Attachment 05: Thermal-Hydraulic Analyses

1.0 PURPOSE

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 pressurizer safety relief valves. Steam and/or water release from pressurizer safety relief valves could result in a stuck open relief valve and subsequent above-core, vapor-space loss of coolant accident.

This evaluation investigates the integrated plant response to a stuck open safety relief valve within the context of the loss of dc event. Theis attachment evaluation is a margin evaluation of employing the charging pumps as a makeup source. The results are provided as information, only.

The current event tree success criteria require HPSI as the makeup source. No changes to this criterion have been made.provides a basis for the event tree structure and success criteria used in the logic model.

This evaluation uses the Modular Accident Analysis Program (MAAP) model for Palisades.

2.0 CONCLUSION

Thermal-hydraulic analysis in this evaluation demonstrates the success criteria for above-core, vapor-space LOCAs can be satisfied with two charging pumps providing makeup..

As long as secondary side cooling is available for decay heat removal, the transient does not require high pressure safety injection to preclude core damage, apart from additional failures that once-through-cooling would be required to mitigate the event.

Long term heat removal via the steam generators or transition to shutdown cooling could then become a success path, even when a SRV sticks open – provided inventory makeup is available. For example, charging with safety injection refueling water tank (SIRWT) inventory, conserved by terminating sprays, or via HPSI in recirculation mode would maintain adequate core cooling.

3.0 INPUT

3.1 MAAP 4.0.6 Model

The baseline model is developed and documented in the MAAP 4.0.6 model parameter file [1] and thermal hydraulic analyses [2]. The baseline model is used as the starting point for this evaluation.

MAAP is a computer code that simulates the response of light water reactor power plants during severe accidents. Given a set of initiating events and operator actions, MAAP predicts plant response as a function of time. Plant response under severe accident scenarios is complex and is best evaluated in an integrated manner. The primary system and containment responses are sensitive to the calculated pressures, temperatures, flows, and event timings. These parameters also affect operator action timings, the radionuclide release timings, and the mitigating system performance assessments. Proper plant-specific characterization of the severe accident progression is important to the realistic representation of the plant and highly desirable for a PRA assessment.

3.2 Event-Specific Plant Data

The timeline in Attachment 01 considered the best available information, including PI data, PPC data, control room recorder data, operator logs, procedures filled-out during the event, and interviews and discussions with operations.

Inputs to this evaluation are based on and consistent with the results of the timeline construction, to the greatest extent possible. Specific data sources are given below.

3.2.1 Process Information (PI) Data

Event-specific plant data for various plant parameters are obtained from the PI data archive. PI is software quality assurance (SQA) category “C” (important to business) per Entergy SQA procedure EN-IT-104. The plant process computer (PPC) provides data to the PI system. PPC is SQA category “B” (regulatory commitments). Most PPC points are calibrated via technical specification surveillance procedure or by 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 provides generally accurate long term values and greater amounts of data when events are changing rapidly.

Since the event resulted in the loss of two preferred ac buses, various PPC/PI data points were unavailable and not recorded in the PPC/PI systems.

This evaluation uses PI data both directly and in support of other data sources for:

- steam generator level
- steam generator pressure
- auxiliary feedwater flow
- pressurizer level
- pressurizer pressure
- charging flow
- primary coolant system average temperature

3.2.2 Control Room Recorder Data

Event-specific plant data for various plant parameters are obtained from control room recorder data. Certain Yokagawa-type control room indicators have the ability to record and store data. Plant instrumentation and control engineers collected post-event data from these recorders and provided both display screen shots and data to the PRA group.

This evaluation uses Yokagawa recorder data both directly and in support of other data sources for:

- pressurizer level
- pressurizer pressure
- charging flow
- primary coolant system average and loop temperatures
- main feewater turbine steam flow
- main feedwater turbine steam pressure

3.2.3 Operator Logs

Event-specific plant data for various parameters and events are obtained from electronic operator round (eSOMS) logs.

This evaluation uses eSOMS logs mainly in support of other data sources.

3.3 Condensate Storage Tank

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

3.4 Atmospheric Dump Valves (ADVs)

Operation of the atmospheric dump valves (CV-0779, CV-0780, CV-0781, and CV-0782) via quick open and manual control is unavailable until power is restored to preferred ac bus EY-10.

The loss of dc event resulted in loss of power to the inverter that supplies preferred ac bus EY-10. Power can be restored by restoring power to the dc bus and re-energizing the inverter or aligning the bypass regulator to re-energize the preferred ac bus. EY-10 was placed on bypass regulator at 16:46, one hour forty minutes into the event.

For cases where ADVs are restored, valve operation to achieve decay heat removal and plant cooldown in accordance with technical specification limits on cooldown rate is used.

In nearly all the MAAP cases reported herein, the ADV's are modeled as "failed closed".

3.5 Auxiliary Feedwater

Auxiliary feedwater pump P-8A does not start on auxiliary feedwater actuation signal due to loss of preferred ac buses EY-10 and EY-30. However, P-8A remains available to be started from the control room or locally. After restoration of power to ED-11-1 and EY-10 or EY-30, P-8A is capable of automatic start should steam generator levels fall to the auxiliary feedwater actuation signal setpoint.

The loss of dc event de-energized left channel dc power. This results in automatic start of P-8B (mechanical governor maintains normal turbine/pump speed) with flow control valves wide open. Steam supply to P-8B was manually isolated at 16:03. P-8B flows to each steam generator are given in Attachment 10. Attachment 04 provides an accounting of AFW delivered to the steam generators during the event.

Right channel dc power remained available. Auxiliary feedwater pump P-8C starts on auxiliary feedwater actuation signal given P-8A failure to deliver required flow (due to loss of EY-10, EY-30 and loss of left channel dc). Flow control valves set to 165 gpm to each steam generator. P-8C flow to E-50A was isolated due to overfill concerns at 15:44. P-8C flow to E-50B was isolated at 16:09 due to adequate E-50B level.

For cases demonstrating event thermal-hydraulics, the following AFW data is used:

Table 3.5-1: Total AFW Flow

Time (event time)	Time (hours)	Time (minutes)	Flow to E-50A (gpm)	Flow to E-50B (gpm)	Flow to E-50A (lbm/hr)	Flow to E-50B (lbm/hr)
time 0 (1506)	0	0	342	350	1.697E+05	1.737E+05
1520.0	0.2333	14.0	342	350	1.697E+05	1.737E+05
1520.1	0.2350	14.1	419	273	2.080E+05	1.355E+05
1530.0	0.4000	24.0	419	273	2.080E+05	1.355E+05
1530.1	0.4017	24.1	495	185	2.457E+05	9.182E+04
1540.0	0.5667	34.0	495	185	2.457E+05	9.182E+04
1540.1	0.5683	34.1	379	163	1.881E+05	8.090E+04
1603.0	1.6167	97.0	379	163	1.881E+05	8.090E+04
1603.1	1.6183	97.1	0	156	0	7.743E+04
1609.0	1.7167	103.0	0	0	0	0
1636.0	2.1667	130.0	0	0	0	0
1636.1	2.1683	130.1	0	129	0	6.403E+04
1730.0	3.7333	224.0	0	129	0	6.403E+04
1730.1	3.7350	224.1	56	96	2.779E+04	4.765E+04
end of problem	24.0000	1440.0	56	96	2.779E+04	4.765E+04

3.6 Charging

Initial charging flow was 93 gpm. At approximately 36 minutes into the event, charging flow was reduced to 73 gpm.

The loss of dc event resulted in failure of the in-service channel A pressurizer level and heater control circuit. With no power to channel A the control program defaulted to maximum flow from the operating pumps (93 gpm: P-55A – 53 gpm; P-55B – 40 gpm).

At approximately 31 minutes into the event operators switched pressurizer level control to channel B to enable pressurizer spray. With channel 'B' in service charging flow reduced to the minimum flow from operating pumps (73 gpm: P-55A – 33 gpm; P-55B – 40 gpm).

Had channel 'B' been in service at the time of the event, charging flow rate would have been at minimum flow from the operating pumps from time zero.

For cases demonstrating event thermal-hydraulics, the following charging data is used:

Table 3.6-1: Total Charging Flow				
Time (event time)	Time (hours)	Time (minutes)	Flow to PCS (gpm)	Flow to PCS (lbm/hr)
time 0 (1506)	0	0	93	
1542.0	0.6000	36	73	
1557.0	0.8500	51	0	0
end of problem	24.0000	1440.0	0	0

4.0 ASSUMPTIONS

4.1 Major Assumptions

4.1.1 AFW flow delivery is under predicted.

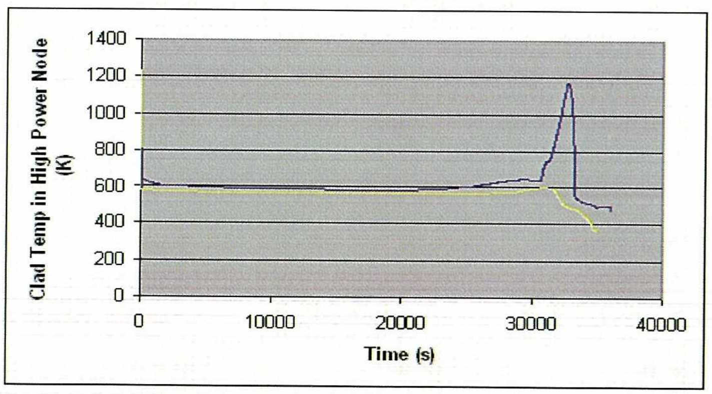
Basis: AFW flow is limited based on S/G level control. Therefore, the Table 3.5-1 data is automatically throttled to match decay heat.

