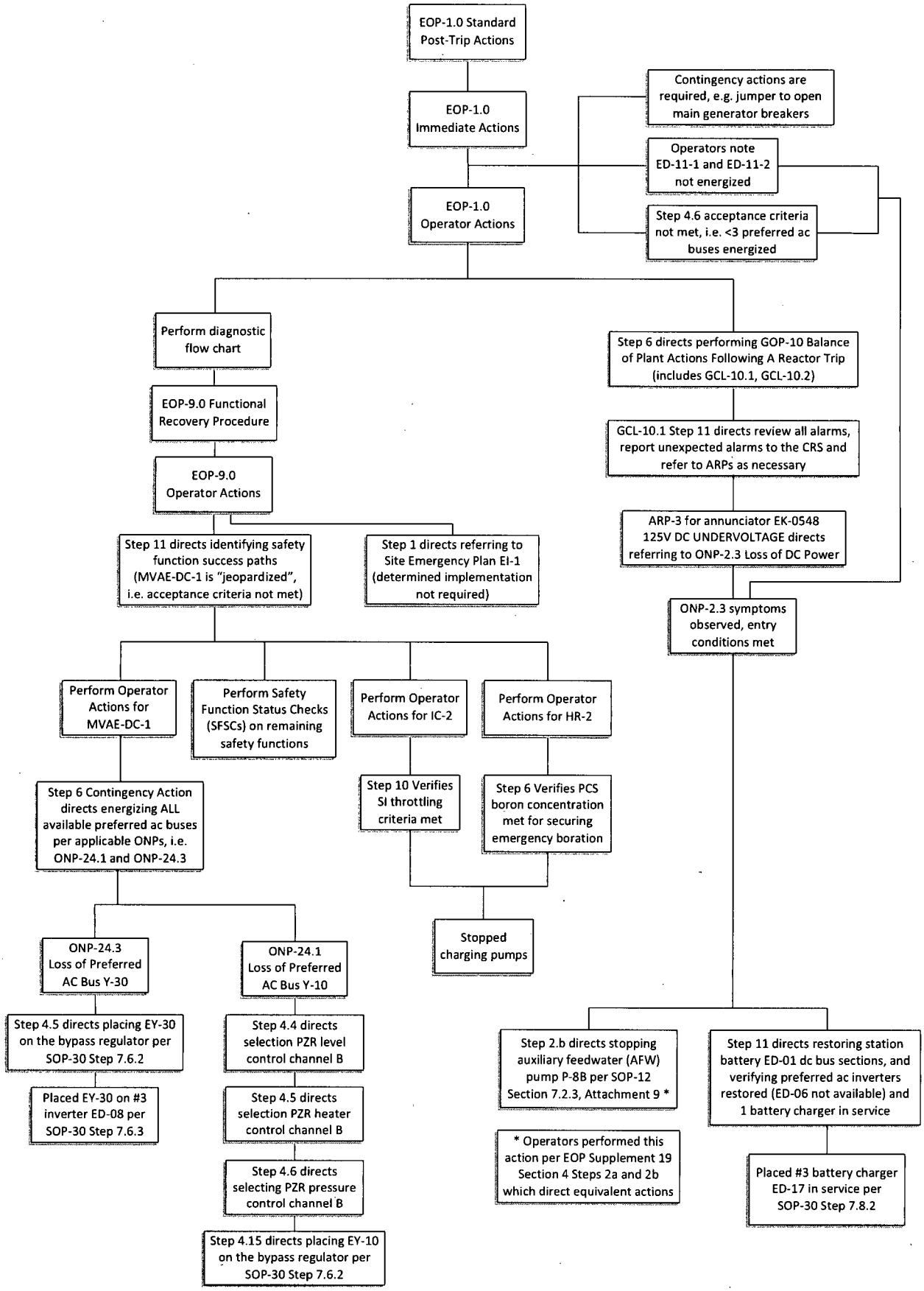
Reenergizing panel ED-11-1 resulted in instrument air compressor C-2A tripping and annunciator EK-1104 AIR COMPRESSORS C2A, C2B, C2C TRIP alarming. Per ARP-7 Auxiliary Systems Scheme EK-11 (C-13) operators manually started C-2B and C-2C and referred to ONP-7.1 Loss of Instrument Air. (Compressors C-2B and C-2C did not automatically start due to breaker 72-119 not being available.)

Procedure Use Flow Chart

Procedure Use Flow Chart

Figure A13-1: Procedure Use Flow Chart

Figure A13-1: Procedure Use Flow Chart



References

[1] Admin 4.06, Revision 20, Emergency Operating Procedure Development and Implementation

[2] Admin 4.16, Revision 3, Off Normal Procedure Development and Implementation

[3] ARP-3, Revision 70, Electrical Auxiliaries and Diesel Generator Scheme EK-05 (EC-11)

[4] ARP-4, Revision 58, Primary System Volume Level Pressure Scheme EK-07 (C-12)

[5] ARP-7, Revision 79, Auxiliary Systems Scheme EK-11 (C-13)

[6] EI-1, Revision 54, Emergency Classification and Actions

[7] EOP Supplement 19, Revision 10, Alternate Auxiliary Feedwater Methods

[8] EOP-1.0, Revision 13, Standard Post-Trip Actions

[9] EOP-9.0, Revision 21, Functional Recovery Procedure

[10] EOP-9.0 HR-2, Revision 22, Heat Removal-2

[11] EOP-9.0 IC-2, Revision 22, Inventory Control-2

[12] EOP-9.0 MVAE-DC-1, Revision 20, Maintenance of Vital Auxiliaries Electric-DC-1

[13] GOP-10, Revision 21, Balance of Plant Actions Following A Reactor Trip

[14] ONP-2.3, Revision 16, Loss of DC Power

[15] ONP-7.1, Revision 13, Loss of Instrument Air

[16] ONP-24.1, Revision 24, Loss of Preferred AC Bus Y10

[17] ONP-24.3, Revision 24, Loss of Preferred AC Bus Y30

[18] SOP-12, Revision 60, Feedwater System

[19] SOP-30, Revision 63, Station Power

Attachment 14: Pressurizer Level and Challenge to Pressurizer Safety Relief Valves – No Credit for RV-2006 PCS Inventory Loss

Issue

The 09/25/2011 dc panel ED-11-2 fault isolated letdown flow and increased charging flow. This resulted in rising pressurizer level and represented a potential challenge to the pressurizer safety relief valves. Steam and/or water release from pressurizer safety relief valves could result in a stuck open relief valve and pressurizer vapor space loss of coolant accident.

