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)

List Report

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 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		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

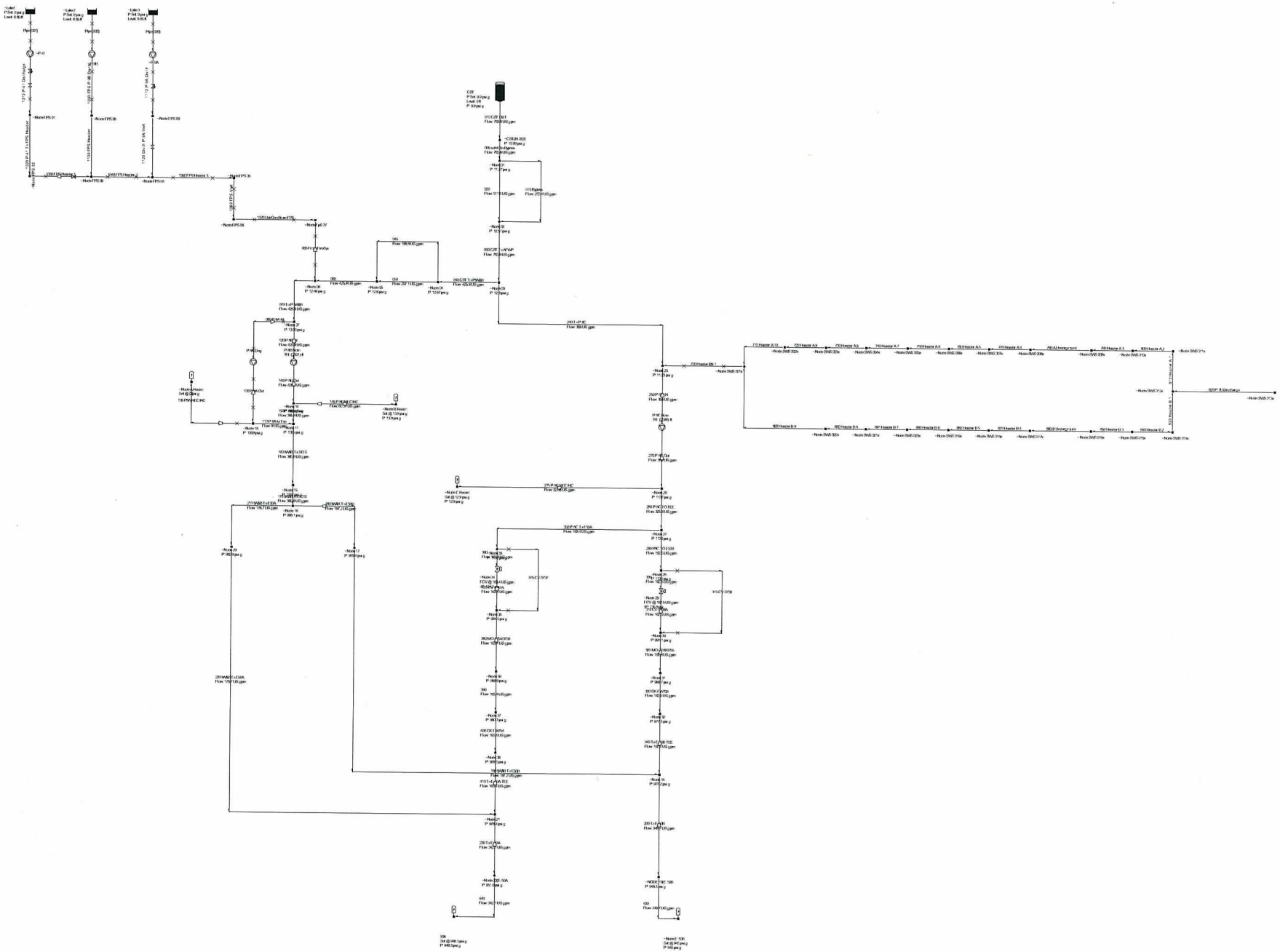
Tanks

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 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		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