Bias: Conservative, as the calculated primary system pressure is greater.

4.1.2 MAAP S/G Modeling Limited

Basis: The Palisades MAAP model runs hotter than the RELAP Version 3 Mod 2 model. Comparisons [3] between MAAP and RELAP have shown that for station blackout sequences with subsequent once-through-cooling (OTC), that the comparative behavior between the codes for the most part, is very similar.

The single biggest difference is the more rapid steam generator dryout calculated by MAAP. This is considered due to the MAAP S/G modeling limitations. Below, the MAAP hot core node temperature peaks at about 1200°K. No peak is exhibited from the RELAP results.



Bias: Conservative, as the MAAP results produce higher pressures and temperatures for above core breaks.

4.2 Minor Assumptions

4.2.1 The onset of core damage has been defined as the time when peak core temperature reaches 1800°F.

Basis: The onset of core damage should be developed consistent with the desire to be as realistic as possible and consistent with current best practice. If the MAAP code is used to predict core response, it is recommended that core damage be defined as the time when peak core temperature reaches 1800°F. This is based on the characteristics of the MAAP code and the guidance provided in the MAAP4 applications guide. A peak core temperature of 1800°F is also consistent with the general guidelines for the definition of core damage provided in the EPRI Probabilistic Safety Assessment (PSA) Applications Guide [4].

Bias: This is considered conservative per Assumption 4.1.2 and given that the fuel design limit is 2200°F.

4.2.2 Quench Tank Model Disabled

Basis: The PORV discharge model to the quench tank was disabled, to improve code execution time.

Bias: This is considered neutral as it results in a slightly higher early containment heat load and somewhat slows the PCS blowdown transient.

5.0 ANALYSIS

Illustrative and/or important MAAP cases are described below. Not all MAAP cases are explicitly discussed. The case name (prefix of the input file name) indentifies the specific MAAP run. The purpose, description and conclusion of each run are provided; selected plots follow.

Two basic types of cases are analyzed:

- Cases utilizing event-specific timing and/or plant response
- Cases utilizing bounding timing and/or plant response.

The first set of cases is meant to envelope the actual event to ensure the actual plant response is bounded by the second set of cases. No cases have been performed to precisely match actual event plant response in all respects. Various model conservatisms add margin to the bounding case results.

Following each case the selected plot results are presented following by the specific MAAP input file is listed.

5.1 D11-2 SDP Case7

5.1.1 D11-2 SDP Case7 Purpose

The purpose of this case is to evaluate the 9/25/11 baseline event incorporating time line data, operating plant equipment, etc. in order to determine the time to refill T-2. In this case, with charging secured in 51 minutes core heat is removed by AFW with steaming through the safeties. Table 5.1.1 provides an overview of the case inputs and boundary conditions. Appendix A includes the specific input file.

Table 5.1.1		
MAAP CASE		**SUMMARY**
	Purpose:	Determine the time to Refill T-2.
	Description:	- AFW initially operable for ~97 minutes. Tripped for ~27 minutes restored in ~2.17 hours. See Table 3.5-1. - ADVs assumed disabled (locked closed) for 24 hours. - P-55A and P-55B available for 51 minutes and secured. See Table 3.5-2 - T-2 refill not credited. Other: - No PCS Break(s) - HPSI Tripped (t=0) - LPSI Tripped (t=0) - PCPs tripped in 11 minutes - Fans/Coolers Tripped (t=0) - Containment Sprays Tripped (t=0) - PZR Sprays Tripped (t=0) - PZR Heaters Tripped (t=0) - Main Feedwater Isolated (t=0) - MSIVs Forced Closed (t=0)
D11-2 SDP Case7		
	Conclusion:	If T-2 can be refilled within 10 hours, core damage will be averted.

Figure 5.1.1-1

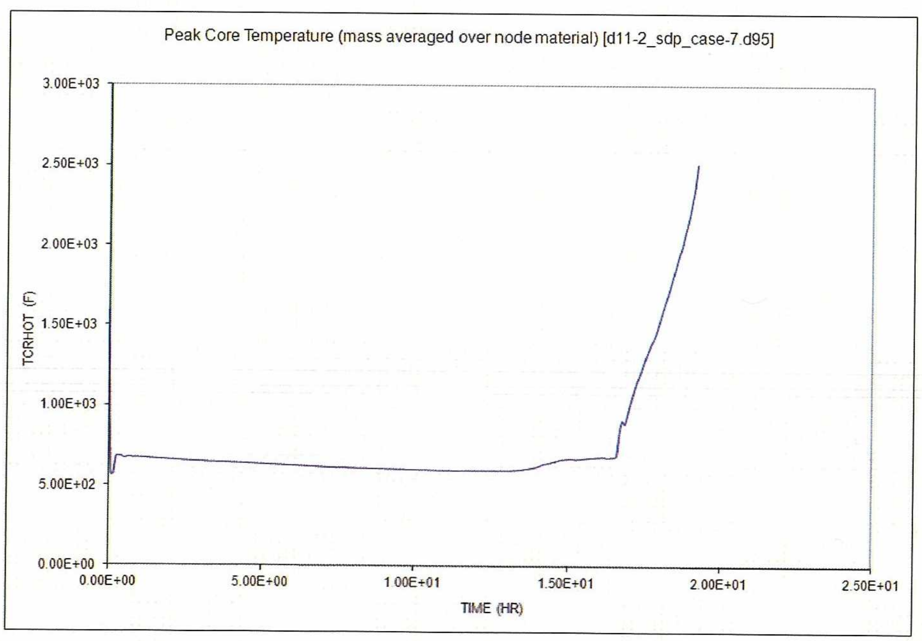


Figure 5.1.1-2

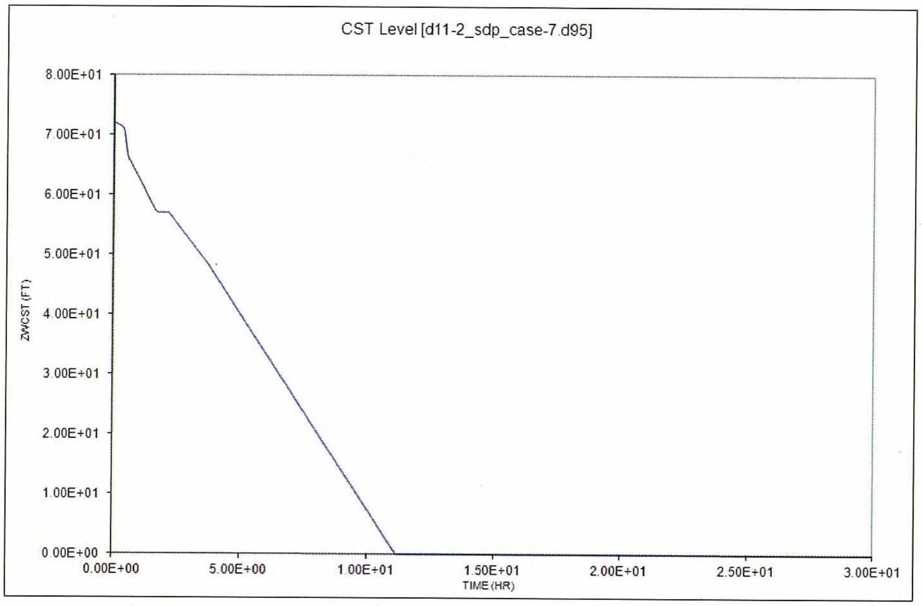
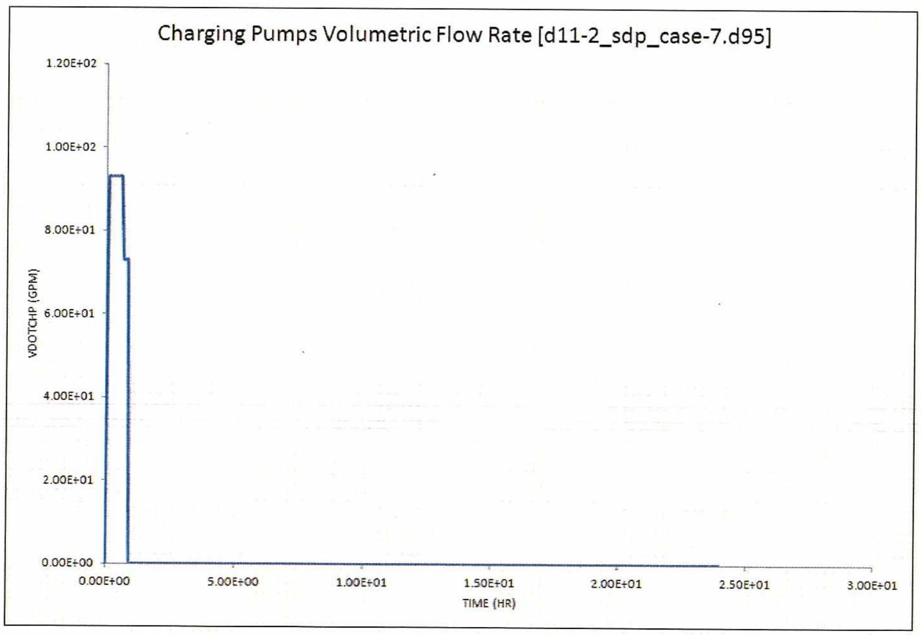


Figure 5.1.1-3



5.1.2 D11-2 SDP Case7 Results

Figure 5.1.1-1 indicates the rise in the peak core node temperature begins in about 16 hours. Figure 5.1.1-2 show the condensate storage tank (T-2) emptying in approximately 11 hours, and Figure 5.1.1-3 presents charging flow termination.