This evaluation summarizes post trip inventory behavior and estimates the additional time to pressurizer safety relief operation had no mitigating actions been taken.

This evaluation removes credit for RV-2006 relief that was taken in Attachment 03.

Background

At the regulatory enforcement conference regarding the loss of dc event held at NRC Region III headquarters on 01/11/2012, the following was requested:

> Provide a revised calculation for time available for controlling pressurizer level (tripping charging pumps) prior to challenging pressurizer safety relief valves that removes credit for PCS inventory lost due to RV-2006 relief during the actual event.

Conclusions

With letdown isolated and not crediting the loss of PCS water via RV-2006, the pressurizer would have gone solid had charging not been secured within ~5 minutes of the actual time of 15:57 (i.e., by ~16:02).

Evaluation

See the event timeline and narrative discussion [1].

During the event, pressurizer level and pressure heater select controls were switched to "B" channel at 15:37. Since CV-2009 was closed (on containment isolation), the action resulted in lifting RV-2006 and PCS relief to the quench tank until the letdown orifice stop valves were closed at 15:42. This resulted in transfer of approximately 540 gallons of PCS water to the quench tank (108 gpm * 5 minutes = 540 gallons).

If this relief had not occurred an additional 540 gallons of PCS water would have been present in the PCS at the time charging pumps were isolated. The Attachment 03 evaluation credits this additional volume by using actual conditions in the pressurizer at the time the charging pumps were tripped.

Approximately 1,000 gallons of additional volume exists between 100% pressurizer level and the solid condition [2]. In the actual event, at the time charging was secured at 15:57, PCS inventory was sufficient to increase pressurizer level to at or near 100% due to thermal expansion from PCS heatup to 544°F.

If RV-2006 relief is not credited, the free volume available above 100% level would have been reduced by

about 540 gallons leaving only 460 gallons of additional volume.

Based on 73 gpm charging flow, 5 gpm primary coolant pump controlled bleedoff, and heatup of charging water from 82°F to 544°F, the pressurize would have gone solid in an additional 5 minutes:

460 gallons / 1.3 density correction / (73 gpm – 5 gpm) = ~5 minutes

With respect to the timeline, charging pumps were secured at 15:57. Therefore, under these conditions charging would need to be secured prior to 16:02 to avoid a PCS solid condition.

References

[1] EA-PSA-SDP-D11-2-11-07, Revision 2, Attachment 1.

[2] SOP-1B, Revision 11, Primary Coolant System – Cooldown.

Attachment 11 Review of NRC Timeline and Affected Equipment List

By letter dated November 29 [1], the NRC published an event timeline and a list of major affected equipment for the 09/25/2011 dc panel ED-11-2 fault event.

The timeline and effected equipment list are reviewed against the current best available information in the annotated documents appended below.

Review Process

The review was performed by the PRA group Ops representative, who also developed and independently verified the event timeline and associated plant parameters. The PRA group Ops representative is a former Palisades SRO and has served as a Palisades Shift Manager and Operations Superintendent. The timeline was developed using process information (PI) data, plant process computer data (PPC), operator logs (eSOMS), and control room recorder instrumentation. The timeline was verified by extensive on-shift crew interviews/discussions, the Ops reconstruction meeting, and crew peer check of indicated event times, parameters, and crew motivation/awareness.

Review Findings

The human error analysis for controlling pressurizer level has a significant impact on the overall risk result. Gaining control of pressurizer level soon enough avoids challenging pressurizer safety relief valves. This eliminates the potential for a stuck open relief valve LOCA.

An important input to the NRC analysis is the belief that the time available to complete the action was equal to the time actually taken to complete action. This limits the analysis to one attempt to complete the action and results in no margin for error recovery.

Our analysis shows much more time was available. The action in our analysis is throttling (terminating) charging flow. This action takes several minutes (2 minutes). Timeline analysis shows the time available to complete the action was 40 minutes. This provides sufficient time to take the action, assess the success/failure of the action and still recover if unsuccessful.

The NRC belief may have been based on the assumption charging was providing 133 gpm to the PCS for an extended period of time – up to the point of challenging the pressurizer safeties. This may be artifact of erroneous or out-of-context information that was collected in the initial event response evaluation: early in the event investigation all three charging pumps were thought to be running.

Our evaluation of the event response and timeline determined only charging pumps P-55A and P-55B were operating during the event. Pump P-55C never ran during the event response. Charging was never higher than 93 gpm (P-55A and P-55B at maximum flow) and reduced to 73 gpm (P-55A and P-55B at minimum flow) at 15:37 when channel B pressurizer level control was placed in service. Charging was reduced to 0 gpm when charging pumps were tripped at 15:57.

In addition, NRC believes the condition diagnosis and action execution to be moderately complex, based on the NRC discussion of factors influencing the human error analysis. However, operators were aware of the condition early in the event and the diagnosis of what to do given indicated high pressurizer level is not complex. In addition, the action to trip charging pumps is simple, straightforward and not complex.

