Appendix B

Modeling Comparisons for Codes used in Ice Condenser Containment Analyses

Calculations for PWR ice condenser containments are typically divided into short and long-term analyses. In both analyses, an evaluation of pressure suppression performance of the plant is the main objective of the analytical modeling included in containment analysis codes. The time frame for short-term analyses is approximately the first five seconds immediately following a postulated large break in the reactor coolant system. Long-term analyses are performed for periods extending from the time of a pipe rupture to hours and perhaps days after the initiating event. Shown in Table B-1 are some of the characteristic modeling requirements for short and long-term ice condenser containment analyses. It has been the traditional approach of the vendor to recognize the unique requirements of each class of ice condenser analyses and develop separate codes, i.e., short and long-term analyses codes. In the case of Westinghouse, the codes used for short and long-term applications are the TMD and LOTIC codes, respectively. Past efforts by the USNRC to developed or modify containment codes for ice condensers have resulted in two codes, CONTEMPT4 (mod 6), and COMPARE. Because there is documented information only on the COMPARE code being used for ice condenser short-term DBA[1] or long-term, beyond DBA-type analyses,[2] we have limited our comparison of USNRC ice condenser containment analysis codes to the CONTAIN and COMPARE codes. Furthermore, we note that there are some gaps in the validation of the various ice condenser codes that also suggests limiting our suite of ice condenser codes. A partial listing of ice condenser code validation studies are shown in Table B-2. The point of this table is to indicate that there is a substantial amount of validation work that has been completed for the CONTAIN code that is directly applicable to ice condenser plant containment analysis. The validation status for other ice condenser codes is less known.

In the following subsections the short and long-term containment analysis codes are compared according to their respective phenomena modeling approaches.

B-1. Short-term Analyses

Shown in Table B-3 are model comparisons between the USNRC codes CONTAIN and

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[1] R. G. Gido, J. S. Gilbert, W. L. Jensen, "Containment Ice-Condenser Analysis using the COMPARE Code," LA-UR-77-1732, Los Alamos National Laboratory, Los Alamos, NM, July 1977.

[2] R. G. Gido and A. Koestel, "Hydrogen Burn Analysis of Ice-Condenser Containments," NUREG/CR-3278, LA-9749-MS, Los Alamos National Laboratory, Los Alamos, NM, July, 1983.

COMPARE, and Westinghouse's TMD (Transient Mass Distribution) code. The CONTAIN and COMPARE codes have modeling capabilities that are applicable to both short and long-term analyses. These capabilities, such as long-term heat sink modeling and spray pressure suppression, are not found in the TMD code. The more significant modeling differences between the CONTAIN code and either the COMPARE or TMD code are the methods of determining ice bed heat and mass transfer and the capability to parametrically set liquid entrainment fractions. In the case of COMPARE and TMD, both ice bed heat and mass transfer and entrainment (or carryover) modeling are treated similarly. CONTAIN, however, uses a more mechanistic, physically based approach to ice bed heat transfer that is essentially identical to its method of treating condensation heat transfer on structures. Entrainment in CONTAIN is limited to two bounding cases: 1) no entrainment (DROPOUT keyword), and the default model 2) 100% entrainment of liquid water condensed in atmosphere. A case of 100% entrainment is the most conservative approach that results in the highest peak pressure and largest pressure differentials between lower and upper compartments.

Critical flow modeling is another modeling area where there are some noted differences between codes. Both the CONTAIN and COMPARE codes allow the user to input multipliers to well known critical flow models; these multipliers provide a calibration or limiting factor to be used with appropriate experimental data to provide a conservative approach for limiting flow from the lower compartment.

Ice condenser door modeling is also an area where the CONTAIN code modeling is different from either COMPARE or TMD. COMPARE and TMD use a more detailed door modeling approach that includes the transient response of the lower and upper plenum doors to a pressure force. CONTAIN, on the other hand, assumes that the doors respond in a static way to pressure differentials. Comparisons between the two types of approaches (transient versus static) for LOCA type blowdowns indicate that the time constant for door response is so fast that there is virtually no differences between transient and static modeling of doors on peak pressures or pressure differentials.

From the Waltz Mill testing program conducted by Westinghouse,[3] we have noted that there is a significant decrease in the containment lower compartment pressure and pressure differential (lower to upper compartment) when hold-up water in the ice bed rapidly drains to the lower compartment. Neither of the codes treats this phenomenon. However, the CONTAIN code can at least provide a simulation of this effect on the containment thermal hydraulics by allowing, through a restarting of the calculation, the option of changing the entrainment from 100% to 0%, thereby dropping out suspended water after the very early turbulent portion of the blowdown period. The importance of this phenomena, where drain-down water appears to de-entrain liquid water in the lower compartment, to estimates of peak pressures and pressure differentials is believed to be minimal. This appears to be confirmed by observations from experiments that show that rapid drain-down occurs after the time of maximum pressures and pressure differentials.

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[3] "Ice Condenser Full-scale Section Tests at the Waltz Mill Facility: Final Report," WCAP-8282, February, 1974.

B-2. Long-term Analyses

Shown in Table B-4 are the model comparisons for the CONTAIN and COMPARE codes that have been used to predict long-term containment response to DBA or beyond DBA events. We observe from the table that the COMPARE code has a number of missing models that could be important to long-term containment responses, and have not been assessed for impact on late time pressurization during a LOCA event.

The LOTIC code is not included in the table comparison, however, some modeling differences may be noted in selected ice condenser plant FSARs. These discussions on the LOTIC modeling point out that this code is very dependent on empirical correlations and limiting assumptions that are not common to a more physically based, mechanistic code like the CONTAIN code. For example, the LOTIC code assumes saturation conditions in each control volume throughout a LOCA scenario. CONTAIN, in contrast, calculates super-saturation, saturation, or superheating based on two-phase equilibrium thermodynamics. During periods when the injection steam is superheated, a superheated condition will generally be calculated unless there is a mechanism modeled to cool and/or add water to the control volume atmosphere. In CONTAIN, saturation conditions are not calculated without a physical process being modeled to limit superheating during an injection (pool evaporation, structure condensate evaporation, thermal radiation, spray water interaction, etc.).

We have noted in the Waltz Mill long-term test that a likely process for forcing saturation is the interaction of ice bed drain-down water with the lower compartment atmosphere. This interaction process appears to be confirmed by both pressure and sump water temperature comparisons between CONTAIN (with a spray-like simulation of drain-down water interaction) and experimental data.

Table B-1. Modeling requirements for PWR ice condenser containment analysis codes.

Requirements	Phenomena
Short-term: (seconds)	
Pressure maximum Pressure differentials	two-phase injection; flow pressure drops; critical two-phase flow; ice heat and mass transfer (high vapor concentration), liquid water entrainment and carryover
Long-term: (hours - days)	
Pressure maximum	single and two-phase injection; ice heat and mass transfer (reduced vapor concentration); melt water and condensate heating; drain-down water thermal interactions with atmospheres; heat and mass transfer to structures; spray pressure suppression (quench and recirculation); sump cooling (heat exchangers)

Table B-2. Code validation exercises for ice condenser containment analysis.

Validation area	CONTAIN	COMPARE	TMD	LOTIC
Integral Effects:				
Ice condenser (short-term pressurization)	Waltz Mill (Test A) Appendix H [H-53, H-82, H-97]	Waltz Mill (Test A) ①	Waltz Mill (Test A) ②	N/A
Ice condenser (long-term pressurization)	Waltz Mill (Test K) Appendix H [H-58, H-90, H-105]	none*	N/A	Waltz Mill (test unknown) ③
Pressurization (w/o ice bed)				
two-phase water blowdown	CAR*** [3-53, 3-54]		none	none
single-phase water injection	CAR [3-31, 3-63]			
Separate effects phenomena:				
Condensation/Evaporation mass and energy transfer to structures	CAR [3-29, 3-31,3-60]	unknown**	N/A	unknown
Spray pressure suppression	CAR [3-33, 3-64]			
Sump cooling (heat exchanger)	Analytical	Analytical	N/A	

* no documentation – author believes that there were no applications in this area

** unknown documentation – possibility that there were applications in this area, but unknown to author

*** CONTAIN assessment report [CAR]

① R. G. Gido, et al., "Containment Ice-condenser Analysis using the COMPARE code," LA-UR-77-1732, Los Alamos National Laboratory, Los Alamos, NM, August 1977.

② "Ice Condenser Full-scale Section Tests at the Waltz Mill Facility," WCAP-8282, Westinghouse Electric Company, Pittsburgh, PA., February, 1974.

③ N. J. Liparulo, et al., "The Ice-Condenser System for Containment Pressure Suppression," Nuclear Safety, Vol. 17., No. 6, Nov.-Dec., 1976.

Table B-3. Comparison of models for codes used to perform short-term analyses of PWR ice condenser containments.

Modeling area	CONTAIN	COMPARE	TMD
Nodalization (control volumes)	multiple volumes	multiple volumes	multiple volumes
Two-phase injection	thermal equilibrium, homogeneous mixture (optional – pressure flash model – constant enthalpy expansion)	thermal equilibrium, homogeneous mixing	thermal equilibrium, homogeneous mixing
Flow	1-D, lumped parameter momentum equation with acceleration terms; constant loss coefficients, flow direction independent	1-D, lumped parameter momentum equation with acceleration terms; constant loss coefficients, flow direction dependent (optional – compressible flow of ideal gas through orifice)	lumped parameter equation, with acceleration terms; radial and hoop flow equations included; variable ice bed loss coefficients; pressure wave propagation
Variable doors	static pressure vs. area tables	inertia, gravity, and spring forces	inertia, gravity forces
Critical flow	frozen, homogeneous equilibrium model (FHEM) with multiplier	compressible, polytropic, orifice flow of ideal gas (isentropic exponent for steam-water-air mixture); Moody two-phase critical flow with multiplier	isentropic, homogeneous equilibrium model [HEM], (optional – augmentation to correct for actual conditions)
Ice bed heat and mass transfer	physically based heat and mass transfer analogy method with calibration factor applied to Nusselt number calculated in ice column	semi-empirical model with calibration factor (HTCP) – model patterned from TMD	semi-empirical model with calibration factor (ELJAC)
Liquid water entrainment	water condensed in atmosphere is retained -- 100% entrainment (optional – liquid water dropout at end of timestep – no entrainment)	parametric, range from 0 to 100% entrainment	parametric, range from 0 to 100% entrainment
Drain-down water interaction	nonmechanistic, de-entrainment of liquid water (restart option)	none	none

Table B-4. Comparison of models for codes used to perform long-term analyses of PWR ice condenser containments.