5.2 D11-2 SDP Case11

5.2.1 D11-2 SDP Case11 Purpose

The purpose of this case is to evaluate the 9/25/11 baseline event incorporating time line data, operating plant equipment, etc. This case reports on the water inventory given a stuck open PZR valve, and unsecured charging flow for a 24 hour period. Table 5.2.1 provides an overview of the case inputs and boundary conditions. Appendix A includes the specific input file.

Table 5.2.1

MAAP CASE		SUMMARY
D11-2 SDP Case11	**Purpose:**	To evaluate the 9/25/11 baseline event incorporating time line data, operating plant equipment, etc. Charging, 80 gpm flow, unsecured (t=0) with a Stuck Open PZR Safety (t=1.15 hrs). 1 CAC operable.
	Description:	- AFW initially operable for ~97 minutes. Tripped for ~27 minutes restored in ~2.17 hours. See Table 3.5-1. - ADVs assumed disabled (locked closed) for 24 hours. - T-2 refill not credited. - 1 Containment Air Cooler credited. - Problem run time 10 hours. Other: - Forced PCS Break Simulating Stuck Open PZR Safety (1.15 hrs) - HPSI Tripped (t=0) - LPSI Tripped (t=0) - PCPs tripped in 11 minutes - Containment Sprays Tripped (t=0) - PZR Sprays Tripped (t=0) - PZR Heaters Tripped (t=0) - Main Feedwater Isolated (t=0) - MSIVs Forced Closed (t=0)
	Conclusion:	In case 11, the PZR safeties begin to pass water in ~1.15 hours at which time a stuck open PZR safety is modeled. Assuming containment sprays are promptly secured, safety injection refueling water tank inventory (T-58) and condensate storage tank (T-2) water will last 24 hours. Moreover, 1 CAC alone can remove containment heat.