Palisades Event Timeline (NRC Att. 3)

Appendix 11-1: Annotated NRC Event Timeline

Major Affected Equip. (NRC Att. 7)

Appendix 11-2: Annotated NRC List of Affected Major Equipment.

References

[1] Letter from U.S. NRC (Steven West) to Entergy Nuclear Operations, Inc. (Anthony Vitale), Subject: Palisades Nuclear Plant – NRC Special Inspection Team (SIT) Report 05000255/2011014 Preliminary Yellow Finding, Dated: November 29, 2011.

PALISADES EVENT TIMELINE

HISTORICAL SEQUENCE of EVENTS

The timeline developed was created independently by the inspectors, with best estimates based on all available information. Items that are approximate times are preceded with "~" prior to the listed time. During the development of this timeline all times were referenced back to the control room clock, which was the official time and differed from the plant process computer and sequence event recorder times. The term "days" refers to activities that were conducted on the dayshift. The times listed below are based on the 24-hour clock.

October 2010

RFO21 During Refueling Outage 21, 10 breakers were replaced by maintenance personnel inside electrical Panel D11-2, associated with the left train 125-Volt DC system (reference Figure 2, Attachment 4).

Thursday, September 22, 2011

Days Maintenance personnel began work on work order (WO) 248834-01 to troubleshoot the inoperative green indication lights for Door MZ-50, the emergency air lock. All interlocks, indication lights, and limit switches were found to be satisfactory; more troubleshooting was planned for this door indication light issue.

Friday, September 23, 2011

Days Maintenance personnel completed WO 291123-01 to troubleshoot Breaker 72-123 in Panel D11-2. Maintenance personnel identified that there was no load side voltage phase to phase (this feeds power to the Door MZ-50 indicating lights).

15:26 Maintenance personnel completed WO 291123-03 to successfully replace Breaker 72-123. Restoration activities included re-installing cover panels inside Panel D11-2.

16:07 Control room alarms were received by reactor operators (ROs) for the "Generator Field Forcing/Over-Excitation" cycling; and for red indication lights flickering for the "Voltage Regulator Control Switch" and "Turbine Generator Exciter Field Breaker Control" alarms. Breaker 72-121, Main Generator Voltage Regulator Control Power, experienced an intermittent connection during these restoration activities of Panel D11-2.

16:17 The ROs experienced a loss of indication for multiple containment isolation valves (CIVs) due to an intermittent loss of power from Breaker 72-119. The ROs entered Technical Specification Action Conditions (TSAC) for Limiting Condition for Operation (LCO) 3.3.7 (30-day TSAC for CIV indication) and LCO 3.6.3 for all valves (4-hour TSAC to administratively lock the valves closed).

16:35 The ROs entered Off-Normal Procedure (ONP) ONP-7.1, "Loss of Instrument Air." The DC power for a junction box common to all three instrument air compressors was a load associated with Breaker 72-119. The intermittent loss of power affected the instrument air compressors standby start feature (the instrument air compressors internal "sleep mode" feature remained available to automatically start the air

compressors). The feedwater (FW) purity air compressor continued to supply the necessary air to equipment through a control valve that failed open upon the intermittent loss of power and cross-connected the two systems, as designed. The running instrument air Compressor C-2A was automatically placed in sleep mode while higher pressure air was supplied by feedwater purity air Compressor C-903B.

~21:30 Maintenance personnel commenced a new troubleshooting plan and identified: no voltage on the load side of Breaker 72-119; misalignments on Breakers 72-119, 72-120, 72-121, and 72-123; and, a 1/16-inch air gap between the horizontal positive bus bar and the line side positive connection on Breaker 72-119. Maintenance personnel also discovered that: the positive feed wire to DC Panel D11-2, was 2°degrees Fahrenheit (°F) hotter than the negative wire; the bus had a slight ground; and, each breaker's positive horizontal bus bars were hotter than the negative horizontal bus bars.

22:23 The ROs exited ONP-7.1 when instrument air Compressors C-2A, C-2B and C-2C were identified as available for manual start.

Saturday, September 24, 2011

Days Licensee personnel continued with troubleshooting activities, challenge boards, work package reviews, and Temporary Modification (TM) EC 31973 development for Breaker 72-121, due to Friday's events.

Sunday, September 25, 2011

05:00 Nightshift maintenance personnel held a pre-job brief for TM EC 31973 to discuss implementation of WO 291209-01 to implement the TM. The electrical superintendent made the decision not to have the nightshift electricians begin work.

~07:00 Turnover between electrical superintendent and mechanical superintendent (acting maintenance manager) discussed the upcoming evolution to commence work on WO 291209-01 to implement the TM and for work on Breakers 72-119, 72-120, 72-121, and 72-123. The turnover highlighted the steps of insulating the bus tie stabs and conducting the evolution in the prescribed sequence for breaker removal to keep positive control over the bus tie stabs.

~08:00 Turnover between electrical superintendent and electrical front line supervisor (FLS) discussed the upcoming evolution to commence work on WO 291209-01 to implement the TM and for work on Breakers 72-119, 72-120, 72-121, and 72-123. The turnover highlighted the steps of insulating the bus tie stabs and conducting the evolution in the prescribed sequence for breaker removal to keep positive control over the horizontal bus tie stabs.

~08:30 A pre-job brief for performing work on WO 291209-01 was held.

11:03 Dayshift maintenance personnel installed TM EC 31973 to power breaker loads from Breaker 72-121, Main Generator Voltage Regulator Control Power, from the spare Breaker 72-127.

1109 based on Ops Log entry.

~12:45 Dayshift maintenance personnel performed an informal pre-job brief for implementing WO 291194-01, WO 291210-01, and WO 291123-03 for work on Breakers 72-119, 72-120, 72-121, and 72-123. The workers and management observers then proceeded to Panel D11-2 for fieldwork.