Modeling area	CONTAIN	COMPARE
Nodalization (control volumes)	multiple volumes	multiple volumes
Two-phase injection (blowdown, frothing) Single-phase injection (reflood, decay heating)	thermal equilibrium, homogeneous mixing	thermal equilibrium, homogeneous mixing
Flow Fans	1-D lumped parameter momentum equation parametric flow rates	1-D lumped parameter momentum equation parametric flow rates
Ice bed heat and mass transfer	physically based heat and mass transfer analogy [HMT] method with calibration factor applied to Nusselt number calculated in the ice column	semi-empirical model with calibration factor (HTCP) – model patterned from TMD code; fixed surface temperature (fusion temperature)
Melt water and condensate heating	nonmechanistic, limit conditions – typically set to ice bed saturation temperature	not modeled
Drain-down water interaction	nonmechanistic, spray-like simulation	not modeled
Structure heat and mass transfer	1-D conduction; heat and mass transfer analogy for condensation; liquid film; evaporation and condensation capability	1-D conduction; Tagami-Uchida heat transfer correlations for condensation; no evaporation capability
Spray pressure suppression	HMT analogy used for representative falling droplet (terminal velocity), corrected for high transfer rates	HMT analogy used for representative falling droplet, not corrected for high transfer rates
Sump heat exchangers	Various exchanger types (shell, parallel, cross-flow, counter-flow) using the effectiveness – NTU method	Once through counter-flow exchanger, log mean temperature difference method with iteration
Pool heat and mass transfer volumes	 HMT analogy, natural convective heat transfer; sensible heat transfer to basemat modeled, with atmospheric displacement	 not modeled not modeled

Appendix C

Listing of Demonstration Decks for CONTEMPT and CONTAIN codes used for Large Dry Containment Calculations

C. 1 CONTAIN Decks C-2

C.1.1 LOCA – Maximum Containment Loads Analysis C-2
C.1.2 LOCA – Minimum Containment Pressure Analysis C-8
C.1.3 MSLB – Short-term Accident Analysis C-17

C.2 CONTEMPT Decks C-23

C.2.1 LOCA – Maximum Containment Loads Analysis C-23
C.2.2 LOCA – Minimum Containment Pressure Analysis C-27
C.2.3 MSLB – Short-term Accident Analysis C-31

C.1 CONTAIN Decks

C.1.1 LOCA – Maximum Containment Loads Analysis

```
cray
&& ****************************control block************************
&&
control
ncells=1
ntitl=3
ntzone=3
eoi
&& ****************************material block**********************
&&
material
compound h2ol h2ov n2 o2 conc fe ss
userdef air conc2 fe2 ss2
&&
&& ***************************title block***************************
&&
title 1
  SAN ONOFRE 2+3 LOCA DEPS MAX SI FAIL 1 SPRAY
  AND 1 PAIR FAN COOLERS.  DRY INITIAL COND.;HS th=(def)+more nodes
&&
&&
&& *************************time zone******************************
times 1000.  0.0
.01 0.25  22.
.02 0.5 50.
0.02 1.0 290.
&& ***********************print options***************************
&&
longedt=100
shortedt=50
&&
prheat prlow-cl prengsys praer
prenacct
thermo
thermal
userdat
air solid molew 50.0
  rho 2 275.0 0.995
      600.0 0.995
 cond 2 275.0 0.0301
      600.0 0.0301
  sph 2 275.0 694.2
      600.0 694.2
eoi
conc2 solid molew 50.0
  rho 2 275.0 2400.
      600.0 2400.
```

```
 cond 2 275.0 1.38
      600.0 1.38
  sph 2 275.0 838.3
      600.0 838.3
eoi
fe2 solid molew 50.0
  rho 2 275.0 7860.
      600.0 7860.
 cond 2 275.0 43.3
      600.0 43.3
  sph 2 275.0 460.7
      600.0 460.7
eoi
ss2 solid molew 50.0
  rho 2 275.0 8020.
      600.0 8020.
 cond 2 275.0 17.3
      600.0 17.3
  sph 2 275.0 451.5
      600.0 451.5
eoi
eoi
&& ****************************cell #1****************************
&&
flows implicit dropout

cell=1
control
jpool=1 jconc=1 nsoatm=1 nspatm=50 nsoeng=2 nspeng=4
naensy=2 nhtm=14 mxslab=22 numtbc=3 maxtbc=22
eoi
geometry 65269.7 60.
atmos=2 1.0132e5 321.88
n2=0.78 o2=0.21
condense
eoi
eoi
source=1
h2ov=50
iflag=2    && linear interpolation between points
t=
0. 0.025 0.175 0.2 0.4 0.85 1.
1.2 2. 3. 4. 5. 6. 8.
10. 12. 13.5 15. 17.1 17.3 18.5
19.3 20.6 20.8 21.6 22. 22.2 22.3
24.3 27.8 28. 44.5 44.8 100. 200.
211. 211.1 225. 235. 240.7 245.5 251.15
262.9 281.6 302.4 573.3 600. 1500. 3700.
10000.
mass=
0.0 34105.1 35352.9 42830.4 39543.7
34477.9 31059.2 28410.1 26152.6 22968.8 19866.6
```

```
16701.4 14272.9 11952.3 9928.78 6861.11 4492.88
3309.44 1409.33 1142.16 775.197 1109.50 525.719
1280.50 223.17 0.0 0.0 73.4827 194.82
362.061 232.378 225.801 352.626 317.382 253.47
246.394 283.226 200.218 159.167 141.522 129.321
117.30 98.9749 81.8289 72.1219 59.7387 39.1182
31.779 26.0183 19.3595
enth=
0.0 1.27066e+06 1.27578e+06 1.27764e+06
1.28648e+06 1.30811e+06 1.31020e+06 1.31253e+06 1.31904e+06
1.33904e+06 1.38859e+06 1.46651e+06 1.53233e+06 1.56210e+06
1.59955e+06 1.78190e+06 2.00961e+06 1.67444e+06 1.52512e+06
1.44511e+06 1.49767e+06 1.07110e+06 1.24391e+06 771515.
851992. 0.0 0.0 3.02372e+06 3.02372e+06
3.02372e+06 3.02372e+06 3.02372e+06 3.02372e+06 3.02372e+06
3.02372e+06 3.02372e+06 2.75973e+06 2.76415e+06 2.76624e+06
2.7674e+06 2.76834e+06 2.76973e+06 2.77182e+06 2.77368e+06
2.77322e+06 2.74833e+06 2.74252e+06 2.72554e+06 2.69902e+06
2.7074e+06
eoi
&& ********************eng. safety system ************************
&& spray starts at 55.08 sec at 100F
engineer domesp 2 1 1 20
source=1
h2ol=4
iflag=2
 t= 0. 55.0 55.08 3697.
mass= 0. 0. 110. 110.
temp= 310.78 310.78 310.78 310.78
eoi
spray spdiam=.0005
sphite=50.
eoi
eoi
&& fan cooler start at 33 sec
engineer fan 1 1 1 25
source=1
h2ol=4 iflag=2
t= 0.0 33.0 33.01 3600.
mass= 0.0 0.0 123.1 123.1
temp= 300. 300. 300. 300.
eoi
fancool
condense
eoi
eoi
&& *************cell#1 structures*****************************
&& ************ #1.cont.dome&cylinder*************************
&& no atmosphere to pool interaction
ht-tran on on on off off
struc
name=dome tunif=321.88
```

```
type=wall shape=slab nslab=18 chrlen=10.
slarea=7399.299 tunif=321.88
bcinner  hpaint=757.1 eoi
compound= fe2 fe2 fe2 fe2 air air conc2 conc2 conc2
  conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2
x= 0.0 0.000229 0.002329 0.004429 0.006578 0.00671
0.006843 .008 .01 .02 .03 .04 0.05536 0.10336 0.159258 0.1595 0.53606
0.9126 1.28919
eoi
&& ******************#2. Basemats****************************
&& Basemat modeled using jconc
&& ****************#3 reactor cavity walls below fl 15 f ****
&& ALSO combined with basemat in lower cell
name=cavity
type=wall shape=slab nslab=9 chrlen=12.
slarea=0.00929 tunif=321.88
bcinner hpaint=295.7 eoi
compound= conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2
   conc2
x= 0.0 0 000585 0.0009 0.0014625 0.05138 0.2042
 0.35428 1.60799 2.85799 4.11541
eoi
&& ****#4. misc rc walls & unlined refueling canal 4 ft thick**
name=rcwalls
type=wall shape=slab nslab=14 chrlen=12.
slarea=432.914 tunif=321.88
bcinner   hpaint=295.7 eoi
compound= conc2 conc2 conc2 conc2 conc2 conc2 conc2
 conc2 conc2 conc2 conc2 conc2 conc2 conc2
x= 0.0 0.000585 0.0009 0.0014625 .003 .005 .007 .01 .02 .03 .04 .05138
 0.2042 0.35428 1.21981
eoi

&& ***************#5. lined refueling canal *****************
name=refuel
type=wall shape=slab nslab=19 chrlen=12.
slarea=854.68 tunif=321.88
bcinner  hpaint=1.e4 eoi
compound= ss2 ss2 ss2 air air conc2 conc2 conc2 conc2
    conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2
x= 0.0 0.001588 0.003176 0.004764 0.004766 0.004775 .006 .008 .01 .02 .03 .04
  0.055 0.1063 0.15718 0.2075 0.4226 0.68819
  0.9536 1.2192
eoi
&& *********#6. interior concrete **************************
name=intconc
type=wall shape=slab nslab=17 chrlen=12.
slarea=3899.5704 tunif=321.88
bcinner   hpaint=295.7 eoi
compound= conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2
   conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2
x= 0.0 0.000585 0.00117 0.00234 .004 .006 .008 .01 .02 .03 .04 0.05333 0.1033
```

```
 0.152985 0.27662 0.399 0.5226 0.52389
eoi
&& ****************#7 gfloor slabs *************************
name=floor
type=wall shape=slab nslab=22 chrlen=12.
slarea=2158.996 tunif=321.88
bcinner   hpaint=4056. eoi
compound= fe2 fe2 fe2 fe2 air air air air conc2 conc2 conc2 conc2
  conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2
x= 0.0 0.0004075 0.000815 0.001222 0.00163 0.001806
 0.001982 0.00215 0.00216 .004 .006 .008 .01 .02 .03 .04
 .055 .07 0.09359 0.1850296 0.2764 0.36789 0.459334
eoi
&& *************#8. lifting devices *************************
name=lift
type=wall shape=slab nslab=7 chrlen=12.
slarea=5321.8694 tunif=321.88
bcinner   hpaint=454.2 eoi
compound= fe2 fe2 fe2 fe2 fe2 fe2 fe2
x= 0.0 0.000127 0.000254 0.000381 0.00355
 0.00673 0.009906 0.013082
eoi
&& ***************#9. misc steel t=2.5 in ********************
name=misc
type=wall shape=slab nslab=7 chrlen=12.
slarea=47.9364 tunif=321.88
bcinner  hpaint=1136. eoi
compound= fe2 fe2 fe2 fe2 fe2 fe2 fe2
x= 0.0 0.000152 0.000304 0.000456 0.000608
  0.03198 0.06298 0.094747
eoi
&& ***************#10. misc steel ***************************
name=miscs
type=wall shape=slab nslab=7 chrlen=12.
slarea=809.9022 tunif=321.88
bcinner   hpaint=901.3 eoi
compound= fe2 fe2 fe2 fe2 fe2 fe2 fe2
x= 0.0 0.000192 0.000384 0 000576 0.000768
 0.01819 0.03562 0.053049
eoi
&& **************#11. misc steel *************************
name=miscst
type=wall shape=slab nslab=8 chrlen=12.
slarea=6009.979 tunif=321.88
bcinner   hpaint=842.4 eoi
compound= fe2 fe2 fe2 fe2 fe2 fe2 fe2 fe2
x= 0.0 0.000205 0.00041 0.000615 0.001541
 0.00247 0.00433 0.008033 0.0117683
eoi
&& **************#12 misc. steel *************************
name=stee
type=wall shape=slab nslab=9 chrlen=12.
```

```
slarea=9189.0177 tunif=321.88
bcinner   hpaint=936.9 eoi
compound= fe2 fe2 fe2 fe2 fe2 fe2 fe2 fe2 fe2
x= 0.0 0.000185 0.00037 0.000555 0.00111
 0.0014 0.00181 0 0025 0.0032 0.003911
eoi
&& **************#13. electrical equip.*****************
name=elect
type=wall shape=slab nslab=5 chrlen=12.
slarea=3497.1276 tunif=321.88
bcinner   hpaint=1.e4 eoi
compound= fe2 fe2 fe2 fe2 fe2
x= 0.0 0.000205 0.0004114 0.0008229 0.001234
 0.001646
eoi
&& ***************#14. misc. stain. steel **************
name=steel
type=wall shape=slab nslab=5 chrlen=12.
slarea=2234.059 tunif=321.88
bcinner   hpaint=1.e4 eoi
compound= ss2 ss2 ss2 ss2 ss2
x= 0.0 0.0006656 0.0013312 0.0026625 0.00399
 0.005325
eoi
&& ************#15. cont. wall with stiffness *********
name=stiff
type=wall shape=slab nslab=10 chrlen=12.
slarea=147.8039 tunif=321.88
bcinner   hpaint=757.1 eoi
compound= fe2 fe2 fe2 fe2 n2 n2 conc2 conc2 conc2 conc2
x= 0.0 0.0002286 0.067962 0.135695 0.203429
 0.20369445 0.2039599 0.52357 0.84319 1.1628
 1.482424
eoi
&& ***************lower cell ***************************

low-cell
geometry=1490. bc=321.88
concrete
compos=1 conc 1.e6
temp=321.88
eoi
pool
compos=1 h2ol 1.0e-4
temp=321.88
physics
boil
eoi
eoi
eof
```