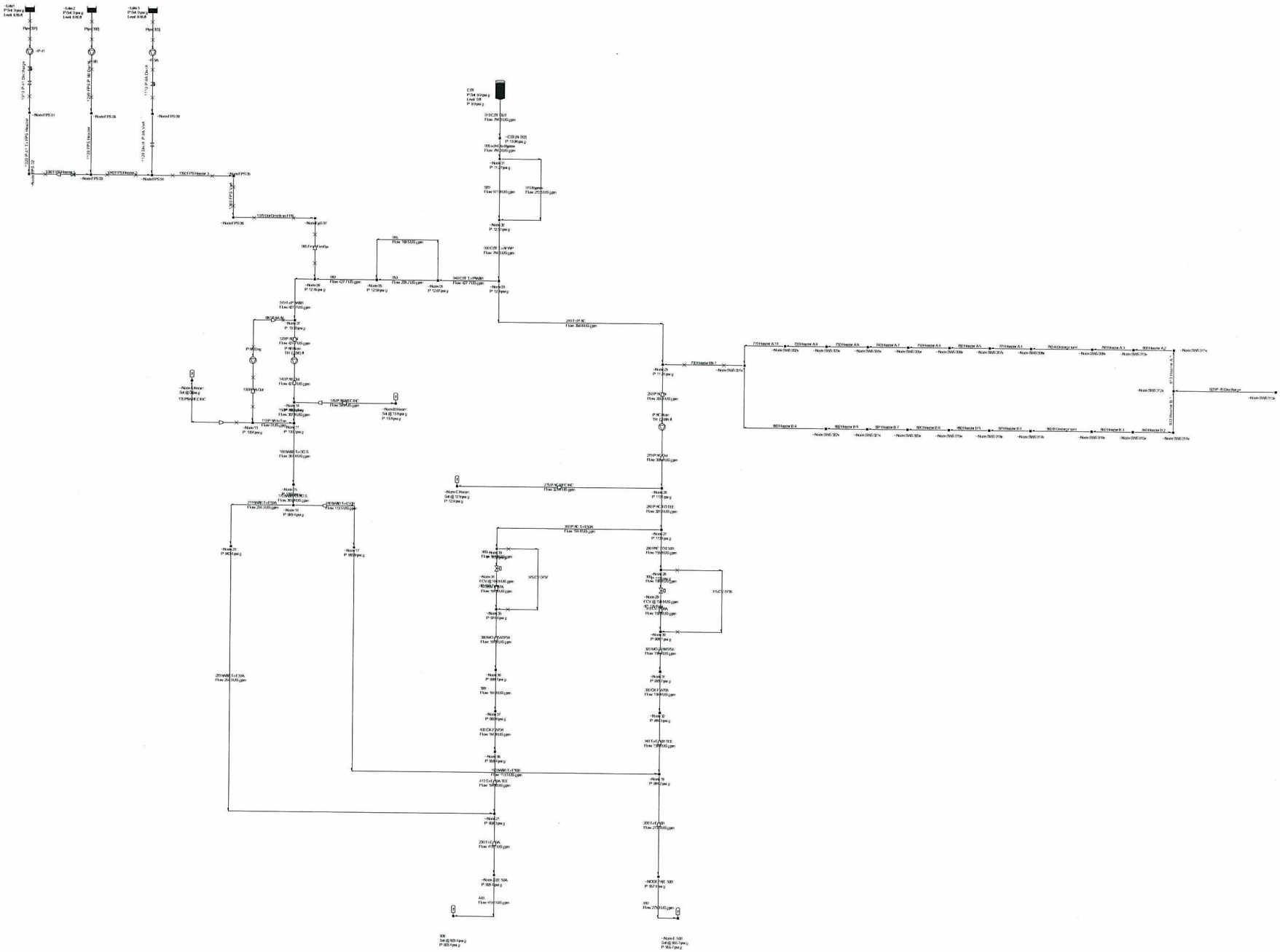
Tanks

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

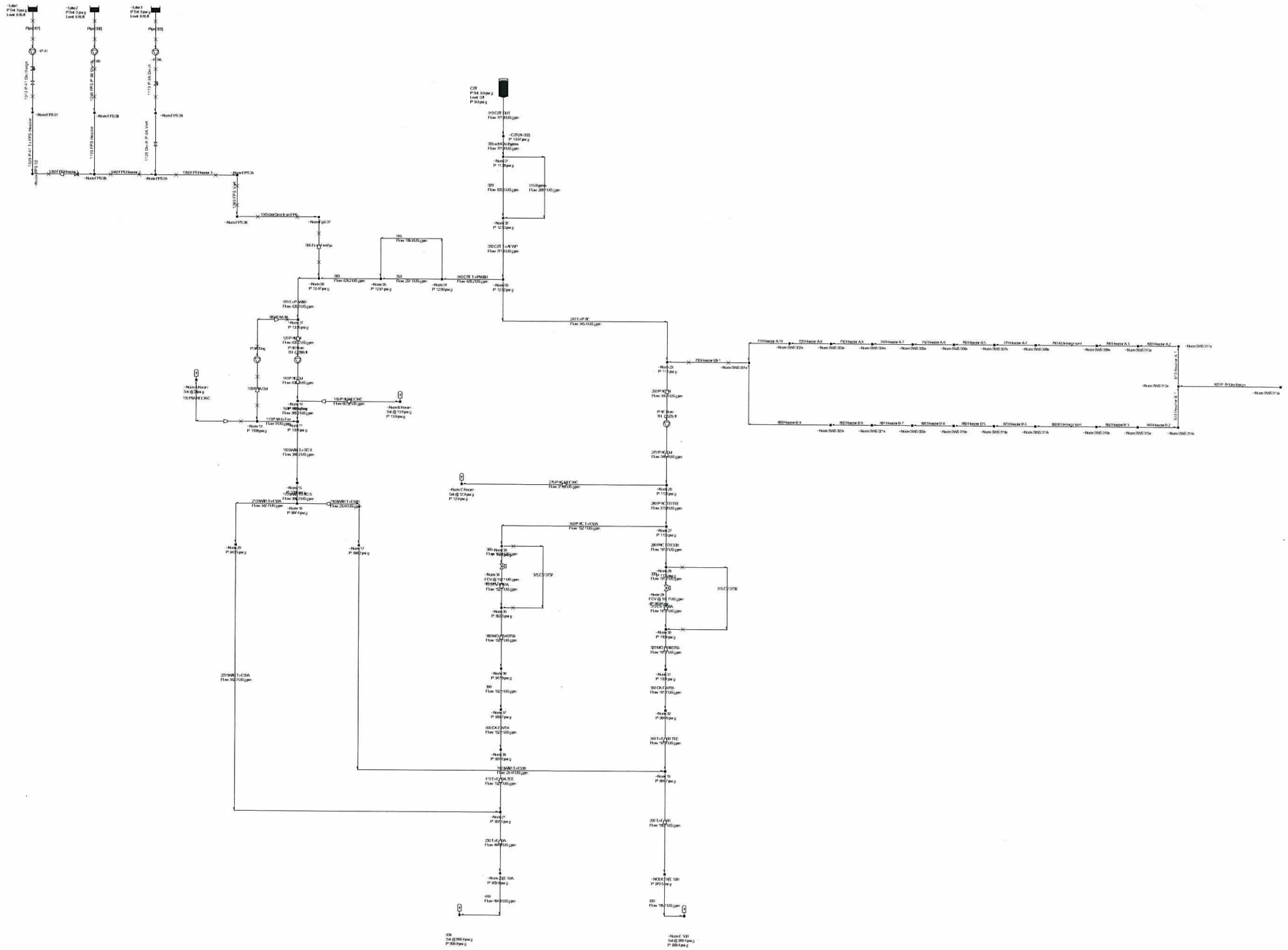