14:14 The Duty Station Manager (DSM) updated plant management on the breaker work via an email that stated: "Breaker 72-119 (top breaker in panel) was removed, Breaker 72-120 (spare breaker) removed, and an approximately 1/16-inch gap was found between the copper bus bar and breaker stab was identified as well as minor indications of arcing in this area, and the bus bar hole showed evidence of cross-threading."

15:03 Palisades Plant Status:

- Reactor power was approximately 98.5 percent;
- Steam Generator (SG) 'A' Level was 65.15 percent;
- SG 'A' Pressure was 970.26 pounds per square inch absolute (psia);
- SG 'B' Level was 63.96 percent;
- SG 'B' Pressure was 983.44 psia;
- Pressurizer level was 57.86 percent;
- Pressurizer pressure was 2063.35 psia;
- Primary coolant system (PCS) average temperature was 559.84°F; and,
- Letdown flow from the PCS was 43.45 gpm.

15:06 Reactor and Turbine Trip occurred. During the work inside 125-Volt DC Panel D11-2, while removing a section of bus bar, the bar rotated and contact was established between the positive and negative horizontal bus bars, which caused an electrical fault.

15:06 Electrical fault on Panel D11-2 caused the shunt trip Breaker 72-01 to open (reference Figure 2 of Attachment 4).

15:06 Opening of the shunt trip Breaker 72-01 de-energized the left train 125-Volt DC, D-10L, and D-10R.

15:06 Loss of D-10L and D-10R de-energized 120-Volt preferred alternating current (AC) busses Y-10 and Y-30.

15:06 Inverter input Breaker 72-37 tripped.

15:06 The loss of two out of the four preferred AC busses caused a loss of power to two reactor protection system (RPS) channels (RPS is a two-out-of-four logic).

15:06 The RPS trip signal caused RPS Breakers 3 and 4 to actuate resulting in a reactor trip (a two-out-of-four RPS logic).

15:06 Reactor trip initiated a turbine trip.

15:06 The ROs entered EOP-1.0, "Standard Post-Trip Actions."

15:06 All controls rods verified inserted into the core by ROs (only the control room supervisor plant process computer lost power, all other RO stations were available, in addition, left train indications to PPC were lost due to the loss of the left train 125-Volt DC).

15:06 Main Steam Isolation Signal (MSIS) initiated the right channel based on a two-out-of-four logic made-up for the loss of 120-Volt preferred AC busses Y-10 and Y-30 (low SG pressure sensed).

15:06 The right channel MSIS signal initiated closure of the right train Main Steam Isolation Valve (MSIV). The left train MSIV closed due to the closure of the first MSIV

Both MSIVs closed due to the MSIS. MFRVs also closed. CV-0703 due to MSIS, CV-0701 due to loss of EY-10 and EY-30.

15:06 Safety Injection Actuation Signal (SIAS) occurred based on a two-out-of-four logic made-up for the loss of 120-Volt preferred AC busses Y-10 and Y-30 (sensed low pressurizer pressure). Right channel initiated and started the following pumps: High pressure safety injection (HPSI) 'A'; low pressure safety injection (LPSI) 'A'; Auxiliary Feedwater (AFW) Pump 8C; and, charging Pumps 'A' and 'B'.

AFW pump P-8C is not associated with SIAS. P-8C did start due to AFAS. Charging pump P-55A was already in service, i.e. it didn't start. Also, bus 1E was shed due to SIAS, which deenerged half of the PZR heaters.

15:06 The LPSI 'A' and HPSI 'A' pumps do NOT inject due to the PCS pressure being greater than the pumps' shutoff head.

15:06 Containment High Radiation (CHR) signal received based on a two-out-of-four logic made-up from loss of 120-Volt preferred AC busses Y-10 and Y-30. This initiated the following: both trains of control room heating, ventilation, and air conditioning (HVAC) in emergency mode; only the right train ('B') started, since the left train ('A') had no power, primary coolant pump (PCP) bleedoff and letdown isolation control Valve CV-2099 closed; and both SG bottom blowdown line control Valves CV-767 and CV-768 closed.

There are actually 2 valves, the PCP CBO valve is CV-2099, the letdown isolation valve is CV-2009.

15:06 Containment Isolation Signal (CIS) initiated based on a two-out-of-four logic made-up for loss of 120-Volt preferred AC busses Y-10 and Y-30. This closed all of the right channel containment isolation valves (CIVs), which included the letdown control valves on the pressurizer.

This should read "… included CVCS letdown containment isolation valve CV-2009 located in the CVCS letdown line downstream of the letdown orifice stop valves", i.e. not "on the pressurizer". The Left channel containment isolation valves also closed due to loss of dc, and the letdown orifice stop valves closed due to loss of PZR level control channel A.

15:06 Containment high pressure alarm occurred, but not an actuation signal. The alarm was seen on the left channel based on a two-out-of-four logic, but since the downstream relays in this logic had no power, a containment high pressure actuation signal was not initiated. The right channel did not receive any signals.

15:06 Turbine Driven Auxiliary Feedwater (TDAFW) Pump P-8B started due to its steam supply control Valve CV-0522B failing open on loss of DC power (powered by Panel D11-1) and the AFW Actuation Signal (AFAS), which overrode the low suction pressure trip signal caused by the loss of the left train 125-Volt DC system.

P-8B started due to the loss of dc to solenoid valves SV-0522G and SV-0522H. The AFAS signal was not available to P-8A or P-8B due to the loss of D-11-1.

15:06 The AFAS was received due to a loss of 120-Volt preferred AC busses Y-10 and Y-30 (sensed low SG water level), which made up the two-out-of-four logic. The AFW Pump P-8A did not start due to the loss of power to the control circuits associated with the low suction pressure trip

P-8A did not start due to the AFAS signal to the P-8A/P-8B train being powered from D-11-1. The low suction pressure trip logic was met, but the signal was not applied due to the loss of D-11-1. Also, P-8B flow control valves failed full-open due to loss of control power.