C.1.2 LOCA – Minimum Containment Pressure Analysis

```
cray
&& ****************************control block************************
&&
control
ncells=1
ntitl=2
ntzone=2
eoi
&& ****************************material block**********************
&&
material
compound h2ol h2ov n2 o2 conc
userdef air conc2 fe2 ss2
&&
&& ***************************title block***************************
&&
title 2
  PWR Demonstation case; Min. ECCS Back-Pressure Analysis(LOCA DEPS)
  Max. cooling, 2 spray trains + 4 fan coolers,"P/Flash"
&&
&&
&& *************************time zone******************************
times 1000.  0.0
.01 0.05 22.
.01 1.00 40.
&& **********************print options***************************
&&
longedt=10
shortedt=100
&&
prheat prlow-cl prengsys
prenacct
thermo
thermal
userdat
air solid molew 50.0
 rho 2 275.0 0.995
      600.0 0.995
 cond 2 275.0 0.0301
      600.0 0.0301
 sph 2 275.0 694.2
      600.0 694.2
eoi
conc2 solid molew 50.0
 rho 2 275.0 2400.
      600.0 2400.
 cond 2 275.0 1.38
      600.0 1.38
 sph 2 275.0 838.3
```

```
     600.0 838.3
eoi
fe2 solid molew 50.0
 rho 2 275.0 7860.
     600.0 7860.
 cond 2 275.0 43.3
     600.0 43.3
  sph 2 275.0 460.7
     600.0 460.7
eoi
ss2 solid molew 50.0
 rho 2 275.0 8020.
     600.0 8020.
 cond 2 275.0 17.3
     600.0 17.3
  sph 2 275.0 451.5
     600.0 451.5
eoi
flows implicit dropout  && needed input for srv model activation
eoi
&& ****************************cell #1****************************
&&
cell=1
control
jpool=1 jconc=1  nsoeng=2 nspeng=4
naensy=2 nhtm=15 mxslab=26 numtbc=18 maxtbc=16
nsosat=1 nspsat=50
eoi
geometry 66091. 60.  &&  2.334e6ft3, 13.3psia, 50f
atmos=2 tgas=283. pgas=91724.
molefrac n2=0.78 o2=0.21 satrat=1.0 && hum=100%
eoi
srvsor elesrv=30.  && "Pressure Flash" activation blowdown
atmos source=1
h2ov=32
iflag=2    && linear interpolation between points
t=
0. 0.025 0.175 0.2 0.4 0.85 1.
1.2 2. 3. 4. 5. 6. 8.
10. 12. 13.5 15. 17.1 17.3 18.5
19.3 20.6 20.8 21.6 22.
22.2 22.3 24.3 27.8 28. 44.5
mass=
0.0 34105.1 35352.9 42830.4 39543.7
34477.9 31059.2 28410.1 26152.6 22968.8 19866.6
16701.4 14272.9 11952.3 9928.78 6861.11 4492.88
3309.44 1409.33 1142.16 775.197 1109.50 525.719
1280.50 223.17 0.0
0.0 73.4827 194.82 362.061 232.378 225.801
enth=
0.0 1.27066e+06 1.27578e+06 1.27764e+06
1.28648e+06 1.30811e+06 1.31020e+06 1.31253e+06 1.31904e+06
```

```
1.33904e+06 1.38859e+06 1.46651e+06 1.53233e+06 1.56210e+06
1.59955e+06 1.78190e+06 2.00961e+06 1.67444e+06 1.52512e+06
1.44511e+06 1.49767e+06 1.07110e+06 1.24391e+06 771515.
851992. 0.0
0.0 1.163e+06 1.163e+06 1.163e+06 1.163e+06 1.163e+06
eoi
eoi

&&
&& ********************eng. safety system ************************
&& spray starts at 5.sec at 35F, 4400gpm
engineer domesp 2 1 1 20
source=1
h2ol=4
iflag=2
 t= 0. 5. 5.01 3600.
mass= 0. 0. 278.5 278.5
temp= 274.7 274.7 274.7 274.7
eoi
spray spdiam=.0001
sphite=50.
eoi
eoi
&& 4 fan coolers start at 10 sec, cooling water=50f
engineer fan 1 1 1 25
source=1
h2ol=4 iflag=1
t= 0 0 10.0 10.01 3600.
mass= 0.0 380. 380. 380.
temp= 283. 283. 283. 283.
eoi
fancool
condense
fcqr=5.0e7
fcefar=150.
eoi
eoi
condense
&& *************cell#1 structures*****************************
&& ************ #1.cont.dome&cylinder************************
&& no atmosphere to pool interaction
ht-tran on on on off off
struc
name=dome tunif=283.2
type=wall shape=slab nslab=20 chrlen=10.
slarea=7399.299 tunif=283.2
bcinner  mindepth=0.000005 hpaint=743.65 hmxmul=1.2
var-parm
 flag=2 name=forc1
 var-x=time
 x=4 0.0 2.0 18.0 24.0
 var-y=velocity
```

```
 y=4 0.0 5.0 5.0 0.0
eoi
eoi
compound= fe2 fe2 fe2 fe2 fe2 fe2 fe2 fe2
        conc2 conc2 conc2 conc2 conc2 conc2 conc2
       conc2 conc2 conc2 conc2 conc2
x= 0.0 0.0002 0.0005 0.001 0.0015 0.002 0.003 0.004 0.006349
  .008 .01 .02 .03 .04 0.05 0.1
  0.15 0.2 0.5 1.0 1.28919
eoi
&& ******************#2. Basemats****************************
&&
name=basem
type=wall shape=slab nslab=22 chrlen=12.
slarea=1341.9 tunif=283.2
bcinner  mindepth=0.000005 hpaint=715. hmxmul=1.2
var-parm
 flag=2 name=forc2
 var-x=time
 x=4 0.0 2.0 18.0 24.0
 var-y=velocity
 y=4 0.0 5.0 5.0 0.0
eoi
eoi
compound= conc2 conc2 conc2 conc2 conc2 conc2 conc2
        conc2 conc2 conc2 conc2 conc2 conc2 conc2
        conc2 conc2 conc2 conc2 conc2 conc2 conc2
        conc2
x= 0.0 0.0001 0.0003 0.0006 0.001 0.0015 .003 .005 .007 .01
  .02 .03 .040 .05 0.1 0.2 0.4 0.8 1.2 1.8 2.2 2.8 3.264
eoi
&&
&& ****************#3 reactor cavity walls below fl 15 f ****
&&
name=rcwallb
type=wall shape=slab nslab=18 chrlen=12.
slarea=147.7 tunif=283.2
bcinner mindepth=0.000005 hpaint=290.5 hmxmul=1.2
var-parm
 flag=2 name=forc3
 var-x=time
 x=4 0.0 2.0 18.0 24.0
 var-y=velocity
 y=4 0.0 5.0 5.0 0.0
eoi
eoi
compound= conc2 conc2 conc2 conc2 conc2 conc2 conc2
        conc2 conc2 conc2 conc2 conc2 conc2 conc2
        conc2 conc2 conc2 conc2
x= 0.0 0.0001 0.0003 0.0006 0.001 0.0015 .003 .005 .007 .01
  .02 .03 .040 .05 0.1 0.2 0.4 0.8 1.21981
 eoi
```

```
&& ****#4. misc rc walls & unlined refueling canal 4 ft thick**
name=rcwalls
type=wall shape=slab nslab=18 chrlen=12.
slarea=432.914 tunif=283.2
bcinner  mindepth=0.000005 hpaint=290.5 hmxmul=1.2
var-parm
 flag=2 name=forc4
 var-x=time
 x=4 0.0 2.0 18.0 24.0
 var-y=velocity
 y=4 0.0 5.0 5.0 0.0
eoi
eoi
compound= conc2 conc2 conc2 conc2 conc2 conc2 conc2
        conc2 conc2 conc2 conc2 conc2 conc2 conc2
        conc2 conc2 conc2 conc2
x= 0.0 0.0001 0.0003 0.0006 0.001 0.0015 .003 .005 .007 .01
  .02 .03 .040 .05 0.1 0.2 0.4 0.8 1.21981
eoi
&& **************#5. lined refueling canal *****************