Tanks

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

List Report

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

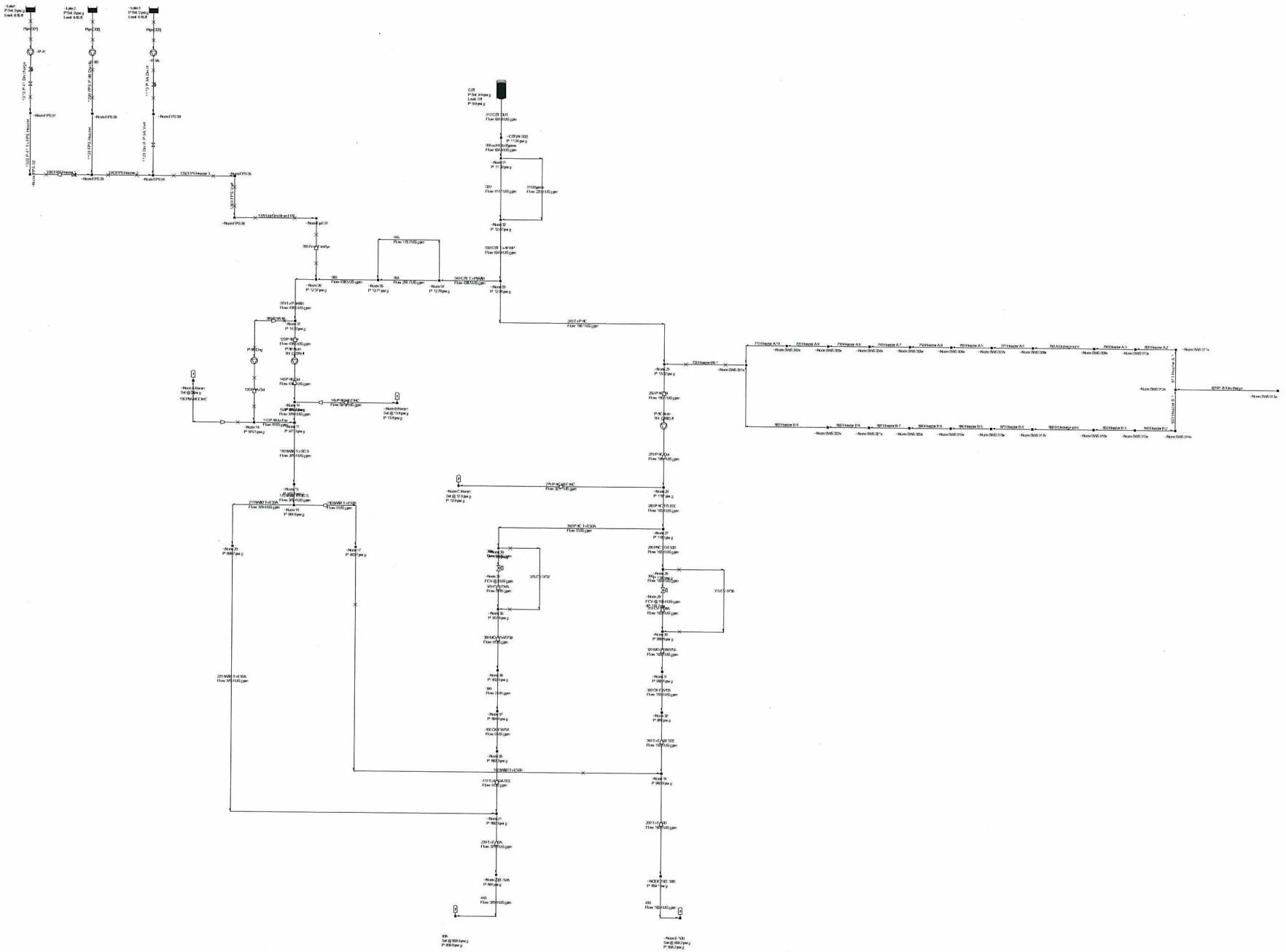
Tanks

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 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.