15:06 The ROs verified that safety-related AC busses 1D and 1C (safety-related 2400-Volt) were available due to loss of AC Bus 1E (nonsafety 2400-Volt).

The NCOs verified buses 1C and 1D available per EOP-1.0, but not "due to the loss of 1E". Bus 1E was load shed as expected due to the SIAS.

15:06 Busses 1A (nonsafety 4160-Volt) and 1F (nonsafety 2400-Volt) did not fast transfer to station transformer (received fast transfer signal with loss of power; however, the loss of the left train 125-Volt DC prevented the fast transfer from occurring).

This should read "Busses 1A (nonsafety 4160-Volt) and 1F (nonsafety 4160-Volt) did not fast transfer to startup transformers…".

Also, bus 1A remained energized from the grid via the main transformer and station power transformer 1-1. Bus 1F remained energized from the grid via station power transformer 1-3.

15:06 The PCPs 'A' and 'C' started a slow coastdown due to the loss of power from Bus 1A (bus still had some energy due to main generator not being fully disconnected immediately). PCPs 'B' and 'D' continued to run.

P-50A and P-50C remained powered from the grid via the main transformer, station power transformer 1-1 and Bus 1A, and were not coasting down until the generator breakers opened, at which time they started coasting down and tripped (~1517).

15:06 The FW Purity Air Compressor C-903B was lost due to the loss of Bus 1E (at the time Compressor C-903B was supplying air to the instrument air header, due to the September 23, 2011, event). Instrument air Compressor C-2A was in "sleep mode" and auto started upon a lowering instrument air header pressure.

Inoperable Technical Specification (TS) Related Equipment and TSACs entered by ROs:

- Preferred AC Bus No. 1, Y-10, TSAC 3.8.9 (B);
- Preferred AC Bus No. 3, Y-30, TSAC 3.8.9 (B);
- Inverter No. 3, D-08, TSAC 3.8.7 (A.1);
- Inverter No. 1, D-06, TSAC 3.8.7 (A.1);
- The TS 3.0.3 was entered due to two preferred AC busses INOPERABLE and two inverters INOPERABLE. The ROs exited this at 19:12;
- Left train 125-Volt DC busses D-10L and D-10R, TSAC 3.8.9 (C);
- Four atmospheric steam dump valves (ASDVs) lost power due to the master controller being powered from Bus Y-10 and lost the quick-open capability (relay lost power with loss of Y-10), TSAC 3.7.4 (A.1 and A.2); and,
- The PCS unidentified leakage TSAC 3.4.13 (unidentified leakage was >1 gpm for PCP-controlled bleedoff being isolated).

15:07 The AFW Pump P-8C started due to AFAS (one minute later due to time delay built in to logic).

~15:16 This time should be 1537. The ROs manually switched (per their ONP) pressurizer pressure and level indication instruments over to Channel 'A' (should read "... over to Channel B") due to the loss of indication from the loss of power on Channel 'B' (should read "...loss of power on Channel A") and actual increased level and pressure seen in the pressurizer. With the failure of the controller, the pressurizer control systems were at maximum charging, no letdown (letdown orifice valves were isolated), and no pressurizer spray. Charging Pumps 'A' and 'B' were running because the pumps started on the SIAS.

"Maximum charging" is 133 gpm (3 pumps in service with P-55A at max speed (53 gpm)). Actual charging at this time is 93 gpm (2 pumps in service with P-55A at max speed). Only P-55B started on SIAS as previously noted, P-55A was already in service.

Once level control B channel was placed in service P-55A speed lowered to minimum (33 gpm), so the charging rate was then 73 gpm, not 93 gpm, and the orifice isolation valves all opened, letting down ~108 gpm to the quench tank until they were closed by the operator 5 minutes later. Also, bus 1D PZR heaters were all energized at this time.

~15:16 This time should be 1537. Pressurizer spray was able to operate with swapping of controllers. Primary system pressure is stable at ~2063 psia.

PCS pressure was 2033 at 1516, and not yet controlled.

15:17 The turbine-side RO in control room manually jumpered main generator output breakers to the "open" position (Breakers 25F7 and 25H9).

This resulted in P-50A and P-50C rapidly coasting down and stopping.

~15:20 Main feedwater Pumps 'A' and 'B' were tripped by the ROs and their respective turbines were tripped. Condensate Pump 'A' was tripped by the ROs. Condensate Pump 'B' was functioning.

K-7B MFP P-1B turbine was tripped by the RO, but K-7A MFP P-1A turbine did not trip automatically and could not be tripped from the control room due to loss of dc. An NPO was directed to trip them locally. Also, the steam supply to K-7A and K-7B was isolated when the MSIVs closed at 1506.

15:27 The ROs Entered EOP-9.0, "Functional Recovery," due to the loss of two preferred AC busses upon completion of EOP-1.0.

15:27 Plant Status:

- Reactor power was 0 percent;
- SG 'A' Level was 65.15 percent;
- SG 'A' Pressure was 925.42 psia;
- SG 'B' Level was 55.56 percent; (48.45%)
- SG 'B' Pressure was 969.67 psia; (956.5 psia)
- Pressurizer level was approximately 66.3 percent; (62%)
- Pressurizer pressure was approximately 2140 psia; (2094 psia) (Note 2140 is > the '2063 and stable' previously stated at time 1516, corroborating that the spray valves had not yet opened.)
- The PCS average temperature was 536.27°F; and
- Charging flow to the pressurizer was 133 gpm (approximate indication).

Max charging possible would be 93 gpm with P-55A and P-55B in service. P-55C did not run during the event.

~15:30 The ROs entered ONP-2.3, "Loss of DC."