name=refuel
type=wall shape=slab nslab=23 chrlen=12.
slarea=854.68 tunif=283.2
bcinner  mindepth=0.000005 hpaint=1.e4 hmxmul=1.2
var-parm
 flag=2 name=forc5
 var-x=time
 x=4 0.0 2.0 18.0 24.0
 var-y=velocity
 y=4 0.0 5.0 5.0 0.0
eoi
eoi
compound= ss2 ss2 ss2 ss2 ss2 ss2 ss2 ss2 ss2  conc2
       conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2
       conc2 conc2 conc2 conc2
x= 0.0 0.0002 0.0003 0.0006 0.001 0.0015 0.002 0.003 0.004
   0.004764  .006 .008 .01 .02 .03 .04
   0.05 0.10 0.15 0.20 0.4 0.8 1.0 1.2192
eoi
&& *********#6. interior concrete **************************
name=intconc
type=wall shape=slab nslab=17 chrlen=12.
slarea=3899.5704 tunif=283.2
bcinner  mindepth=0.000005 hpaint=290.5 hmxmul=1.2
var-parm
 flag=2 name=forc6
 var-x=time
 x=4 0.0 2.0 18.0 24.0
 var-y=velocity
 y=4 0.0 5.0 5.0 0.0
eoi
eoi
```

```
compound= conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2
        conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2
        x= 0.0 .0001 0.0003 0.0006 0.0010 0.002 .004 .006 .008
         .01 .02 .03 .04 0.05 0.1 0.15 0.3 0.52389
eoi
&& ****************#7 gfloor slabs *************************
name=floor
type=wall shape=slab nslab=24 chrlen=12.
slarea=2158.996 tunif=283.2
bcinner  mindepth=0.000005 hpaint=3984. hmxmul=1.2
var-parm
 flag=2 name=forc7
 var-x=time
 x=4 0.0 2.0 18.0 24.0
 var-y=velocity
 y=4 0.0 5.0 5.0 0.0
eoi
eoi
compound= fe2 fe2 fe2 fe2 conc2 conc2 conc2 conc2 conc2
        conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2
        conc2 conc2 conc2 conc2 conc2 conc2
x= 0.0 0.0002 0.0006 0.001 0.001587  0.0025 0.003
  .004 .006 .008 .01 .02 .03 .04 .055 .07 0.09 0.12 0.15 0.2 0.25
  0.3 0.35 0.4 0.459334
eoi
&& *************#8. lifting devices *************************
name=lift
type=wall shape=slab nslab=9 chrlen=12.
slarea=5321.8694 tunif=283.2
bcinner  mindepth=0.000005 hpaint=446. hmxmul=1.2
var-parm
 flag=2 name=forc8
 var-x=time
 x=4 0.0 2.0 18.0 24.0
 var-y=velocity
 y=4 0.0 5.0 5.0 0.0
eoi
eoi
compound= fe2 fe2 fe2 fe2 fe2 fe2 fe2 fe2 fe2
x= 0.0  0.0002 0.0004 0.0006 0.001 0.002 0.004 0.008 0.01 0.013082
eoi
&& ***************#9. misc steel t=2.5 in ********************
name=misc
type=wall shape=slab nslab=14 chrlen=12.
slarea=47.9364 tunif=283.2
bcinner mindepth=0.000005  hpaint=1115. hmxmul=1.2
var-parm
 flag=2 name=forc9
 var-x=time
 x=4 0.0 2.0 18.0 24.0
 var-y=velocity
 y=4 0.0 5.0 5.0 0.0
```

```
eoi
eoi
compound= fe2 fe2 fe2 fe2 fe2 fe2 fe2 fe2 fe2
      fe2 fe2 fe2 fe2 fe2
x= 0.0 0.0002 0.0004 0.0006 0.001 0.002 0.004 0.006 0.01 0.015
  0.02 0.03 0.05 0.07 0.094747
eoi
&& **************#10. misc steel ***************************
name=miscs
type=wall shape=slab nslab=12 chrlen=12.
slarea=809.9022 tunif=283.2
bcinner mindepth=0.000005  hpaint=885.3 hmxmul=1.2
var-parm
 flag=2 name=forc10
 var-x=time
 x=4 0.0 2.0 18.0 24.0
 var-y=velocity
 y=4 0.0 5.0 5.0 0.0
eoi
eoi
compound= fe2 fe2 fe2 fe2 fe2 fe2 fe2 fe2 fe2 fe2 fe2 fe2
x= 0.0  0.0002 0.0004 0.0006 0.001 0.002 0.004 0.008
  0.01 0.014 0.018 0.025 0.053049
eoi
&& *************#11. misc steel **************************
name=miscst
type=wall shape=slab nslab=9 chrlen=12.
slarea=6009.979 tunif=283.2
bcinner mindepth=0.000005  hpaint=827. hmxmul=1.2
var-parm
 flag=2 name=forc11
 var-x=time
 x=4 0.0 2.0 18.0 24.0
 var-y=velocity
 y=4 0.0 5.0 5.0 0.0
eoi
eoi
compound= fe2 fe2 fe2 fe2 fe2 fe2 fe2 fe2 fe2
x= 0.0 0.0002 0.0004 0.0006 0.001 0.0015
 0.0025 0.004 0.008 0.0117683
eoi
&& *************#12 misc. steel **************************
name=stee
type=wall shape=slab nslab=9 chrlen=12.
slarea=9189.0177 tunif=283.2
bcinner  mindepth=0.000005 hpaint=920.4 hmxmul=1.2
var-parm
 flag=2 name=forc12
 var-x=time
 x=4 0.0 2.0 18.0 24.0
 var-y=velocity
 y=4 0.0 5.0 5.0 0.0
```

```
eoi
eoi
compound= fe2 fe2 fe2 fe2 fe2 fe2 fe2 fe2 fe2
x= 0.0 0.0002 0.0004 0.0006 0.001
 0.0015 0.002 0.0025 0.003 0.003911
eoi
&& ***************#13. electrical equip.******************
name=elect
type=wall shape=slab nslab=7 chrlen=12.
slarea=3497.1276 tunif=283.2
bcinner  mindepth=0.000005 hpaint=1.e4 hmxmul=1.2
var-parm
 flag=2 name=forc13
 var-x=time
 x=4 0.0 2.0 18.0 24.0
 var-y=velocity
 y=4 0.0 5.0 5.0 0.0
eoi
eoi
compound= fe2 fe2 fe2 fe2 fe2 fe2 fe2
x= 0.0 0.0002 0.0004 0.0006 0.0008 0.001 0.00125
  0.001646
eoi
&& ***************#14. misc. stain. steel **************
name=steel
type=wall shape=slab nslab=8 chrlen=12.
slarea=2234.059 tunif=283.2
bcinner mindepth=0.000005 hpaint=1.e4 hmxmul=1.2
var-parm
 flag=2 name=forc14
 var-x=time
 x=4 0.0 2.0 18.0 24.0
 var-y=velocity
 y=4 0.0 5.0 5.0 0.0
eoi
eoi
compound= ss2 ss2 ss2 ss2 ss2 ss2 ss2 ss2
x= 0.0 0.0002 0.0004 0.0006 0.001 0.0015 0.002 0.004
  0.005325
eoi
&& ************#15. cont. wall with stiffness *********
name=stiff
type=wall shape=slab nslab=26 chrlen=12.
slarea=147.8039 tunif=283.2
bcinner  mindepth=0.000005  hpaint=743.6 hmxmul=1.2
var-parm
 flag=2 name=forc15
 var-x=time
 x=4 0.0 2.0 18.0 24.0
 var-y=velocity
 y=4 0.0 5.0 5.0 0.0
eoi
```

```
eoi
compound= fe2 fe2 fe2 fe2 fe2 fe2 fe2 fe2 fe2 fe2
        conc2 conc2 conc2 conc2
        conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2
        conc2 conc2 conc2
x= 0.0 0.0002 0.0004 0.0006 0.001 0.0015 0.0025 0.006 0.01 0.015
&&  0.02032 0 020585 0.020850
  0.02032
  0.0215 0.024 0.027 0.03 0.035 0.04 0.05 0.075 0.1 0.15 0.2
  0.4 0.6 0.8 1.0 1.482424
eoi


&& ****************lower cell ***************************

low-cell
geometry=1. bc=283.
concrete
compos=1 conc 67.46
temp=283.
eoi
pool
compos=1 h2ol 1.0e-4
temp=283.
physics
boil
eoi
eoi
eof
```