Figure 5.2.1-1

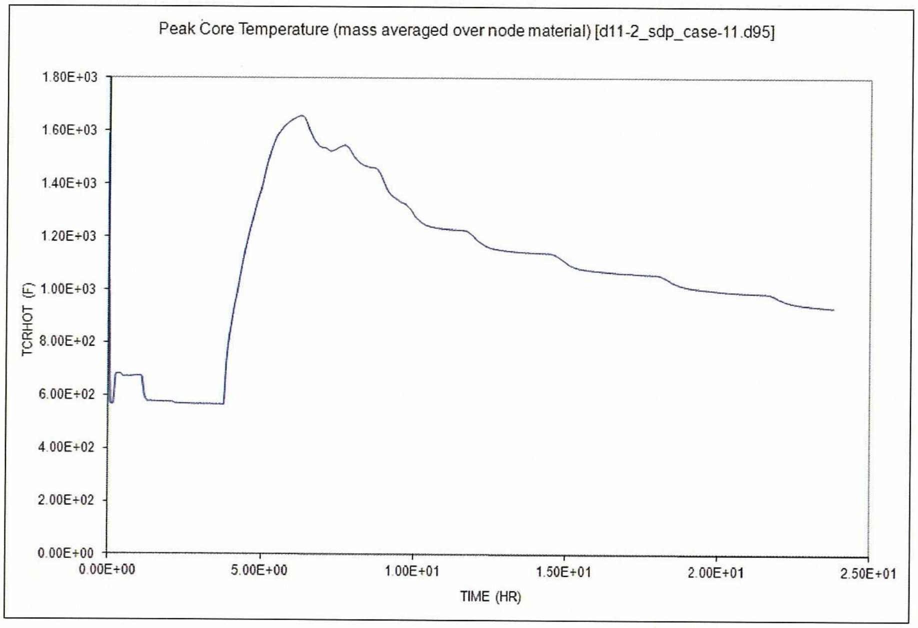


Figure 5.2.1-2

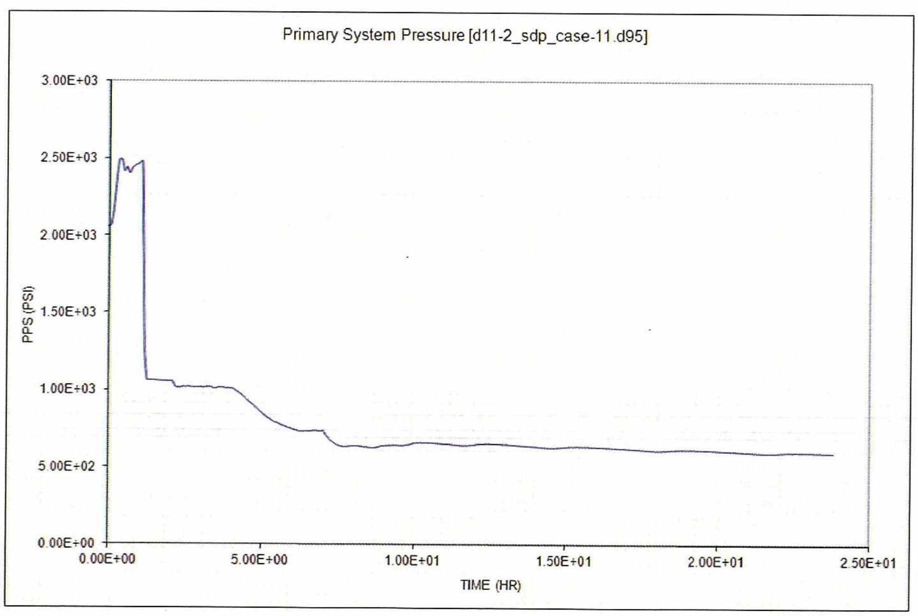


Figure 5.2.1-3

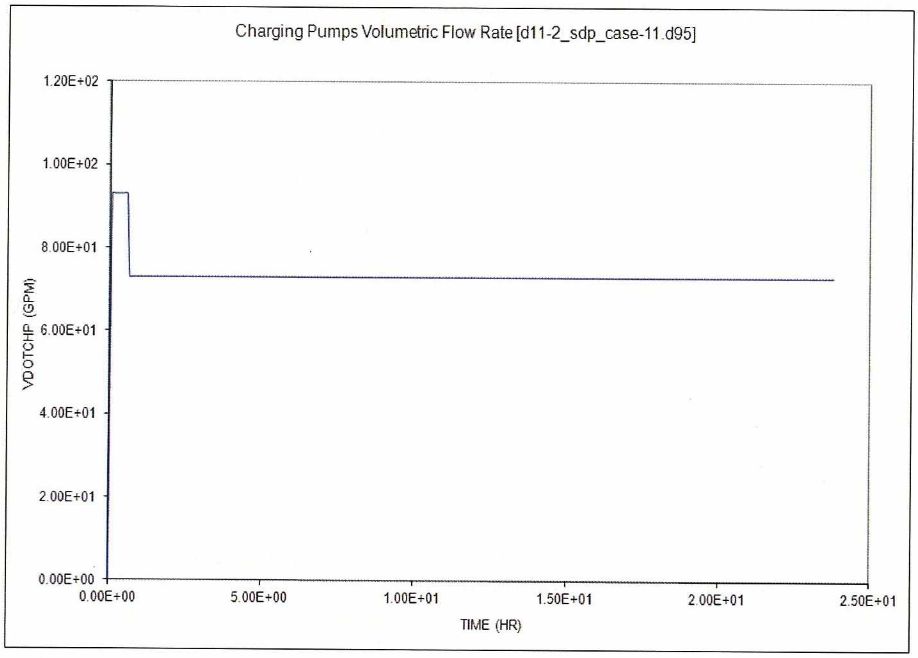


Figure 5.2.1-4

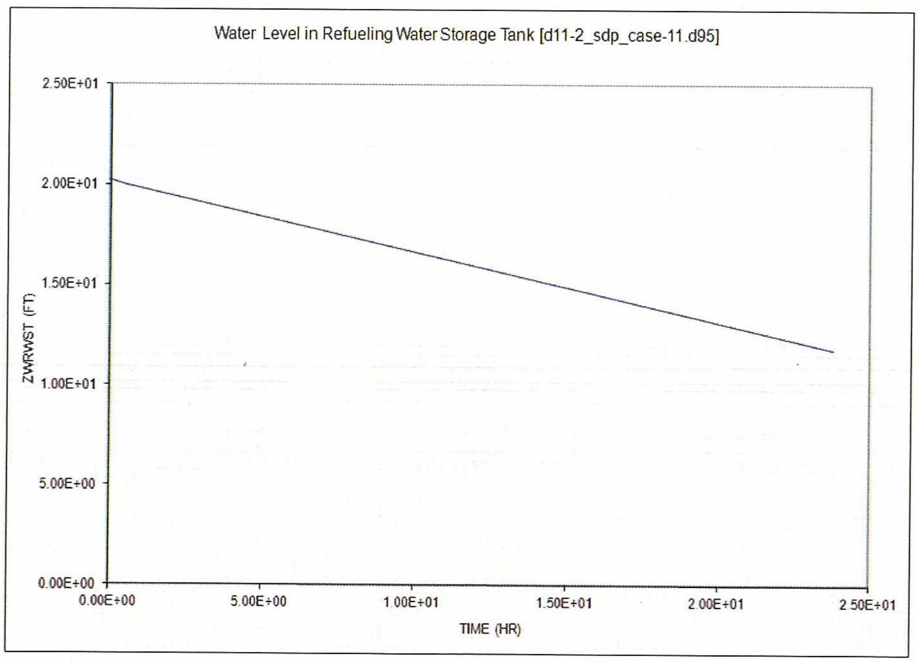


Figure 5.2.1-5

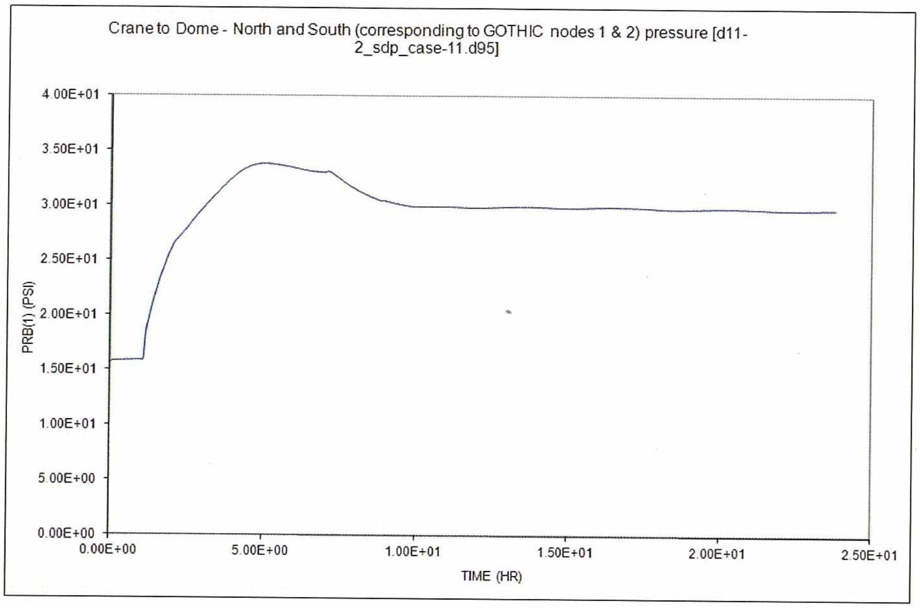


Figure 5.2.1-6

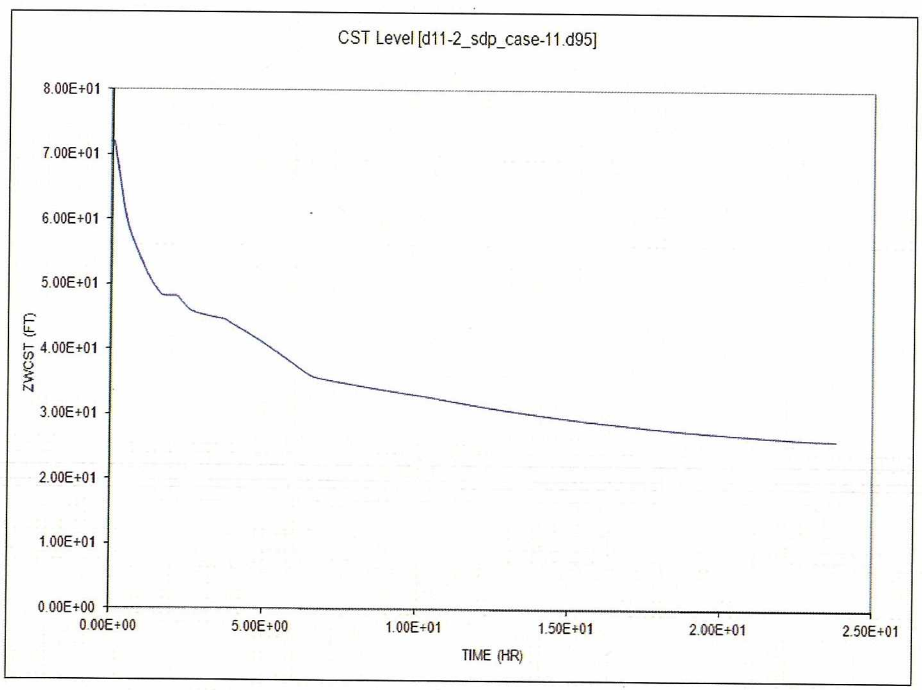


Figure 5.2.1-7

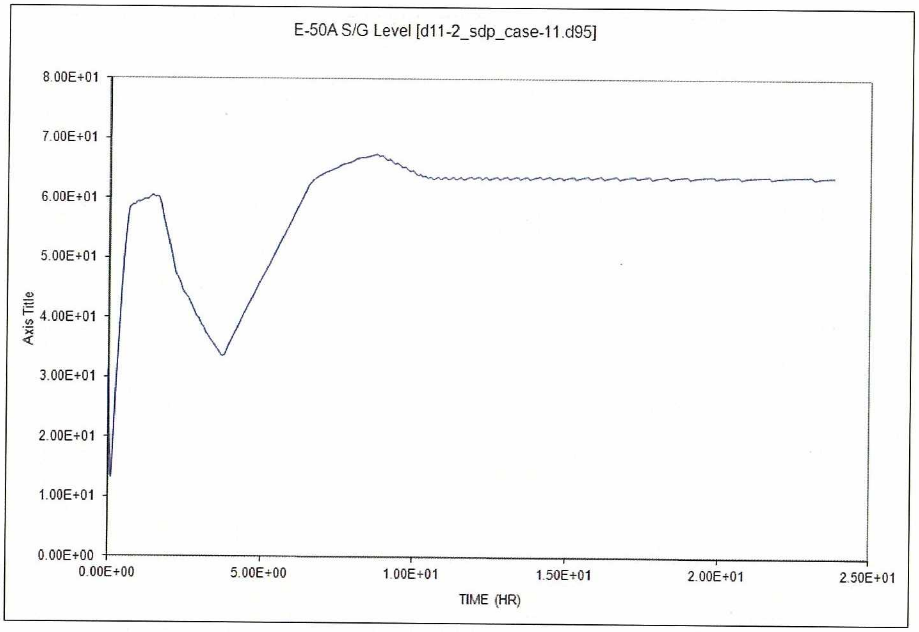


Figure 5.2.1-8

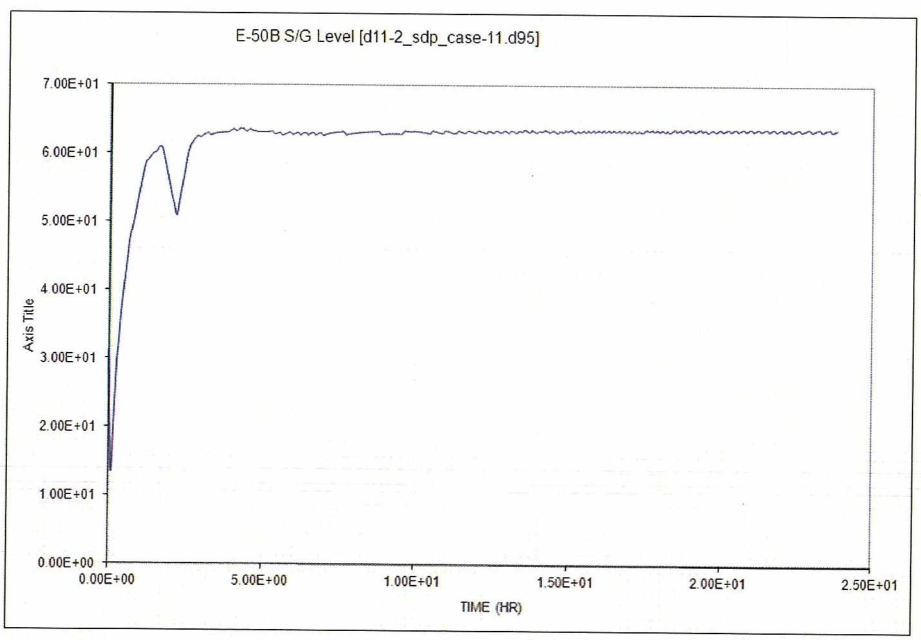


Figure 5.2.1-9

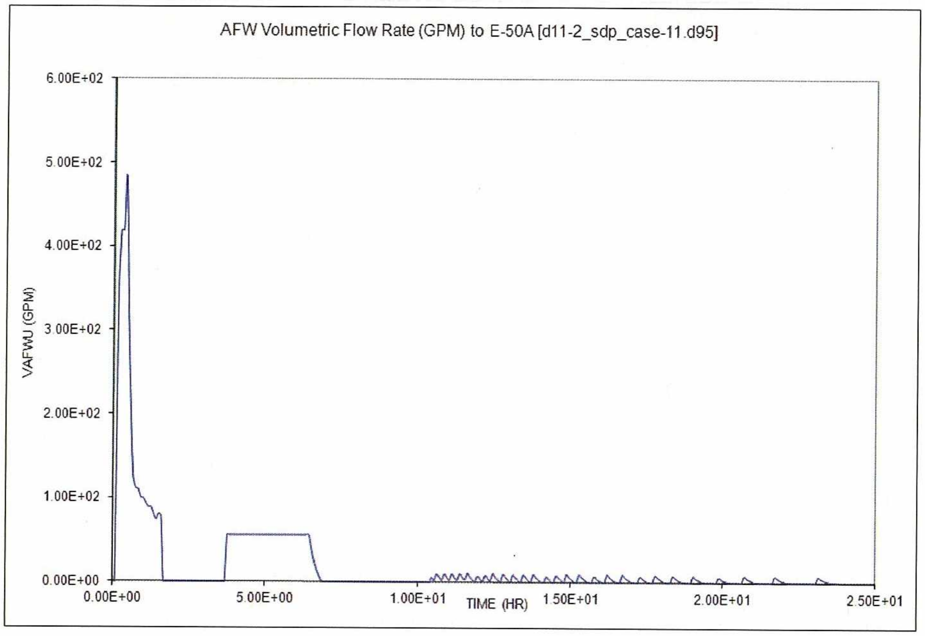
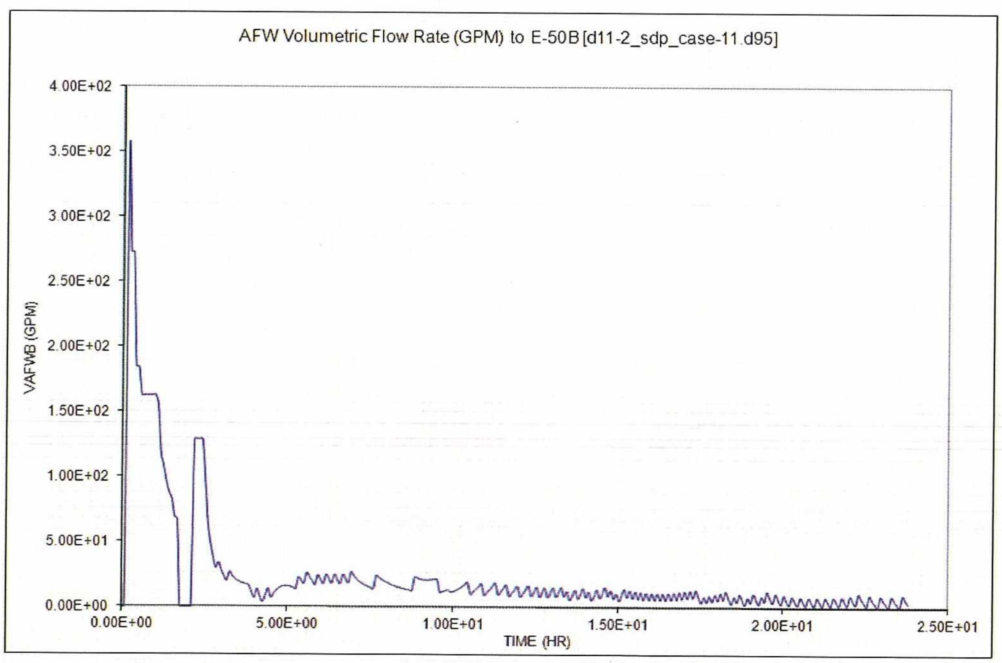


Figure 5.2.1-10



5.2.2 D11-2 SDP Case11 Results

Figure 5.2-1 shows the rise in the peak core node temperature given a stuck open pressurizer safety valve at approximately 1 hour. The peak temperature of 1650°F remained less than the success criteria limit of 1800°F. Figure 5.2.1-2 displays the primary coolant system pressure (PCS). Figure 5.2.1-3 presents the unsecured charging flow dropping from 93 gpm to 73 gpm at 36 minutes into the event. Figure 5.2.1-4 shows the safety injection refueling water storage tank (SIRWT) dropping about 8 feet during the 24 hour period. Figure 5.2.1-5 demonstrates that 1 containment air cooler (CAC) is sufficient to keep containment pressure less than the 55 psig design value. Figure 5.2.1-6 indicates that the condensate storage tank (T-2) dropped from about 72 feet to 26 feet during the 24 hour duration. Figures 5.2.1-7 and 5.2.1-8 present displays the E-50A and E-50B steam generator levels, and similarly Figures 5.2.1-9 and 5.2.1-10 report the AFW flow to each generator.