15:31 An AO was dispatched to the field to respond to a fire alarm in the AFW pump room. The AO was also directed to manually close CV-0522B (AFW 'B' steam supply control valve) for isolation of TDAFW Pump P-8B. Level in SG 'A' was approximately 67 percent and level in SG 'B' was approximately 58.6 percent. This rendered the left train of AFW INOPERABLE and the ROs entered TSAC 3.7.5.

15:37 Pressurizer pressure increased to a maximum of 2206 psia (indicated on PTR-0122).This was below the first pressurizer code safety valve setting of 2500 psia (The pressurizer power operated relief valves were isolated at Palisades during normal operations).

This is when the PZR pressure and level controllers were switched to channel B in service, see previous 1516 entry.

15:37 The ROs entered ONP-24.1, "Loss of Preferred AC Bus No. 1 (Y-10)."

The ROs entered ONP-24.3, "Loss of Preferred AC Bus No. 3 (Y-30)."

15:42 Letdown heat exchanger inlet safety relief Valve RV-2006, was isolated after not re-seating correctly during the event.

RV-2006 opened when the PZR level controller was switched to channel B due to the letdown orifice stop valves opening at 1537, and was isolated per ARP-4 due to downstream letdown containment isolation valve CV-2009 being closed (CHR/loss of dc), not due to not seating correctly.

15:49 Bus 1E (nonsafety 2400-Volt AC that was lost during event) was restored by maintenance and operations personnel in field (load shed on SIAS).

Operators restored bus 1E from the control room (normal restoration, nothing was done in the field) and associated PZR heaters were reenergized.

~15:51 Main Steam Safety Valve(s) maintained secondary side pressures, which subsequently maintained PCS temperature, from the start of the event.

The excess AFW supplied by P-8B also contributed significantly to the PCS temperature control/lowering (especially in E-50A) until P-8B was isolated. After initially opening/closing, the E-50A MSSVs remained closed until 1615.

15:53 The plant process computer (PPC) for control room supervisor was restored.

15:55 Pressurizer level reached greater than 62.8 percent, which was the TS limit. The ROs entered TSAC 3.4.9(A.1) and (A.2) to reduce levels to less than the limit. Pressurizer level was approximately 81 percent at this time.

PZR level was logged as >62.8% at 1555, but actually reached 62.8% at 1528.

15:57 In EOP-9.0, Attachment 5, "Safety Injection Throttling Criteria," was met so the ROs throttled reduced flow on the charging pumps in an attempt to lower the PCS level in the pressurizer; however, the letdown system was still isolated.

At this time charging flow was "reduced" to 0 gpm, i.e. there was no further PCS inventory addition.

15:57 <u>Plant Status:</u>

- SG 'A' Level was 97.02 percent;
- SG 'A' Pressure was 853.33 psia;
- SG 'B' Level was 63.96 percent;
- SG 'B' Pressure was 965.86 psia;
- Pressurizer level was 81.17 percent; (79.7%)
- Pressurizer pressure was 2046.04 psia; and, (2068 psia)
- The PCS average temperature was 532.77°F. (527°F)

15:57 120-Volt Preferred AC Bus No. 3 (Y-30) was OPERABLE on the bypass regulator. Bus 1E (nonsafety 2400 Volt AC) was lost with these actions.

Bus 1E load shed due to Left channel SIAS initiating.

15:57 Busses D-10L and D-10R, 125-Volt DC Left Train, were OPERABLE due to Y-30 being restored and the shunt trip Breaker 72-01 re-closed. Upon restoration generator field Breaker 341 automatically opened and instrument air Compressor C-2A tripped for an unknown reason.

D-10L and D-10R being operable is not dependent on Y-30 restoration. Instrument air compressor C-2A tripped due to its breaker trip circuit being energized when dc power was restored.

15:57 The SG 'A' reaches a maximum level of ~97.02 percent (per PPC).

16:02 Charging Pump 'B' (P-55B) suction relief Valve RV-2096 lifted and did not properly re-seat. This caused volume control tank water to fill up the equipment drain tank and spill-over onto the floor in pump Cubicle 'B' (backed-up floor drain).

RV-2096 was reported to be lifting at 1602, but had been for some time (possibly since 1506). The water filling the EDT was from the BASTs, not the VCT. The BA pumps were running, keeping the VCT outlet check valve closed, so charging makeup to the PCS was from the BASTs.

~16:02 Main steam safety valve(s) continue to lift to maintain secondary side pressures, which subsequently maintained PCS temperature.

MSSVs on E-50B continue lifting (partially open), but not on E-50A (pressure remained below the full closure value since ~1516). The major heat removal contributor is excess AFW. PCS temperature at this time begins rising due to CV-0522B having been closed, stopping P-8B.

16:15 Pressurizer level reached a maximum of approximately 98 percent.

MSSVs on both SGs open, stopping the PCS temperature rise and PZR level peaks at 101.5%. MSSVs remain partially open, controlling PCS temperature until the ASDVs are put in service.

16:21 Procedure ONP-7.1, "Loss of Instrument Air," entered since instrument air compressor C-2A tripped at 15:57 upon restoration of the 125-Volt DC left train. Instrument air Compressors C-2B and C-2C were placed in service by the AOs.

Air compressors were started by a control room operator and verified operating normally by auxiliary operators.

16:30 Operators in the field manually isolated charging Pump P-55B, by closing the discharge and suction isolation valves. This was necessary due to an abundance of water in the cubicle from the improperly seated relief Valve RV-2096.

16:34 The HPSI and LPSI Pumps 'A' were secured due to SIAS throttling criteria being met (were never injecting but started on SIAS signal).

16:44 The SG 'B' level reached a maximum of approximately 69.06 percent.