C.1.3 MSLB – Short-term Accident Analysis

```
&& ****************************control block************************
&&
control
ncells=1
ntitl=3
ntzone=2
eoi
&& ****************************material block**********************
&&
material
compound h2ol h2ov n2 o2 conc fe ss
userdef air conc2 fe2 ss2
&&
&& ***************************title block***************************
&&
title 1
  SAN ONOFRE 2+3 MSLB 1 SPRAY AND 1 PAIR FAN COOLERS.  DRY INITIAL COND.
  Film th=(def)+more nodes in concrete similar pattern as in LOCA
&&
&&
&& *************************time zone******************************
times 1000.  0.0
&& .01 50. 70.
0.01 0.2 20.
0.01 0.5 100.
&& 0.02 0.2 52.
&& 0.02 1.0 100.
&& ***********************print options***************************
&&
longedt=5
shortedt=50
&&
prheat prlow-cl prengsys praer
prenacct
thermo
thermal
userdat
air solid molew 50.0
 rho 2 275.0 0.995
      600.0 0.995
 cond 2 275.0 0.0301
      600.0 0.0301
 sph 2 275.0 694.2
      600.0 694.2
eoi
conc2 solid molew 50.0
 rho 2 275.0 2400.
      600.0 2400.
 cond 2 275.0 1.38
```

```
      600.0 1.38
  sph 2 275.0 838.3
      600.0 838.3
eoi
fe2 solid molew 50.0
  rho 2 275.0 7860.
      600.0 7860.
 cond 2 275.0 43.3
      600.0 43.3
  sph 2 275.0 460.7
      600.0 460.7
eoi
ss2 solid molew 50.0
  rho 2 275.0 8020.
      600.0 8020.
 cond 2 275.0 17.3
      600.0 17.3
  sph 2 275.0 451.5
      600.0 451.5
eoi
eoi
&& ****************************cell #1****************************
&&
cell=1
control
jpool=1 jconc=1 nsoatm=1 nspatm=34 nsoeng=2 nspeng=4
naensy=2 nhtm=14 mxslab=22 numtbc=3 maxtbc=22
eoi
geometry 65269.7 60.
atmos=2 1.0132e5 321.88
n2=0.78 o2=0.21
condense
eoi
eoi
source=1
h2ov=34
iflag=2    && linear interpolation between points
t=
0.0 0.22 0.42 0.62 1.08 1.58 2.08 2.58 3.58 4.58
5.58 6.58 7.58 8.58 9.58 10.58 12.58 14.58 16.58 18.58
20.58 25.58 30.58 35.58 40.58 45.58 50.58 60.58 61.08
62.08 62.58 64.58 68.58 71.08
mass=
6483.262 6134.9 5824.186 5551.574 5043.999
4648.009 4341.831 4191.237 3972.149 3815.658 3704.527
3622.426 3410.142 3109.861 2891.681 2721.582 2448.517
2224.893 2062.959 1946.385 1856.119 1672.866 1539.508
1444.253 1334.482 1235.145 1148.054 1043.273 913.0908
731.1984 408.2373 49.89567 13.60791 0.
enth=
2.78090e6 2.78532e6 2.78764e6
2.78973e6 2.79485e6 2.79532e6 2.79578e6 2.79346e6
```

```
2.79369e6 2.79508e6 2.79369e6 2.79369e6 2.80136e6
2.80136e6 2.8009e6 2.8002e6 2.79857e6 2.79648e6
2.79485e6 2.79346e6 2.79206e6 2.78834e6 2.78601e6
2.78369e6 2.7802e6 2.77764e6 2.77508e6 2.76996e6
2.77020e6 2.76601e6 2.76717e6 2.74461e6 2.90998e6 0.0
eoi
&& ********************eng. safety system ************************
&& spray starts at 45.08 sec at 100F
engineer domesp 2 1 1 20
source=1
h2ol=4
iflag=2
 t= 0. 45.0 45.08 3697.
mass= 0. 0. 110. 110.
temp= 310.78 310.78 310.78 310.78
eoi
spray spdiam=.0007
sphite=50.
eoi
eoi
&& fan cooler start at 13 sec
engineer fan 1 1 1 25
source=1
h2ol=4 iflag=2
t= 0.0 13.0 13.01 3600.
&& mass= 0.0 0.0 123.1 123.1
mass= 0 0 0.0 170.0 170.0
temp= 300.00 300.00 300.00 300.00
eoi
fancool
condense
fcqr=1.0e7
fcefar=40.0
eoi
eoi
&& *************cell#1 structures****************************
&& ************ #1.cont.dome&cylinder*************************
&& no atmosphere to pool interaction
ht-tran on on on off off
struc
name=dome tunif=321.88
type=wall shape=slab nslab=18 chrlen=10.
slarea=7399.299 tunif=321.88
bcinner mindepth=.0005 hpaint=757.1 eoi
compound= fe2 fe2 fe2 fe2 air air conc2 conc2 conc2
 conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2
x= 0.0 0.000229 0.002329 0.004429 0.006578 0.00671
0.006843 .008 .01 .02 .03 .04 0.05536 0.10336 0.159258 0.1595 0.53606
0.9126 1.28919
eoi
&& ******************#2. Basemats****************************
&& Basemat modeled using jconc
```

```
&& ****************#3 reactor cavity walls below fl 15 f ****
&& ALSO combined with basemat in lower cell
name=cavity
type=wall shape=slab nslab=9 chrlen=12.
slarea=0.00929 tunif=321.88
bcinner hpaint=295.7 eoi
compound= conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2
   conc2
x= 0.0 0.000585 0.0009 0.0014625  0.05138
 0.2042 0.35428 1.60799 2.85799 4.11541
eoi
&& ****#4. misc rc walls & unlined refueling canal 4 ft thick**
name=rcwalls
type=wall shape=slab nslab=14 chrlen=12.
slarea=432.914 tunif=321.88
bcinner  mindepth=.0005 hpaint=295.7 eoi
compound= conc2 conc2 conc2 conc2 conc2 conc2 conc2
conc2 conc2 conc2 conc2 conc2 conc2 conc2
x= 0.0 0.000585 0.0009 0.0014625 .003 .005 .007 .01 .02 .03 .040 .05138
 0.2042 0.35428 1.21981
eoi
&& ***************#5. lined refueling canal *****************
name=refuel
type=wall shape=slab nslab=19 chrlen=12.
slarea=854.68 tunif=321.88
bcinner  mindepth=.0005 hpaint=1.e4 eoi
compound= ss2 ss2 ss2 air air conc2 conc2 conc2 conc2
    conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2
x= 0.0 0.001588 0.003176 0.004764 0.004766 0.004775 .006 .008 .01 .02 .03 .04
  0.055 0.1063 0.15718 0.2075 0.4226 0.68819
  0.9536 1.2192
eoi
&& *********#6. interior concrete **************************
name=intconc
type=wall shape=slab nslab=17 chrlen=12.
slarea=3899.5704 tunif=321.88
bcinner  mindepth=.0005 hpaint=295.7 eoi
compound= conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2
   conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2
x= 0.0 0.000585 0.00117 0.00234 .004 .006 .008 .01 .02 .03 .04 0.05333 0.1033
  0.152985 0.27662 0.399 0.5226 0.52389
eoi
&& ****************#7 gfloor slabs *************************
name=floor
type=wall shape=slab nslab=22 chrlen=12.
slarea=2158.996 tunif=321.88
bcinner  mindepth=.0005 hpaint=4056. eoi
compound= fe2 fe2 fe2 fe2 air air air air conc2 conc2
   conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2 conc2
x= 0.0 0.0004075 0.000815 0.001222 0.00163 0.001806
 0.001982 0.00215 0.00216 .004 .006 .008 .01 .02 .03 .04 .055 .07
 0.09359 0.1850296 0.2764 0.36789 0.459334
```

```
eoi
&& ************#8. lifting devices *************************
name=lift
type=wall shape=slab nslab=7 chrlen=12.
slarea=5321.8694 tunif=321.88
bcinner  mindepth=.0005 hpaint=454.2 eoi
compound= fe2 fe2 fe2 fe2 fe2 fe2 fe2
x= 0.0 0.000127 0.000254 0.000381 0.00355
 0.00673 0.009906 0.013082
eoi
&& **************#9. misc steel t=2.5 in ********************
name=misc
type=wall shape=slab nslab=7 chrlen=12.
slarea=47.9364 tunif=321.88
bcinner mindepth=.0005  hpaint=1136. eoi
compound= fe2 fe2 fe2 fe2 fe2 fe2 fe2
x= 0.0 0.000152 0.000304 0.000456 0.000608
  0.03198 0.06298 0.094747
eoi
&& **************#10. misc steel ***************************
name=miscs
type=wall shape=slab nslab=7 chrlen=12.
slarea=809.9022 tunif=321.88
bcinner mindepth=.0005  hpaint=901.3 eoi
compound= fe2 fe2 fe2 fe2 fe2 fe2 fe2
x= 0.0 0.000192 0.000384 0.000576 0.000768
 0.01819 0.03562 0.053049
eoi
&& *************#11. misc steel *************************
name=miscst
type=wall shape=slab nslab=8 chrlen=12.
slarea=6009.979 tunif=321.88
bcinner mindepth=.0005  hpaint=842.4 eoi
compound= fe2 fe2 fe2 fe2 fe2 fe2 fe2 fe2
x= 0.0 0.000205 0.00041 0.000615 0.001541
 0.00247 0.00433 0.008033 0.0117683
eoi
&& *************#12 misc. steel *************************
name=stee
type=wall shape=slab nslab=9 chrlen=12.
slarea=9189.0177 tunif=321.88
bcinner  mindepth=.0005 hpaint=936.9 eoi
compound= fe2 fe2 fe2 fe2 fe2 fe2 fe2 fe2 fe2
x= 0.0 0.000185 0.00037 0.000555 0.00111
 0.0014 0.00181 0.0025 0.0032 0.003911
eoi
&& **************#13. electrical equip.******************
name=elect
type=wall shape=slab nslab=5 chrlen=12.
slarea=3497.1276 tunif=321.88
bcinner  mindepth=.0005 hpaint=1.e4 eoi
compound= fe2 fe2 fe2 fe2 fe2
```

```
x= 0.0 0.000205 0.0004114 0.0008229 0.001234
 0.001646
eoi
&& ***************#14. misc. stain. steel **************
name=steel
type=wall shape=slab nslab=5 chrlen=12.
slarea=2234.059 tunif=321.88
bcinner  mindepth=.0005 hpaint=1.e4 eoi
compound= ss2 ss2 ss2 ss2 ss2
x= 0.0 0.0006656 0.0013312 0.0026625 0.00399
 0.005325
eoi
&& ************#15. cont. wall with stiffness *********
name=stiff
type=wall shape=slab nslab=10 chrlen=12.
slarea=147.8039 tunif=321.88
bcinner mindepth=.0005  hpaint=757.1 eoi
compound= fe2 fe2 fe2 fe2 n2 n2 conc2 conc2 conc2 conc2
x= 0.0 0.0002286 0.067962 0.135695 0.203429
 0.20369445 0.2039599 0.52357 0.84319 1.1628
 1.482424
eoi
&& ****************lower cell ***************************

low-cell
geometry=1490. bc=321.88
concrete
compos=1 conc 1.e6
temp=321.88
eoi
pool
compos=1 h2ol 1.0e-4
temp=321.88
physics
boil
eoi
eoi
eof
```