In summary, Case 11 results show that if 2 charging pumps, SIRWT water and AFW are available then HPSI injection is not required. However, the logic model as described in Section 6.2 conservatively requires HPSI for success in all RAS sequences, to achieve a safe and stable state for the 24 hour mission.

5.3 D11-2 SDP Case17

5.3.1 D11-2 SDP Case17 Purpose

The purpose of this case is to evaluate the 9/25/11 baseline event incorporating time line data, operating plant equipment, etc. This case presents the minimum time to empty the SIRWT. A failed open PZR valve modeled at 1.15 hours with all three spray pumps running is considered. The time to emptying the pressuizer may be used as an operator recovery action.

Table 5.3.1

MAAP CASE		SUMMARY
D11-2 SDP Case17	**Purpose:**	To evaluate the 9/25/11 baseline event incorporating time line data, operating plant equipment, etc. 80 gpm charging flow with a Stuck Open PZR Safety (t=1.15 hrs). All 3 containment spray pumps are operating to determine the time to SIRWT depletion.
	Description:	- No AFW. - ADVs assumed disabled (locked closed) for 24 hours. - T-2 refill not credited. - Problem run time 10 hours. Other: - Forced PCS Break Simulating Stuck Open PZR Safety (1.15 hrs) - HPSI Tripped (t=0) - LPSI Tripped (t=0) - PCPs tripped in 11 minutes - PZR Sprays Tripped (t=0) - PZR Heaters Tripped (t=0) - Main Feedwater Isolated (t=0) - MSIVs Forced Closed (t=0)

Conclusion:	In case 17, the PZR safeties begin to pass water in ~1.15 hours and a stuck open PZR safety is modeled. Assuming containment sprays are not secured, the SIRWT runs out of water in a little over two hours.

Figure 5.3.1-1

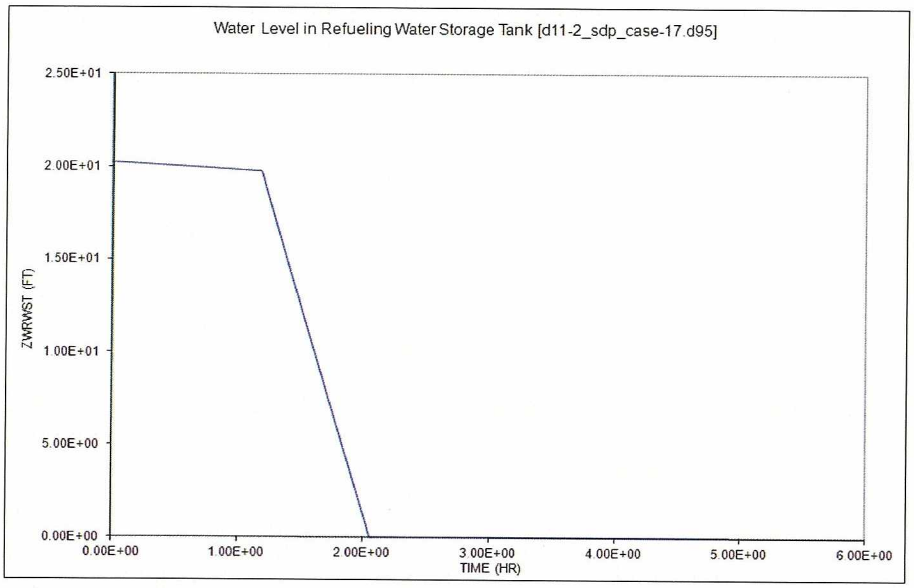


Figure 5.3.1-2

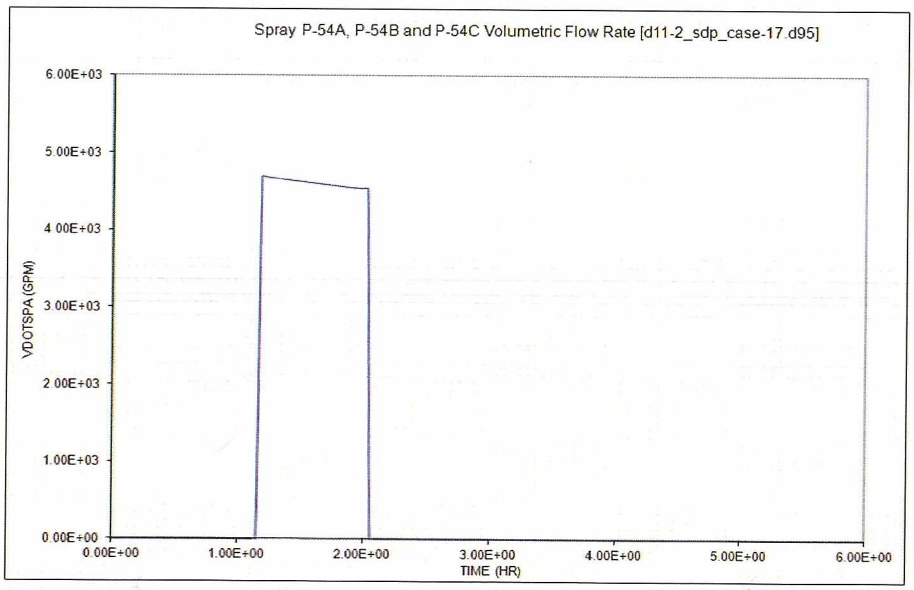
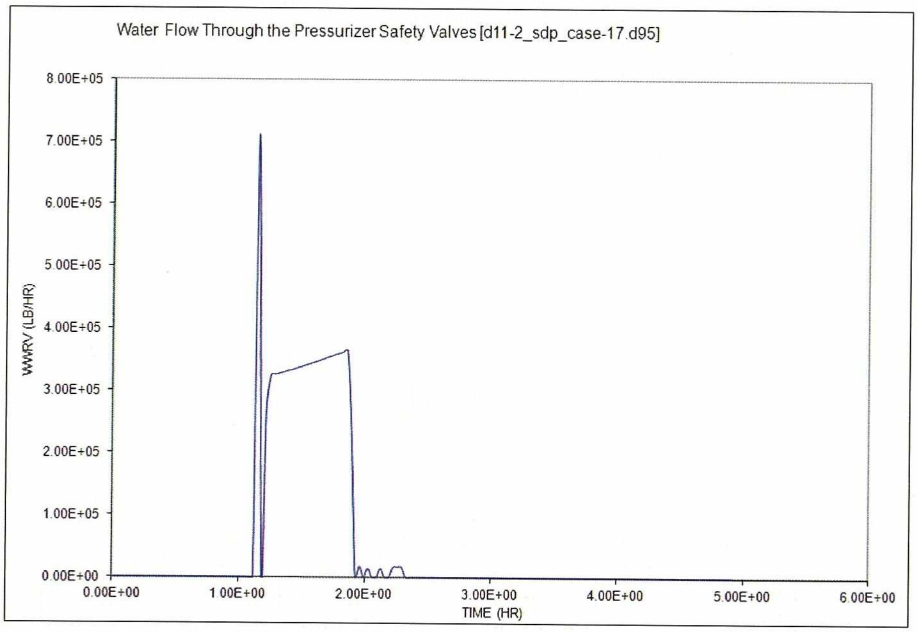