16:44 Plant Status:

- SG 'A' level was 90.45 percent;
- SG 'A' pressure was 932.45 psia;
- SG 'B' level was 69.06 percent;
- SG 'B' pressure was 930.70 psia; (949.6 psia)
- Pressurizer level was 91.94 percent; (97.3%)
- Pressurizer pressure was 1864.13 psia; and,
- The PCS average temperature was 539.48°F.

16:46 120-Volt preferred AC Bus No. 1 (Y-10) was OPERABLE on bypass regulator. 120-Volt Preferred AC Bus No. 3 (Y-30) was taken off of the bypass regulator and powered from the inverter.

16:46 All four ASDVs were OPERABLE with the return of 120-Volt Preferred AC power source No. 1, Y-10 (power restored to controller).

At this time operators started using ASDVs for heat removal, and the MSSVs closed and remained closed.

17:20 Procedure ONP-4.1, "Spurious Containment Isolation," was entered due to loss of preferred AC busses Y-10 and Y-30 causing a CIS.

ONP-4.1 was entered at this time to reset the CHR-CIS which occurred at 1506.

17:46 The ROs exited EOP-9.0 with restoration of the preferred AC busses and entered GOP-8, "Power Reduction and Plant Shutdown to Mode 2 or Mode 3 ≤525°F."

The above should read "… ≥ 525°F", not ≤525°F.

18:00 Once the ROs exited EOP-9.0, the criteria was met to reset the SIAS.

18:00 Cooling was restored to Spent Fuel Pool (SFP) Heat Exchanger (lost during loss of power). The temperature in the SFP at 15:00 was 83.4°F and the temperature of the pool at the time of restoration of the heat exchanger was 87.4°F.

18:52 The AFW Pump P-8B was declared OPERABLE when steam supply control Valve CV-0522B was re-opened and controller placed in AUTO.

19:09 The ROs exited ONP-24.1, "Loss of Preferred AC Bus No. 1," with restoration of Y-10 and associated loads.

19:11 The ROs exited ONP-24.3, "Loss of Preferred AC Bus No. 3," with restoration of Y-30 and associated loads.

19:12 The ROs declared Inverter No. 3, D-08, OPERABLE which enabled the exit of TSAC 3.0.3 with busses Y-10, Y-30, and Inverter D-08 restored.

19:12 The ROs exited ONP-7.1, "Loss of Instrument Air," when power was returned to the right channel controller.

19:23 Battery Charger No. 1 D-15 was still INOPERABLE and TSAC 3.8.4(A.2) was entered by the ROs.

19:23 Main Station Battery left Channel D-01 was still INOPERABLE and TSAC 3.8.4(B.1) and 3.8.6(A.1 and A.2) were entered by the ROs due to not being connected to a charger.

19:33 The ROs connected battery Charger No. 3, D-17, to the 125-Volt DC bus to charge main station battery left channel D-01.

20:16 Main station battery left channel D-01 met the TSAC requirement 3.8.6 (A.1) and its terminal voltage was greater than 125-Volt; however the ROs were still in TSAC 3.8.6(A.2).

23:48 The ROs restored pressurizer level to less than 62.8 percent (TS limit) which enabled the exiting of TSAC 3.4.9 (A.1 and A.2).

Monday, September 26, 2011

01:23 WO 291210-03 started to remove Breaker 72-122 to use those bus tie stabs to replace the ones on Breaker 72-119 that were damaged during the event.

01:56 Charging Pump P-55B was declared OPERABLE by the ROs after leaking suction relief Valve RV-2096 was verified to function and water was cleaned up in cubicle.

03:00 Breakers 72-119 and 72-120 were installed and restored.

04:41 Main station battery left channel D-01 was declared OPERABLE by the ROs and TSACs 3.8.4 and 3.8.6 were exited.

06:40 Power was restored back to Breaker 72-119 loads and thermography was completed satisfactorily on all of the restored breakers, with no anomalies identified.

11:58 Charging Pump P-55B was started to initiate double charging and letdown to aid in PCS cooldown and transition to Mode 4 (Hot Shutdown).

16:09 The ROs exited ONP-4.1, "Spurious Containment Isolation."

16:30 The ROs commenced a PCS cooldown with turbine bypass valve.

23:06 Reactor entered Mode 4.

Tuesday, September 27, 2011

04:30 Shutdown cooling was placed in-service per GOP-9 and GOP-14 when PCS pressure was less than 265 psia and PCS temperature was less than 300°F.

06:33 Reactor entered Mode 5 (Cold Shutdown).

Friday, September 30, 2011

20:05 Revision 1 of the operability evaluation for the 125-Volt DC system was accepted by operations.

21:31 Reactor entered Mode 4.

Saturday, October 1, 2011

02:48 Reactor entered Mode 3.
23:30 Reactor entered Mode 2.

Sunday, October 2, 2011

01:35 Initial criticality achieved with Group 3 rods at 99.3 inches.

02:26 Achieved the Point of Adding Heat.

03:27 The MSIVs were opened with no issues on operation of valves.

07:37 AFW Pump P-8C was secured with no issues.

08:24 Reactor entered Mode 1.

10:20 Generator output breakers closed.

Monday, October 3, 2011

11:50 Reactor power was at 100 percent.

LIST OF MAJOR AFFECTED EQUIPMENT

REVIEW OF DE-ENERGIZED EQUIPMENT ON 9/25/11 PLANT TRIP

This is a preliminary review of equipment response to the plant trip on 9/25/11. The initial set of components lost on 9/25 is D11-1, D11-2, D-10R, D-10L. The loss of D-10R and D-10L led to the loss of Y-10 and Y-30, which led to the plant trip. This table identifies the loss of major components. Other components may have been lost, but did not have a significant impact on mitigating the event in the short term. The instrument air system was in an abnormal lineup at the time, with Feedwater Purity Air cross-tied to plant air. 'A' Channel of Pressurizer Pressure and Level control systems were in-service.