C.2 CONTEMPT Decks

C.2.1 LOCA – Maximum Containment Loads Analysis

```
= san onofre LOCA DEPS; Replicate case in the ERI report 93-209
* Units 2 & 3; sensitivity no. 1: 8% reavap.
    11001 .083 15 0 100. 14.7 .3 120. 0. 0. 0. 0. 1. .92
    10031 2.305+6 0. 120. 120. 14.7 0. 0. 1. 1.
  $**** single failure assumes loss of 1 spray and 1 pair of fan coolers
    $********
    9000 sec
    9001    22.     .01    400    100
    9002    260.    .1     500    10
    9003    573.    1.     1000   20
    9004    1000000. 10.   5000   100
    $*****m/e release from san onofre fsar table 6.2-8
    300 sec lbm/sec btu/lbm
    301 0.00 0.0 0.0
    302 .025 75188. 546.3
    303 .175 77939. 548 5
    304 .20 94424. 549.3
    305 .400 87178. 553.1
    306 .85 76010. 562.4
    307 1.00 68473. 563.3
    308 1.2 62633. 564.3
    309 2.0 57656. 567.1
    310 3.0 50637. 575.7
    311 4.0 43798. 597.
    312 5.0 36820. 630.5
    313 6.0 31466. 658.8
    314 8.0 26350. 671.6
    315 10.0 21889. 687.7
    316 12.0 15126. 766.1
    317 13.5 9905. 864.
    318 15.0 7296. 719.9
    319 17.1 3107. 655.7
    320 17.3 2518. 621.3
    321 18.5 1709. 643.9
    322 19.3 2446. 460.5
    323 20.6 1159. 534.8
    324 20.8 2823. 331.7
    325 21.6 492. 366.3
    326 22.0 0.0 0.0
    327 22.2 0.0 0.0
    328 22.3 162. 1300.
    329 24.3 429.5 1300.
    330 27.8 798.2 1300.
    331 28.0 512.3 1300.
    332 44.5 497.8 1300.
    333 44.8 777.4 1300.
    334 100. 699.7 1300.
```

```
335  200.  558.8 1300.
336  211.  543.2 1300.
337  211.1  624.4 1186.5
338  225.  441.4 1188.4
339  235.  350.9 1189.3
340  240.7  312.  1189.8
341  245.5  295.1 1190.2
342  251.15 258.6 1190.8
343  262.9  218.2 1191.7
344  281.6  180.4 1192.5
345  302.4  159.  1192.3
$****
 $**** spray start at 55 sec and fan cooler at 33 sec
800  1  7000.  285.  105.  2.98+6  0.  0.
801  0.  0.  1.  1.  0.  0.  0.  0.  0.  100.
802  .0152  0.  1.  1.  0.  0.  0.  0.  0.  100.
803  .0153  .87+6  1.  1.  0.  0.  0.  0.  0.  100.
804  1.027  .87+6  1.  1.  0.  0.  0.  0.  0.  100.
805  1.028  .87+6  1.  1.  0.  0.  0.  1.  0.  105.
806  25.  .87+6  1.  1.  0.  0.  0.  1.  0.  105.
$* fan coolers start(hrs)    stop
2000        .00917        25.
$***  temp(f)  heat removal(b/hr)
2001  300.    -144.4+6
2002  250.    -99.0+6
2003  200.    -55.2+6
2004  180.    -39.0+6
2005  165.    -28.0+6
2006  150.    -17.6+6
2007  130.    -6.40+6
2008  105.    0.0

$****    basemats and reactor cav walls below 15 ft will be
$****    covered with water, modeled with heat transfer to sump h=0.4
101000    containment dome and cylinder
101001  100  5  0  0  0  0  79648.  3  0
101101  3  .00075  20  .02158  5  .02332  60  .52332  11  4.2296
101201  1  2  5  3  3
102000    basemats
102001  100  3  0  0  0  0  14444.    3  0
102101  3  .00078  60  .50078  36  10.71
102201  1  3  3
103000    reactor cavity walls below el 15 ft
103001  100  3  0  0  0  0  1590.    3  3
103101  3  .00192  60  .50192  36  13.502
103201  1  3  3
104000    misc rc walls and unlined refueling canal 4 ft thick
104001  100  3  0  0  0  0  4660.  3  3
104101  3  .00192  60  .50192  36  4.002
104201  1  3  3
105000    lined refueling canal
105001  90  3  0  0  0  0  9200.  3  0
```

```
100     105101 24 .01563 5 .015665 60 .5
101     105201 4 5 3
102     106000    interior concrete
103     106001 100 3 0 0 0 0 41976. 3 3
104     106101 3 .00192 60 .50192 36 1.7188
105     106201 1 3 3
106     107000   gfloor slabs
107     107001 100 5 0 0 0 0 23240. 3 0
108     107101 3 .00014 10 .005348 10 .007088 60 .507 16 1.507
109     107201 1 2 5 3 3
110     108000  lifting devices
111     108001 25 2 0 0 0 0 57286. 3 3
112     108101 3 .00125 21 .04292
113     108201 1 2
114     109000  misc steel t>2.5 in
115     109001 50 2 0 0 0 0 516. 3 3
116     109101 3 .0005 46 .310849
117     109201 1 2
118     110000  misc steel 1.0 ) t )2.5 in
119     110001 40 2 0 0 0 0 8718. 3 3
120     110101 3 .00063 36 .17404
121     110201 1 2
122     111000   misc steel .5 ) t ) 1. in
123     111001 25 2 0 0 0 0 64693. 3 3
124     111101 3 .000674 21 .03861
125     111201 1 2
126     112000   misc steel t ).5 in
127     112001 25 2 0 0 0 0 98913. 3 3
128     112101 3 .000606 21 .01283
129     112201 1 2
130     113000   electrical equipment galvanizing neglected
131     113001 25 1 0 0 0 0 37644. 3 3
132     113101 24 .0054
133     113201 2
134     114000   misc stainless steel
135     114001 25 1 0 0 0 0 24048. 3 3
136     114101 24 .01747
137     114201 4
138     115000  containment wall with stiffeners
139     115001 100 5 0 0 0 0 1591. 3 0
140     115101 3 .00075 40 .66742 5 .66916 40 1.06916 11 4.88
141     115201 1 2 5 3 3
142     101300 0 0
143     102300 0 0
144     103300 0 0
145     104300 0 0
146     105300 0 0
147     106300 0 0
148     107300 0 0
149     108300 0 0
150     109300 0 0
151     110300 0 0
```

```
111300 0 0
112300 0 0
113300 0 0
114300 0 0
115300 0 0
101400 53 2 0 0 0 .0053 2. 2.
102400 3 3 0 0
103400 3 3 0 0
104400 53 2 0 0 0 .0053 2. 2.
105400 53 2 0 0 0 .0053 2. 2.
106400 53 2 0 0 0 .0053 2. 2.
107400 53 2 0 0 0 .0053 2. 2.
108400 53 2 0 0 0 .0053 2. 2.
109400 53 2 0 0 0 .0053 2. 2.
110400 53 2 0 0 0 .0053 2. 2.
111400 53 2 0 0 0 .0053 2. 2.
112400 53 2 0 0 0 .0053 2. 2.
113400 53 2 0 0 0 .0053 2. 2.
114400 53 2 0 0 0 .0053 2. 2.
115400 53 2 0 0 0 .0053 2. 2.
410001 .1      20.
410002 25.     54.
410003 .8      30.
410004 10.     54.
410005 .0174   .0103
$***** steel to concrete conductance = 10. modeled as air gap
```

C.2.2 LOCA – Minimum Containment Pressure Analysis

```
= PWR Demostration case; Min. ECCS Back-Pressure Analysis(LOCA DEPS)
* Pressure Flash; 4 X's Tagami/**made air gap as concrete & changed LT h@22s
    11001 .0111 15 0 100. 14.7 .3 120. 0. 0. 0. 0. 1. 1.0
    10031 2.334+6 0. 50. 50. 13.3 1.0 0. 1. 1. 1.0
* Max. cooling, 2 spray trains and 4 fan coolers
    9000 sec
    9001    22.     .01    200    100
    9002    260.    .02    200     50
    300 sec  lbm/sec  btu/lbm
    301  0.00  0.0 0.0
    302  .025  75188. 546.3
    303  .175  77939. 548.5
    304  .20   94424. 549.3
    305  .400  87178. 553.1
    306  .85   76010. 562.4
    307  1.00  68473. 563.3
    308  1.2   62633. 564.3
    309  2.0   57656. 567.1
    310  3.0   50637. 575.7
    311  4.0   43798. 597.
    312  5.0   36820. 630.5
    313  6.0   31466. 658.8
    314  8.0   26350. 671.6
    315  10.0  21889. 687.7
    316  12.0  15126. 766.1
    317  13.5  9905.  864.
    318  15.0  7296.  719.9
    319  17.1  3107.  655.7
    320  17.3  2518.  621.3
    321  18.5  1709.  643.9
    322  19.3  2446.  460.5
    323  20.6  1159.  534.8
    324  20.8  2823.  331.7
    325  21.6  492.   366.3
    326  22.0 0.0  0.0
    327  22.2 0.0  0.0
    328  22.3  162.  500.
    329  24.3  429.5 500.
    330  27.8  798.2 500.
    331  28.0  512.3 500.
    332  44.5  497.8 500.
  * spray start at 5 sec and fan cooler at 10 sec
    801  0. 0. 1. 1. 0. 0. 0. 0. 0. 35.
    802  0.00138 0. 1. 1. 0. 0. 0. 0. 0. 35.
    803  .00139 2.2+6 1. 1. 0. 0. 0. 0. 0. 35.
    804  .0014 2.2+6 1. 1. 0. 0. 0. 0. 0. 35.
    805  1.000 2.2+6 1. 1. 0. 0. 0. 0. 0. 35.
  * fan coolers start(hrs)    stop
    2000        .00278       25.
```

```
$*** temp(f)  heat removal(b/hr)
2001 300.   -331.+6
2002 250.   -244.0+6
2003 200.   -158.0+6
2004 150.  -72.0+6
2005 50.   -72.0+6

$****   basemats and reactor cav walls below 15 ft will be
$****   exposed to atmosphere
101000   containment dome and cylinder/***no air gap
101001 100 5 0 0 0 0 79648. 3 0
101101 3 .00075 20 .02158 5 .02332 60 .52332 11 4.2296
101201 1 2 3 3 3
102000   basemats
102001 100 3 0 0 0 0 14444.   3 0
102101 3 .00078 60 .50078 36 10.71
102201 1 3 3
103000   reactor cavity walls below el 15 ft
103001 100 3 0 0 0 0 1590.   3 3
103101 3 .00192 60 .50192 36 13.502
103201 1 3 3
104000   misc rc walls and unlined refueling canal 4 ft thick
104001 100 3 0 0 0 0 4660. 3 3
104101 3 .00192 60 .50192 36 4.002
104201 1 3 3
105000   lined refueling canal/***no air gap
105001 90 3 0 0 0 0 9200. 3 0
105101 24 .01563 5 .015665 60 .5
105201 4 3 3
106000   interior concrete
106001 100 3 0 0 0 0 41976. 3 3
106101 3 .00192 60 .50192 36 1.7188
106201 1 3 3
107000   gfloor slabs/***no air gap
107001 100 5 0 0 0 0 23240. 3 0
107101 3 .00014 10 .005348 10 .007088 60 .507 16 1.507
107201 1 2 3 3 3
108000  lifting devices
108001 25 2 0 0 0 0 57286. 3 3
108101 3 .00125 21 .04292
108201 1 2
109000  misc steel t>2.5 in
109001 50 2 0 0 0 0 516. 3 3
109101 3 .0005 46 .310849
109201 1 2
110000  misc steel 1.0 ) t )2.5 in
110001 40 2 0 0 0 0 8718. 3 3
110101 3 .00063 36 .17404
110201 1 2
111000  misc steel .5 ) t ) 1. in
111001 25 2 0 0 0 0 64693. 3 3
111101 3 .000674 21 .03861
```

```
111201 1 2
112000  misc steel t ).5 in
112001 25 2 0 0 0 0 98913. 3 3
112101 3 .000606 21 .01283
112201 1 2
113000  electrical equipment galvanizing neglected
113001 25 1 0 0 0 0 37644. 3 3
113101 24 .0054
113201 2
114000  misc stainless steel
114001 25 1 0 0 0 0 24048. 3 3
114101 24 .01747
114201 4
115000  containment wall with stiffeners/***no air gap
115001 100 5 0 0 0 0 1591. 3 0
115101 3 .00075 40 .66742 5 .66916 40 1.06916 11 4.88
115201 1 2 3 3 3
101300 0 0
102300 0 0
103300 0 0
104300 0 0
105300 0 0
106300 0 0
107300 0 0
108300 0 0
109300 0 0
110300 0 0
111300 0 0
112300 0 0
113300 0 0
114300 0 0
115300 0 0
* 101400 53 2 0 0 0 .0053 2. 2.
* 102400 53 2 0 0 0 .0053 2. 2.
* 103400 53 2 0 0 0 .0053 2. 2.
* 104400 53 2 0 0 0 .0053 2. 2.
* 105400 53 2 0 0 0 .0053 2. 2.
* 106400 53 2 0 0 0 .0053 2. 2.
* 107400 53 2 0 0 0 .0053 2. 2.
* 108400 53 2 0 0 0 .0053 2. 2.
* 109400 53 2 0 0 0 .0053 2. 2.
* 110400 53 2 0 0 0 .0053 2. 2.
* 111400 53 2 0 0 0 .0053 2. 2.
* 112400 53 2 0 0 0 .0053 2. 2.
* 113400 53 2 0 0 0 .0053 2. 2.
* 114400 53 2 0 0 0 .0053 2. 2.
* 115400 53 2 0 0 0 .0053 2. 2.
 101400 5 2 0 0
 102400 5 2 0 0
 103400 5 2 0 0
 104400 5 2 0 0
 105400 5 2 0 0
```

```
106400 5 2 0 0
107400 5 2 0 0
108400 5 2 0 0
109400 5 2 0 0
110400 5 2 0 0
111400 5 2 0 0
112400 5 2 0 0
113400 5 2 0 0
114400 5 2 0 0
115400 5 2 0 0
410001 .1      20.
410002 25.     54.
410003 .8      30.
410004 10.     54.
410005 .0174   .0103
$***** steel to concrete conductance = 10. modeled as air gap
* 4 Xs Tagami + 1.2 Xs Uchida
430001 0.0 8.0
430002 .0053 984.0
430003 .0056 124.0
430004 .0112 118.0
```