Figure 5.3.1-3



5.3.2 D11-2 SDP Case17 Results

Figure 5.3.1-1 shows the time when the SIRWT would empty, given that containment spray pumps are not secured and charging is providing makeup. Figure 5.3.1-2 plots the containment spray delivery curve. Figure 5.3.1-3 presents the water flow rate through the pressurizer safety valve starting at approximately 1 hour.

6.0 WATER SUMMARY

Water summary results are listed below in Table 6.

Table 6 Case Water Makeup Requirements

Case #	Water Source	Refill Time	ADV's	AFW	PZR Safeties	Charging Flow	Containment Heat Removal	Comments
7	Condensate Storage Tank	10 hours	Closed	Table 3.5-1	closed	Table 3.5-2		Assuming Table 3.5-1 delivery rates.
11	SIRWT Empty	> 24 hours	Closed	Table 3.5-1	Failed Open	80 gpm	1 CAC	Failed open per PCS high pressure demand at 1.15 hours. Assumes containment sprays initially secured.
11	Condensate Storage Tank	> 24 hours	Closed	Table 3.5-1	Failed Open	80 gpm	1 CAC	Failed open per PCS high pressure demand at 1.15 hours. Assumes containment sprays initially secured.
17	SIRWT Empty	~ 2 hours	Closed	none	Failed Open	80 gpm	3 Spray Pumps	PZR Safeties failed open at 0.2 hrs, chosen to bound the results. Three containment spray pumps are modeled.

7.0 REFERENCES

[1] PLP0247-07-0004.02R1, Revision 1, Palisades Nuclear Plant MAAP 4.0.6 Parameter Files Notebook, Volumes 1-8, August 2009.

[2] PLP0247-07-0004.01R2, Revision 2, Palisades Nuclear Plant Thermal Hydraulic MAAP Calculations, October 2009.

[3] Letter from Jeff R. Gabor to Brian Brogan, "MAAP4/RELAP5 Comparison Final Report", PP0495050004-2613, March, 2006.

[4] Palisades PSA Notebook NB-PSA-ETSC Rev. 2, "Event Trees and Success Criteria".

8.0 APPENDICES

Appendix A - MAAP Input Files

Appendix A - MAAP Input Files

Appendix B - MAAP Attach & Plot Files

Appendix B - MAAP Attach & Plot Files.pd

Appendix A: MAAP Input Files

1.0 D11-2_SDP_CASE-7.INP

```
SENSITIVITY ON

 TITLE
 Loss of D11-2 Case 7
 END TITLE

 INCLUDE attach.dat
 INCLUDE attach_charging1_D11_2(2).dat
 INCLUDE sc_plots(1).dat

 PARAMETER CHANGE
C
     PSGRV = 2000  PSI // Lock the ADV closed
     TDMFW = 0.0 HR // Time delay between MFW isol & actual isol
C Set CST to large value but keep same level
C     MWCST0 = 1.E9 LB
C     ACST = 738220. FT**2
C Given MAAP will use the minimum of WAFWXU or the flowrate from the pump head
curve,
C set the head curve data high.
       WVAFW(1)=  1000.  GPM
       WVAFW(2)=  1000.  GPM
       WVAFW(3)=  1000.  GPM
       WVAFW(4)=  1000.  GPM
       WVAFW(5)=  1000.  GPM
END

 START TIME IS 0.

 END TIME IS 24.0 HR
 PRINT INTERVAL IS 1. HR

 INITIATORS
C   PS BREAK(S) FAILED
    HPI FORCED OFF
    LPI FORCED OFF
C   MCP SWITCH OFF OR HI-VIBR TRIP
    FANS/COOLERS FORCED OFF
    ESF UPPER/LOWER COMPT. SPRAYS FORCED OFF
C   MOTOR-DRIVEN AUX FEED WATER FORCED OFF
    PZR SPRAYS FORCED OFF
    PZR HTRS FORCED OFF
    MANUAL SCRAM
    MAIN FW SHUT OFF
C   CHARGING PUMPS FORCED OFF
    S/G MSIV: FORCED CLOSED
    PS MAKEUP OFF
    LETDOWN SWITCH OFF
```

```
   END

WHEN REACTOR SCRAM IS TRUE
   SET TIMER 1
END

WHEN TIMER 1 > 0.000833 HR
   CHARGING PUMPS SWITCH: AUTO
   CHARGING PUMP SWITCH: MAN ON
C PARAMETER CHANGE
    C 342 GPM to E-50A and 350 GPM to E-50B
    C TAFW = 120. F  @ 900 psia
    C specific volume = 1.61605e-2 FT**3/LB
    C 1 [LB/HR] * 0.0161605 [FT3/LB] * 1/0.1336805556[GAL/FT3] * 1/60[HR/MIN]
    C 1 [LB/HR] =  0.0020148156 [GAL/MIN]
      WAFWXU = 1.697E+05  LB/HR
      WAFWXB = 1.737E+05  LB/HR
C END
END

WHEN TIMER 1 > 0.1833 HR
   MCP SWITCH OFF OR HI-VIBR TRIP
END

WHEN TIMER 1 > 0.2350 HR
C PARAMETER CHANGE
    C 419 GPM to E-50A and 273 GPM to E-50B
    C TAFW = 120. F  @ 900 psia
    C specific volume = 1.61605e-2 FT**3/LB
    C 1 [LB/HR] * 0.0161605 [FT3/LB] * 1/0.1336805556[GAL/FT3] * 1/60[HR/MIN]
    C 1 [LB/HR] =  0.0020148156 [GAL/MIN]
      WAFWXU = 2.08E+05  LB/HR
      WAFWXB = 1.355E+05  LB/HR
C END
END

WHEN TIMER 1 > 0.4017 HR
C PARAMETER CHANGE
    C 495 GPM to E-50A and 185 GPM to E-50B
    C TAFW = 120. F  @ 900 psia
    C specific volume = 1.61605e-2 FT**3/LB
    C 1 [LB/HR] * 0.0161605 [FT3/LB] * 1/0.1336805556[GAL/FT3] * 1/60[HR/MIN]
    C 1 [LB/HR] =  0.0020148156 [GAL/MIN]
      WAFWXU = 2.457E+05  LB/HR
      WAFWXB = 9.182E+04  LB/HR
C END
END

WHEN TIMER 1 > 0.5683 HR
C PARAMETER CHANGE
C 379 GPM to E-50A and 163 GPM to E-50B
    C TAFW = 120. F  @ 900 psia
```

```
    C specific volume = 1.61605e-2 FT**3/LB
    C 1 [LB/HR] * 0.0161605 [FT3/LB] * 1/0.1336805556[GAL/FT3] * 1/60[HR/MIN]
    C 1 [LB/HR] =  0.0020148156 [GAL/MIN]
      WAFWXU = 1.881E+05  LB/HR
      WAFWXB = 8.09E+04  LB/HR
C END
END

WHEN TIMER 1 > 0.6 HR
C PARAMETER CHANGE
    C P-55A and P-55B assumed operating at time 0
    C Reduce P-55A flow rate from 53 gpm to 33 gpm
     WVPM6(1)  = 73.0 GPM
     WVPM6(2)  = 73.0 GPM
     WVPM6(3)  = 73.0 GPM
     WVPM6(4)  = 73.0 GPM
     WVPM6(5)  = 73.0 GPM
C END
END

 WHEN TIMER 1 > 0.85 HR
     WVPM6(1)  = 0.0 GPM
     WVPM6(2)  = 0.0 GPM
     WVPM6(3)  = 0.0 GPM
     WVPM6(4)  = 0.0 GPM
     WVPM6(5)  = 0.0 GPM
 END

WHEN TIMER 1 > 1.6183 HR
C PARAMETER CHANGE
C 0 GPM to E-50A and 156 GPM to E-50B
    C TAFW = 120. F  @ 900 psia
    C specific volume = 1.61605e-2 FT**3/LB
    C 1 [LB/HR] * 0.0161605 [FT3/LB] * 1/0.1336805556[GAL/FT3] * 1/60[HR/MIN]
    C 1 [LB/HR] =  0.0020148156 [GAL/MIN]
      WAFWXU = 0.0  LB/HR
      WAFWXB = 7.743E+04 LB/HR
C END
END

WHEN TIMER 1 > 1.7167 HR
C PARAMETER CHANGE
C 0 GPM to E-50A and 165 GPM to E-50B
    C TAFW = 120. F  @ 900 psia
    C specific volume = 1.61605e-2 FT**3/LB
    C 1 [LB/HR] * 0.0161605 [FT3/LB] * 1/0.1336805556[GAL/FT3] * 1/60[HR/MIN]
    C 1 [LB/HR] =  0.0020148156 [GAL/MIN]
      WAFWXU = 0.0  LB/HR
      WAFWXB = 0.0  LB/HR
C END
END
```

```
WHEN TIMER 1 > 2.1683 HR
C PARAMETER CHANGE
C 0 GPM to E-50A and 129 GPM to E-50B
    C TAFW = 120. F  @ 900 psia
    C specific volume = 1.61605e-2 FT**3/LB
    C 1 [LB/HR] * 0.0161605 [FT3/LB] * 1/0.1336805556[GAL/FT3] * 1/60[HR/MIN]
    C 1 [LB/HR] =  0.0020148156 [GAL/MIN]
      WAFWXU = 0.0  LB/HR
      WAFWXB = 6.403E+04  LB/HR
C END
END

WHEN TIMER 1 > 3.735 HR
C PARAMETER CHANGE
C 56 GPM to E-50A and 96 GPM to E-50B
    C TAFW = 120. F  @ 900 psia
    C specific volume = 1.61605e-2 FT**3/LB
    C 1 [LB/HR] * 0.0161605 [FT3/LB] * 1/0.1336805556[GAL/FT3] * 1/60[HR/MIN]
    C 1 [LB/HR] =  0.0020148156 [GAL/MIN]
      WAFWXU = 2.779E+04  LB/HR
      WAFWXB = 4.765E+04  LB/HR
C END
END
```