Affected Component	Actual Component State Following Transient	Additional Information
Loss of DC Power		
SV-0522G & SV-0522H, Air Control to Steam Supply Valve for 'B' AFW pump	De-energized	Fails open 'B' AFW pump steam supply valve CV-0522B
CV-1212, Service Air Header Isolation	Failed closed	Loss of Service Air
25F7, Main Generator Output Breaker	Did not auto trip (stayed closed)	Required to relay terminals to be jumpered in control room panel to Open
Main Generator Field Breaker, 341	Did not open (should open on turbine trip)	Locally tripped open The field breaker opened automatically when dc power was restored.
Bus 1A, Non-Safety 4160V	De-energized and did not fast transfer to Station Transformer (from Start-up Transformer) Should read "…did not transfer from station power xfmr 1-1 to startup transformer 1-1."	Lost control power for all breakers and indicating lights
Bus 1F, Non-Safety 4160V	De-energized and did not fast transfer to Station Transformer (from Start-up Transformer) Should read "…did not transfer from station power xfmr 1-3 to startup transformer 1-1."	Lost control power for all breakers and indicating lights
Load Center -11 (480V AC	Lost control power for all	Local manual control available

Affected Component	Actual Component State Following Transient	Additional Information
Loss of DC Power		
Safety-related)	breakers (with loss of DC bus)	
Load Center -19 (480V AC Safety-related)	Lost control power for all breakers (with loss of DC bus)	Local manual control available
Load Center -17 (480V AC Safety-related)	Lost control power for all breakers (with loss of DC bus)	Local manual control available
Load Center -77 (480V AC Safety-related)	Lost control power for all breakers (with loss of DC bus)	Local manual control available
CV-2009, Letdown Containment Isolation Valve	Failed closed	Caused Letdown Heat Exchanger Inlet Relief Valve, RV-2006, to lift RV-2006 did not lift until PZR level control channel B was placed in service.
CV-2083, Primary Coolant Pumps (P-50A/B/C/D) Controlled Bleedoff Control Valve	Failed closed	Controlled Bleedoff instead went to Primary System Drain Tank via Relief Valve, RV-2082
Instrument Air Compressors, C-2A/B/C	Lost standby start feature, internal "sleep mode" feature still available	Manual Start capability available The "sleep mode" provides an auto start feature for compressors whose breakers are closed.
CV-1212, Service Air Header Isolation Valve	Failed closed	Service Air was not needed during this event
CV-1221, Feedwater Purity Air Cross-Tie to Plant Air Valve	Failed open	Feedwater Purity Air System fed air to the Instrument Air System loads The FWP air supply to plant loads was not available from event initiation (bus 1E de-energized on SIAS) until bus 1E was reenergized.
EK-02, Alarms on Control Room panel C-11A (Radiation Control Room HVAC panel)	Lost alarm scheme due to loss of power	
EK-21, Left Channel alarms on Safety Injection Signal	Lost alarm scheme due to loss of power	

Affected Component	Actual Component State Following Transient	Additional Information
Loss of DC Power		
sequencer display		
EK-24, alarms on Isophase Bus Panel	Lost alarm scheme due to loss of power	
EK-33, alarms on Control Room panel C-106 (Cooling Tower Master Supervisory and Control Cabinet)	Lost alarm scheme due to loss of power	
EK-35, alarms on Control Room panel C-126 (Circulation Water and Iodine Removal Panel)	Lost alarm scheme due to loss of power	
Various Containment Isolation and Radwaste Valves	Failed closed and lost position indication due to loss of DC power	

Affected Component	Actual Component State Following Transient	Additional Information
Loss of Y-10 and Y-30		
Safety Injection Actuation Signal	2 out of 4 channels received actuation signal which meets circuit logic start criteria	Right Channel logic was met – Left Channel lost power to its relays when Y-30 was lost, therefore Charging Pump P-55C was unavailable. P-55C did not automatically start, but it was available to be manually started throughout the event.
Containment High Radiation Signal	2 out of 4 channels received actuation signal which meets circuit logic start criteria	Right Channel logic was met – Left Channel lost power to its relays when Y-10 was lost
Containment High Pressure Alarm	Alarmed in Control Room	Left Channel created alarm – no actuation initiated due to relays losing power when Y-10 was lost
Main Steam Isolation Signal	2 out of 4 channels received actuation signal which meets circuit logic start criteria	Right Channel logic was met – Left Channel lost power to its relays when Y-30 was lost
'A' Channel of Pressurizer Pressure Control (in Control Room)	Lost power with loss of AC	Pressurizer pressure control systems responded by the Heaters going to maximum capacity and the Spray not actuating
'A' Channel of Pressurizer Level Control (in Control Room)	Lost power with loss of AC	Pressurizer level control systems responded by having maximum Charging flow from the available charging pumps and minimum Letdown capability by closing the Letdown Isolation Valves

Affected Component	Actual Component State Following Transient	Additional Information
Loss of Y-10 and Y-30		
Auxiliary Feedwater Pumps P-8A/B receive low suction pressure trip The low suction pressure trip logic was met, but the pumps did not receive the trip signal due to panel D-11-1 being de-energized.	2 out of 3 channels received trip signal which meets circuit logic trip criteria	'A' AFW Pump P-8A did not have power, AFW Pump P-8B was running at full capacity due to AFAS that overrode the low suction pressure trip and was manually isolated during the event by operators P-8A did have power available. It did not start on AFAS, but could have been started manually from the control room or locally.
HIC-0780A/B & HIC-0781B, Atmospheric Steam Dump Valve Controllers (in Control Room)	Lost power with loss of AC	Could not manually or automatically control ASDVs (valves were not available for use during the event) The ASDVs were available once preferred bus EY-10 was reenergized.