C.2.3 MSLB – Short-term Accident Analysis

```
= san onofre mslb 7.47 ft2  102( power
* Units 2 & 3
    11001  .0278  15  0  100.  14.7  .3  120.  0.  0.  0.  0.  1.  .92
    10031  2.305+6  0.  120.  120.  14.7  0.  0.  1.  1.
  $**** single failure assumes loss of 1 spray and 1 pair of fan coolers
    $********
    9000  sec
    9001    22.     .01    400    100
    9002    260.    .1     100    10
    9003    573.    1.     1000   20
    9004    1000000.  10.    5000   100
    $*****m/e  release from san onofre fsar table 6.2-4 b
    300  sec   lbm/sec  btu/lbm
    301  0.00   14293.  1195.6
    302  .220   13525.  1197.5
    303  .420   12840.  1198.5
    304  .620   12239.  1199.4
    305  1.08   11120.  1201.6
    306  1.58   10247.  1201.8
    307  2.08   9572.   1202.0
    308  2.58   9240.   1201.0
    309  3.58   8757.   1201.1
    310  4.58   8412.   1201.7
    311  5.58   8167.   1201.1
    312  6.58   7986.   1201.1
    313  7.58   7518.   1204.4
    314  8.58   6856.   1204.4
    315  9.58   6375.   1204.2
    316  10.58  6000.   1203.9
    317  12.58  5398.   1203.2
    318  14.58  4905.   1202.3
    319  16.58  4548.   1201.6
    320  18.58  4291.   1201.0
    321  20.58  4092.   1200.4
    322  25.58  3688.   1198.8
    323  30.58  3394.   1197.8
    324  35.58  3184.   1196.8
    325  40.58  2942.   1195.3
    326  45.58  2723.   1194.2
    327  50.58  2531.   1193.1
    328  60.58  2300.   1190.9
    329  61.08  2013.   1191.
    330  62.08  1612.   1189.2
    331  62.58  900.    1189.7
    332  64.58  110.    1180.
    333  68.58  30.     1251.1
    334  71.08  0.      1251.1
    335  503.   0.      1251.1
    $****
```

```
50      $**** spray start at 45 sec and fan cooler at 13 sec
51      800  1 7000. 285. 105. 2.98+6 0. 0.
52      801  0. 0. 1. 1. 0. 0. 0. 0. 0. 100.
53      802  .0125 0. 1. 1. 0. 0. 0. 0. 0. 100.
54      803  .0126 .87+6 1. 1. 0. 0. 0. 0. 0. 100.
55      804  1.027 .87+6 1. 1. 0. 0. 0. 0. 0. 100.
56      805  1.028 .87+6 1. 1. 0. 0. 0. 1. 0. 105.
57      806  25.  .87+6 1. 1. 0. 0. 0. 1. 0. 105.
58      $***  m/e release for worst case mslb  7.47 ft2  102( power
59      $***  m/e release from table 6.2-4 d
60    $***  single failure of 1 containment cooling train, 1 spray and 2 fans
61      $**** spray flows and shutdown heat exchanger data from table 6.2-11
62      $****
63      $**** fan cooler data from fig 6.2-41a
64      $********
65      $**** spray and fan cooler start time from table 6.2-25
66      $* fan coolers start(hrs)    stop
67      2000        .00361       25.
68      $***  temp(f)  heat removal(b/hr)
69      2001 300.    -144.4+6
70      2002 250.    -99.0+6
71      2003 200.    -55.2+6
72      2004 180.    -39.0+6
73      2005 165.    -28.0+6
74      2006 150.    -17.6+6
75      2007 130.    -6.40+6
76      2008 105.    0.0
77
78      $****    basemats and reactor cav walls below 15 ft will be
79      $****   covered with water, modeled with heat transfer to sump h=0.4
80      101000    containment dome and cylinder
81      101001  100 5 0 0 0 0 79648. 3 0
82      101101  3 .00075 20 .02158 5 .02332 60 .52332 11 4.2296
83      101201  1 2 5 3 3
84      102000     basemats
85      102001  100 3 0 0 0 0 14444.    3 0
86      102101  3 .00078 60 .50078 36 10.71
87      102201  1 3 3
88      103000    reactor cavity walls below el 15 ft
89      103001  100 3 0 0 0 0 1590.    3 3
90      103101  3 .00192 60 .50192 36 13.502
91      103201  1 3 3
92      104000     misc rc walls and unlined refueling canal 4 ft thick
93      104001  100 3 0 0 0 0 4660. 3 3
94      104101  3 .00192 60 .50192 36 4.002
95      104201  1 3 3
96      105000     lined refueling canal
97      105001  25 1 0 0 0 0 9200. 3 0
98      105101  24 .01563
99      105201  4
100     106000     interior concrete
101     106001  100 3 0 0 0 0 41976. 3 3
```

```
106101 3 .00192 60 .50192 36 1.7188
106201 1 3 3
107000   gfloor slabs
107001 100 5 0 0 0 0 23240. 3 0
107101 3 .00014 10 .005348 10 .007088 60 .507 16 1.507
107201 1 2 5 3 3
108000  lifting devices
108001 25 2 0 0 0 0 57286. 3 3
108101 3 .00125 21 .04292
108201 1 2
109000  misc steel t>2.5 in
109001 50 2 0 0 0 0 516. 3 3
109101 3 .0005 46 .310849
109201 1 2
110000  misc steel  1.0 ) t )2.5 in
110001 40 2 0 0 0 0 8718. 3 3
110101 3 .00063 36 .17404
110201 1 2
111000   misc steel  .5 ) t ) 1. in
111001 25 2 0 0 0 0 64693. 3 3
111101 3 .000674 21 .03861
111201 1 2
112000   misc steel t ).5 in
112001 25 2 0 0 0 0 98913. 3 3
112101 3 .000606 21 .01283
112201 1 2
113000   electrical equipment galvanizing neglected
113001 25 1 0 0 0 0 37644. 3 3
113101 24 .0054
113201 2
114000   misc stainless steel
114001 25 1 0 0 0 0 24048. 3 3
114101 24 .01747
114201 4
115000  containment wall with stiffeners
115001 100 5 0 0 0 0 1591. 3 0
115101 3 .00075 40 .66742 5 .66916 40 1.06916 11 4.88
115201 1 2 5 3 3
101300 0 0
102300 0 0
103300 0 0
104300 0 0
105300 0 0
106300 0 0
107300 0 0
108300 0 0
109300 0 0
110300 0 0
111300 0 0
112300 0 0
113300 0 0
114300 0 0
```

```
115300 0 0
101400 2 2 0 0
102400 3 3 0 0
103400 3 3 0 0
104400 2 2 0 0
105400 2 2 0 0
106400 2 2 0 0
107400 2 2 0 0
108400 2 2 0 0
109400 2 2 0 0
110400 2 2 0 0
111400 2 2 0 0
112400 2 2 0 0
113400 2 2 0 0
114400 2 2 0 0
115400 2 2 0 0
410001 .1      20.
410002 25.     54.
410003 .8      30.
410004 10.     54.
410005 .0174   .0103
$***** steel to concrete conductance = 10. modeled as air gap
```