2.0 D11-2_SDP_CASE-11.INP

```
SENSITIVITY ON

 TITLE
 Loss of D11-2 Case 11
 END TITLE

 INCLUDE attach.dat
 INCLUDE attach_charging1_D11_2(2).dat
 INCLUDE sc_plots(1).dat

 PARAMETER CHANGE
C
     PSGRV = 2000  PSI // Lock the ADV closed
     TDMFW = 0.0 HR // Time delay between MFW isol & actual isol
C Set CST to large value but keep same level
C     MWCST0 = 1.E9 LB
C     ACST = 738220. FT**2
C Given MAAP will use the minimum of WAFWXU or the flowrate from the pump head
curve,
C set the head curve data high.
       WVAFW(1)=  1000.  GPM
       WVAFW(2)=  1000.  GPM
       WVAFW(3)=  1000.  GPM
       WVAFW(4)=  1000.  GPM
       WVAFW(5)=  1000.  GPM
 C 3 CACs = 12 Coils
```

```
C 2 CACs = 8 Coils
C 1 CAC =  4 Coils
C NFN = 12, number of containment air cooler coils for 3 CACs
C Credit only 1 Fan Cooler
      NFN = 4
END

START TIME IS 0.

END TIME IS 24.0 HR
PRINT INTERVAL IS 1. HR

INITIATORS
C    PS BREAK(S) FAILED
     HPI FORCED OFF
     LPI FORCED OFF
C    MCP SWITCH OFF OR HI-VIBR TRIP
C    FANS/COOLERS FORCED OFF
     ESF UPPER/LOWER COMPT. SPRAYS FORCED OFF
C    MOTOR-DRIVEN AUX FEED WATER FORCED OFF
     PZR SPRAYS FORCED OFF
     PZR HTRS FORCED OFF
     MANUAL SCRAM
     MAIN FW SHUT OFF
     CHARGING PUMPS FORCED OFF
     S/G MSIV: FORCED CLOSED
     PS MAKEUP OFF
     LETDOWN SWITCH OFF
     END

WHEN REACTOR SCRAM IS TRUE
   SET TIMER 1
END

WHEN TIMER 1 > 0.000833 HR
   CHARGING PUMPS SWITCH: AUTO
   CHARGING PUMP SWITCH: MAN ON
C PARAMETER CHANGE
    C 342 GPM to E-50A and 350 GPM to E-50B
    C TAFW = 120. F  @ 900 psia
    C specific volume = 1.61605e-2 FT**3/LB
    C 1 [LB/HR] * 0.0161605 [FT3/LB] * 1/0.1336805556[GAL/FT3] * 1/60[HR/MIN]
    C 1 [LB/HR] =  0.0020148156 [GAL/MIN]
      WAFWXU = 1.697E+05  LB/HR
      WAFWXB = 1.737E+05  LB/HR
C END
END

WHEN TIMER 1 > 0.1833 HR
   MCP SWITCH OFF OR HI-VIBR TRIP
END
```

```
WHEN TIMER 1 > 0.2350 HR
C PARAMETER CHANGE
    C 419 GPM to E-50A and 273 GPM to E-50B
    C TAFW = 120. F  @ 900 psia
    C specific volume = 1.61605e-2 FT**3/LB
    C 1 [LB/HR] * 0.0161605 [FT3/LB] * 1/0.1336805556[GAL/FT3] * 1/60[HR/MIN]
    C 1 [LB/HR] =  0.0020148156 [GAL/MIN]
      WAFWXU = 2.08E+05  LB/HR
      WAFWXB = 1.355E+05  LB/HR
C END
END

WHEN TIMER 1 > 0.4017 HR
C PARAMETER CHANGE
    C 495 GPM to E-50A and 185 GPM to E-50B
    C TAFW = 120. F  @ 900 psia
    C specific volume = 1.61605e-2 FT**3/LB
    C 1 [LB/HR] * 0.0161605 [FT3/LB] * 1/0.1336805556[GAL/FT3] * 1/60[HR/MIN]
    C 1 [LB/HR] =  0.0020148156 [GAL/MIN]
      WAFWXU = 2.457E+05  LB/HR
      WAFWXB = 9.182E+04  LB/HR
C END
END

WHEN TIMER 1 > 0.5683 HR
C PARAMETER CHANGE
C 379 GPM to E-50A and 163 GPM to E-50B
    C TAFW = 120. F  @ 900 psia
    C specific volume = 1.61605e-2 FT**3/LB
    C 1 [LB/HR] * 0.0161605 [FT3/LB] * 1/0.1336805556[GAL/FT3] * 1/60[HR/MIN]
    C 1 [LB/HR] =  0.0020148156 [GAL/MIN]
      WAFWXU = 1.881E+05  LB/HR
      WAFWXB = 8.09E+04  LB/HR
C END
END

 WHEN TIMER 1 > 0.6 HR
C PARAMETER CHANGE
    C P-55A and P-55B assumed operating at time 0
    C Reduce P-55A flow rate from 53 gpm to 33 gpm
     WVPM6(1)  = 73.0 GPM
     WVPM6(2)  = 73.0 GPM
     WVPM6(3)  = 73.0 GPM
     WVPM6(4)  = 73.0 GPM
     WVPM6(5)  = 73.0 GPM
C END
 END

C WHEN TIMER 1 > 0.85 HR
C      WVPM6(1)  = 0.0 GPM
C      WVPM6(2)  = 0.0 GPM
C      WVPM6(3)  = 0.0 GPM
```

```
C      WVPM6(4)  = 0.0 GPM
C      WVPM6(5)  = 0.0 GPM
C END

WHEN TIMER 1 > 1.15 HR
C PARAMETER CHANGE
C Set PORV to model Stuck Open PZR Safety
C At 16:15(analysis timeline)the PCS is solid and PZR Safety Lifts
C and passes water.  Event duration 15:06 start and 16:15 safeties lift.
C
C PZR Safety ASRV(3)     0.0097  FT**2
C The POV is assumed to be always open for a LOCA
C so the setpoint pressure to open is set to a low value
C
    PSETRV(1) = 10 PSI
    ASRV(1) =  0.0097 FT**2

C Since the PORV discharges to the quench tank,
C the quench tank needs to be disabled. The rupture
C pressure is set to a low value
C Setting IQT = 0 disables the quench tank model
    IQT = 0
C END PORV PZR Safety Relief Model
END

WHEN TIMER 1 > 1.6183 HR
C PARAMETER CHANGE
C 0 GPM to E-50A and 156 GPM to E-50B
    C TAFW = 120. F  @ 900 psia
    C specific volume = 1.61605e-2 FT**3/LB
    C 1 [LB/HR] * 0.0161605 [FT3/LB] * 1/0.1336805556[GAL/FT3] * 1/60[HR/MIN]
    C 1 [LB/HR] =  0.0020148156 [GAL/MIN]
      WAFWXU = 0.0  LB/HR
      WAFWXB = 7.743E+04 LB/HR
C END
END

WHEN TIMER 1 > 1.7167 HR
C PARAMETER CHANGE
C 0 GPM to E-50A and 165 GPM to E-50B
    C TAFW = 120. F  @ 900 psia
    C specific volume = 1.61605e-2 FT**3/LB
    C 1 [LB/HR] * 0.0161605 [FT3/LB] * 1/0.1336805556[GAL/FT3] * 1/60[HR/MIN]
    C 1 [LB/HR] =  0.0020148156 [GAL/MIN]
      WAFWXU = 0.0  LB/HR
      WAFWXB = 0.0  LB/HR
C END
END

WHEN TIMER 1 > 2.1683 HR
C PARAMETER CHANGE
C 0 GPM to E-50A and 129 GPM to E-50B
```

```
     C TAFW = 120. F  @ 900 psia
     C specific volume = 1.61605e-2 FT**3/LB
     C 1 [LB/HR] * 0.0161605 [FT3/LB] * 1/0.1336805556[GAL/FT3] * 1/60[HR/MIN]
     C 1 [LB/HR] =  0.0020148156 [GAL/MIN]
       WAFWXU = 0.0  LB/HR
       WAFWXB = 6.403E+04  LB/HR
 C END
 END

 WHEN TIMER 1 > 3.735 HR
 C PARAMETER CHANGE
 C 56 GPM to E-50A and 96 GPM to E-50B
     C TAFW = 120. F  @ 900 psia
     C specific volume = 1.61605e-2 FT**3/LB
     C 1 [LB/HR] * 0.0161605 [FT3/LB] * 1/0.1336805556[GAL/FT3] * 1/60[HR/MIN]
     C 1 [LB/HR] =  0.0020148156 [GAL/MIN]
       WAFWXU = 2.779E+04  LB/HR
       WAFWXB = 4.765E+04  LB/HR
 C END
 END
```

3.0 D11-2_SDP_CASE-17.INP

```
SENSITIVITY ON


 TITLE
 Loss of D11-2 Case 17
 END TITLE

 INCLUDE attach.dat
 INCLUDE attach_charging2.dat
 INCLUDE sc_plots(1).dat

 PARAMETER CHANGE
C
     PSGRV = 2000  PSI // Lock the ADV closed
     TDMFW = 0.0 HR // Time delay between MFW isol & actual isol
C Set CST to large value but keep same level
C     MWCST0 = 1.E9 LB
C     ACST = 738220. FT**2
C Given MAAP will use the minimum of WAFWXU or the flowrate from the pump head
curve,
C set the head curve data high.
       WVAFW(1)=  1000.  GPM
       WVAFW(2)=  1000.  GPM
       WVAFW(3)=  1000.  GPM
       WVAFW(4)=  1000.  GPM
       WVAFW(5)=  1000.  GPM
 C 3 CACs = 12 Coils
 C 2 CACs = 8 Coils
 C 1 CAC =  4 Coils
 C NFN = 12, number of containment air cooler coils for 3 CACs
```

```
C Credit only 1 Fan Cooler
C       NFN = 4
C Credit 3 Spray Pumps
       NSPAG = 3
END

START TIME IS 0.

END TIME IS 5.0 HR
PRINT INTERVAL IS 1. HR

INITIATORS
C    PS BREAK(S) FAILED
     HPI FORCED OFF
     LPI FORCED OFF
C    MCP SWITCH OFF OR HI-VIBR TRIP
     FANS/COOLERS FORCED OFF
C    ESF UPPER/LOWER COMPT. SPRAYS FORCED OFF
     MOTOR-DRIVEN AUX FEED WATER FORCED OFF
     PZR SPRAYS FORCED OFF
     PZR HTRS FORCED OFF
     MANUAL SCRAM
     MAIN FW SHUT OFF
     CHARGING PUMPS FORCED OFF
     S/G MSIV: FORCED CLOSED
     PS MAKEUP OFF
     LETDOWN SWITCH OFF
     END

WHEN REACTOR SCRAM IS TRUE
   SET TIMER 1
END

WHEN TIMER 1 > 0.000833 HR
   CHARGING PUMPS SWITCH: AUTO
   CHARGING PUMP SWITCH: MAN ON
C PARAMETER CHANGE
    C 342 GPM to E-50A and 350 GPM to E-50B
    C TAFW = 120. F  @ 900 psia
    C specific volume = 1.61605e-2 FT**3/LB
    C 1 [LB/HR] * 0.0161605 [FT3/LB] * 1/0.1336805556[GAL/FT3] * 1/60[HR/MIN]
    C 1 [LB/HR] =  0.0020148156 [GAL/MIN]
    C  WAFWXU = 1.697E+05  LB/HR
    C  WAFWXB = 1.737E+05  LB/HR
C END
END

WHEN TIMER 1 > 0.1833 HR
   MCP SWITCH OFF OR HI-VIBR TRIP
END

WHEN TIMER 1 > 1.15 HR
```

```
C PARAMETER CHANGE
C Set PORV to model Stuck Open PZR Safety
C At 1.93 hours the PCS is solid and PZR Safety Lifts
C and passes water.  Refer to Case 8.
C
C PZR Safety ASRV(3)     0.0097  FT**2
C The POV is assumed to be always open for a LOCA
C so the setpoint pressure to open is set to a low value
C
     PSETRV(1) = 10 PSI
     ASRV(1) =  0.0097 FT**2

C Since the PORV discharges to the quench tank,
C the quench tank needs to be disabled. The rupture
C pressure is set to a low value
C Setting IQT = 0 disables the quench tank model
     IQT = 0
C END PORV PZR Safety Relief Model
END
WHEN TIMER 1 > 0.2350 HR
C PARAMETER CHANGE
     C 419 GPM to E-50A and 273 GPM to E-50B
     C TAFW = 120. F  @ 900 psia
     C specific volume = 1.61605e-2 FT**3/LB
     C 1 [LB/HR] * 0.0161605 [FT3/LB] * 1/0.1336805556[GAL/FT3] * 1/60[HR/MIN]
     C 1 [LB/HR] =  0.0020148156 [GAL/MIN]
     C WAFWXU = 2.08E+05  LB/HR
     C WAFWXB = 1.355E+05  LB/HR
C END
END

WHEN TIMER 1 > 0.4017 HR
C PARAMETER CHANGE
     C 495 GPM to E-50A and 185 GPM to E-50B
     C TAFW = 120. F  @ 900 psia
     C specific volume = 1.61605e-2 FT**3/LB
     C 1 [LB/HR] * 0.0161605 [FT3/LB] * 1/0.1336805556[GAL/FT3] * 1/60[HR/MIN]
     C 1 [LB/HR] =  0.0020148156 [GAL/MIN]
     C WAFWXU = 2.457E+05  LB/HR
     C WAFWXB = 9.182E+04  LB/HR
C END
END

 WHEN TIMER 1 > 0.5683 HR
C PARAMETER CHANGE
C 379 GPM to E-50A and 163 GPM to E-50B
     C TAFW = 120. F  @ 900 psia
     C specific volume = 1.61605e-2 FT**3/LB
     C 1 [LB/HR] * 0.0161605 [FT3/LB] * 1/0.1336805556[GAL/FT3] * 1/60[HR/MIN]
     C 1 [LB/HR] =  0.0020148156 [GAL/MIN]
     C WAFWXU = 1.881E+05  LB/HR
     C WAFWXB = 8.09E+04  LB/HR
```

```
C END
END
 WHEN TIMER 1 > 0.6 HR
C PARAMETER CHANGE
    C P-55A and P-55B assumed operating at time 0
    C Reduce P-55A flow rate from 53 gpm to 33 gpm
    C WVPM6(1) = 73.0 GPM
    C WVPM6(2) = 73.0 GPM
    C WVPM6(3) = 73.0 GPM
    C WVPM6(4) = 73.0 GPM
    C WVPM6(5) = 73.0 GPM
C END
 END

C WHEN TIMER 1 > 0.85 HR
C     WVPM6(1) = 0.0 GPM
C     WVPM6(2) = 0.0 GPM
C     WVPM6(3) = 0.0 GPM
C     WVPM6(4) = 0.0 GPM
C     WVPM6(5) = 0.0 GPM
C END

WHEN TIMER 1 > 1.6183 HR
C PARAMETER CHANGE
C 0 GPM to E-50A and 156 GPM to E-50B
    C TAFW = 120. F  @ 900 psia
    C specific volume = 1.61605e-2 FT**3/LB
    C 1 [LB/HR] * 0.0161605 [FT3/LB] * 1/0.1336805556[GAL/FT3] * 1/60[HR/MIN]
    C 1 [LB/HR] =  0.0020148156 [GAL/MIN]
    C WAFWXU = 0.0  LB/HR
    C WAFWXB = 7.743E+04 LB/HR
C END
END

WHEN TIMER 1 > 1.7167 HR
C PARAMETER CHANGE
C 0 GPM to E-50A and 165 GPM to E-50B
    C TAFW = 120. F  @ 900 psia
    C specific volume = 1.61605e-2 FT**3/LB
    C 1 [LB/HR] * 0.0161605 [FT3/LB] * 1/0.1336805556[GAL/FT3] * 1/60[HR/MIN]
    C 1 [LB/HR] =  0.0020148156 [GAL/MIN]
    C WAFWXU = 0.0  LB/HR
    C WAFWXB = 0.0  LB/HR
C END
END

WHEN TIMER 1 > 2.1683 HR
C PARAMETER CHANGE
C 0 GPM to E-50A and 129 GPM to E-50B
    C TAFW = 120. F  @ 900 psia
    C specific volume = 1.61605e-2 FT**3/LB
    C 1 [LB/HR] * 0.0161605 [FT3/LB] * 1/0.1336805556[GAL/FT3] * 1/60[HR/MIN]
```

```
    C 1 [LB/HR] =  0.0020148156 [GAL/MIN]
    C WAFWXU = 0.0  LB/HR
    C WAFWXB = 6.403E+04  LB/HR
C END
END

WHEN TIMER 1 > 3.735 HR
C PARAMETER CHANGE
C 56 GPM to E-50A and 96 GPM to E-50B
    C TAFW = 120. F  @ 900 psia
    C specific volume = 1.61605e-2 FT**3/LB
    C 1 [LB/HR] * 0.0161605 [FT3/LB] * 1/0.1336805556[GAL/FT3] * 1/60[HR/MIN]
    C 1 [LB/HR] =  0.0020148156 [GAL/MIN]
    C WAFWXU = 2.779E+04  LB/HR
    C WAFWXB = 4.765E+04  LB/HR
C END
END
```

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 (((\$ZWBSC\$-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 (((\$ZWUSC\$-6.7612)*21.8723) < 100.0) > (-138.0)

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