Appendix D

Listing of Demonstration Deck for CONTAIN code used for Subatmospheric Calculation

```
cray
&& North Anna 1+2; Subatmospheric Plant DBA Demonstration Case
&& Used UFSAR Data(2/98); LOCA-DEPSLB Min. SI
control
  ncells=3   ntitl=4   ntzone=7 nengv=2
eoi
material
  compound   h2ol h2ov n2 o2 conc
    userdef  crbstl stnstl plncon  && FSAR values
userdat
  crbstl  solid  && carbon steel
   molew  1.   && req'd so dummy value used
      rho  2  200. 7849.  800.  7849.  && 490lb/ft3
      cond  2  200.  45.  800.  45.   && 26.btu/hr-ft-f
      sph  2  200.  460.5  800. 460.5  && .11 btu/lb-f
  eoi
  stnstl  solid  && stainless steel
   molew  1.   && req'd so dummy value used
      rho  2  200. 7849.  800.  7849.  && 490lb/ft3
      cond  2  200.  17.3  800.  17.3   && 10.btu/hr-ft-f
      sph  2  200.  460.5  800. 460.5  && .11 btu/lb-f
  eoi
  plncon  solid  && plant concrete
   molew 1.  && req'd so dummy value used
      rho  2  200. 2323.  800.  2323.  && 145lb/ft3
      cond  2  200.  1.385  800.  1.385   && 0.8 btu/hr-ft-f
      sph  2  200.  670.  800. 670.  && .16 btu/lb-f
   eoi
eoi
flows implicit dropout eoi
engvent
from=1 to=2 vtopen=3420. vmflow=252. type=pool && si inject. from sump
eoi
from=1 to=3 vtopen=303. vmflow=182.3 type=pool && 2880gpm to mix w/chiller
eoi
times  400.   0.0
&&  dt    plot    end time
    .01    0.1      2.0
    .02    1.0      10.0
    .05    1.0     20.0
    .10    1.0      200.0
    1.0    10.0     1000.0
    2.0    20.0     2000.0
    2.0    25.0     7000.0
   eoi

shortedt=10
longedt=50
prengsys  prheat prlow-cl
title 4

North Anna 1+2: Subatmospheric Plant DBA Demonstration Case
```

UFSAR, DEPSLB-Min SI, one-cell model

```
cell=1
control
  nhtm=6  mxslab=23  nsoatm=4 nspatm=100
  naensy=3  nsoeng=1  nspeng=10  jpool=1 jconc=20
  nsosat=2  nspsat=100
eoi
title
cell 1  && Plant free volume
geometry  51678.  47.3  && v=1825000 ft**3, h=(estimated)
  atmos=3   tgas=322.  pgas=94388.  && 120f, 13.69 psia
  molefrac  n2=0.79  o2=0.21
  satrat=1.0    && hum=100%
eoi

srvsor elesrv=30.
atmos source=2
 h2ov=24  iflag=1  && table is step function
t=1400. 1650. 1900. 2150. 2400. 2650. 2900. 3150. 3400.
3650. 3900. 4150. 4400. 4650. 4900. 5150. 5400. 5650.
5900. 6150. 6400. 6650. 6900. 7150.
mass=258.6 260.9 264.2 266.6 268.3 269.4 270.0 270.2
231.2 230.5 231.1 231.6 232.0 232.4 232.8 233.4
234.2 234.2 234.4 234.5 234.7 234.8 235.0 235.3
enth=2.6484e5  4.4555e4 4.4555e4  4.4549e4 4.4549e4 4.4553e4 4.4562e4 4.4567e4
2.7047e5 2.7351e5 2.7177e5 2.6989e5 2.6798e5 2.6603e5 2.6409e5 2.6218e5
2.6090e5 2.6046e5 2.6031e5 2.6020e5 2.6015e5 2.6008e5 2.6002e5 2.5982e5
eoi

 h2ov=61  iflag=2
 t= 20.8 25.8
  26.8 27.4 27.9 28.9 30.9 32.9
  33.9 35.9 37.9 38.8 39.9 41.9 43.9 45.9 46.1
  49.9 51.9 52.9 53.9 64.9 83.9 85.9 149.9 151.9
  167.9 169.9 201.9 207.9 239.9 253.4
  253.5 258.4 273.4 278.4 293.4 313.4 328.4 333.4 358.4
  378.4 393.4 413.4 428.4 433.4 453.4 488.4 523.4 548.4
  568.4 593.4 608.4 633.4 648.4 738.4 753.4 818.4 1233.4
  1233.5 1399.9
 mass= 0.0 0.0
  1498. 1942. 1981. 1944. 1850. 1761.
  1720. 1642. 1570. 1738. 1704. 1645. 1590. 1538. 1533.
  1444. 1401. 160.5 166.1 176.3 182.4 182.9 198.4 198.9
  202.6 203.1 210.6 212.  219.5 222.8
  231.3 231.0 231.5 231.2 231.7 231.5 232.0 231.7 232.2
  232.0 232.5 232.3 232.6 232.4 232.5 233.0 232.8 233.2
  233.0 233.5 233.2 233.7 233.5 234.0 233.9 234.3 234.4
  257.7 257.7
 enth= 0.0 0.0
3.0588e5 3.1563e5 3.1941e5 3.2176e5 3.2485e5 3.2796e5
3.2949e5 3.3258e5 3.3571e5 3.0236e5 3.0304e5 3.0431e5 3.0558e5 3.0687e5 3.0698e5
```

```
3.0950e5 3.1081e5 6.5617e5 6.3836e5 6.1272e5 5.7908e5 5.7576e5 4.8536e5 4.8266e5
4.6272e5 4.6064e5 4.2416e5 4.1785e5 3.8720e5 3.7581e5
3.8386e5 3.8249e5 3.8075e5 3.7990e5 3.7817e5 3.7489e5 3.7317e5 3.7178e5 3.6832e5
3.6497e5 3.6320e5 3.5999e5 3.5806e5 3.5666e5 3.5379e5 3.4888e5 3.4325e5 3.3954e5
3.4836e5 3.4451e5 3.4129e5 3.3746e5 3.3462e5 3.2926e5 3.2590e5 3.2346e5 3.2250e5
3.3269e5 3.3557e5
eoi
eoi

source=4
  h2ov=98  iflag=2
t= 0.0  0.1  0.2  0.4  0.5  0.7  1.0  1.5  1.9  2.2
  2.5  2.7  2.9  3.6  4.2  4.6  5.4  6.0  6.4  6.8
  7.0  8.2  9.0  10.8  12.2  13.0  14.0  16.0  16.2  16.4
  17.0  17.4  18.4  19.6 20.8 21.6
  22.5 24.8 25.8 26.8 27.4 27.9 28.9 30.9 32.9
  33.9 35.9 37.9 38.8 39.9 41.9 43.9 45.9 46.1
  49.9 51.9 52.9 53.9 64.9 83.9 85.9 149.9 151.9
  167.9 169.9 201.9 207.9 239.9 253.4
  253.5 258.4 273.4 278.4 293.4 313.4 328.4 333.4 358.4
  378.4 393.4 413.4 428.4 433.4 453.4 488.4 523.4 548 4
  568.4 593.4 608.4 633.4 648.4 738.4 753.4 818.4 1233.4
  1233.5 1399.9
mass= 0.0 18982. 20810. 21631. 20926. 20637. 19308. 17580. 15978. 13788.
  9673. 8160. 7254. 5751. 5063. 4812. 4612. 4614. 4825. 3956.
  3863. 3961. 3702. 2894. 2443. 2200. 1929. 1490. 1426. 1362.
  1102. 834.  433.  153.  0.0  0.0
  27.7  57.7 66.8 159. 201. 206. 202. 192. 183.
  179. 171. 164. 178. 175. 169. 164. 159. 158.
  150. 146. 84.7 80.6 73.2 69.6 69.4 61.7 61.5
  59.5 59.3 55.4 54.6 50.8 49.3
  56.8 57.1 56.6 57.0 56.5 56.7 56.2 56.5 56.0
  56.2 55.6 55.9 55.5 55.8 55.7 55.2 55.4 55.0
  55.1 54.7 55.0 54.5 54.7 54.1 54.3 53.9 53.8
  30.5 30.5
enth= 0.0 1.284e6 1.2945e6 1.3233e6 1.3401e6 1.3703e6 1.4077e6 1.4578e6 1.5139e6
1.5810e6 1.6461e6 1.6767e6 1.6918e6 1.7283e6 1.7447e6 1.7364e6 1.7086e6 1.6790e6
1.7000e6 1.8927e6 1.8868e6 1.7292e6 1.7220e6 1.8321e6 1.8690e6 1.8599e6 1.8375e6
2.0446e6 2.1035e6 2.1853e6 2.6066e6 2.8853e6 2.9687e6 2.9953e6 0.0 0.0
2.7373e6 2.7413e6 2.7401e6 2.7496e6 2.7545e6 2.7554e6 2.7547e6 2.7539e6 2.7528e6
2.7516e6 2.7507e6 2.7504e6 2.7527e6 2.7513e6 2.7511e6 2.7503e6 2.7504e6 2.7496e6
2.7488e6 2.7489e6 2.7423e6 2.7411e6 2.7401e6 2.7415e6 2.7398e6 2.7417e6 2.7398e6
2.7392e6 2.7411e6 2.7399e6 2.7419e6 2.7399e6 2.7396e6
2.9228e6 2.9213e6 2.9228e6 2.9214e6 2.9210e6 2.9228e6 2.9201e6 2.9210e6 2.9221e6
2.9220e6 2.9222e6 2.9230e6 2.9212e6 2.9221e6 2.9212e6 2.9213e6 2.9213e6 2.9214e6
2.9218e6 2.9210e6 2.9200e6 2.9210e6 2.9205e6 2.9211e6 2.9230e6 2.9202e6 2.9227e6
2.9009e6 2.9018e6
 eoi

h2ov=24   iflag=1  && table is step function
t=1400. 1650. 1900. 2150. 2400. 2650. 2900. 3150. 3400.
3650. 3900. 4150. 4400. 4650. 4900. 5150. 5400. 5650.
```

```
5900. 6150. 6400. 6650. 6900. 7150.
mass=30.605 29.644 27.172 25.131 23.385 21.893 20.639 19.6 19.974
19.308 18.71 18.285 17.927 17.595 17.273 16.765 15.976 15.957
15.8 15.663 15.518 15.366 15.21 14.927
enth=2.8505e6 2.6922e6 2.6896e6 2.6856e6 2.6797e6 2.6789e6 2.6770e6 2.6754e6
2.6744e6 2.6736e6 2.6731e6 2.6728e6 2.6723e6 2.6721e6 2.6716e6 2.6715e6
2.6730e6 2.6740e6 2.6745e6 2.6747e6 2.6747e6 2.6745e6 2.6745e6 2.6747e6
eoi

 h2ov=35  iflag=2
t= 0.0  0.1  0.2  0.4  0.5  0.7  1.0  1.5  1.9  2.2
  2.5  2.7  2.9  3.6  4.2  4.6  5.4  6.0  6.4  6.8
  7.0  8.2  9.0  10.8  12.2  13.0  14.0  16.0  16.2  16.4
  17.0  17.4  18.4  19.6 20.8
mass= 0.0 9588. 10716. 10561. 10166. 9330. 8731. 8370. 8148. 7930.
  7599. 7377. 7088. 6385. 5946. 6202. 5844. 5701. 5625. 5457.
  5388. 4930. 4634. 3991. 3528. 3132. 2960. 2380. 2571. 2214.
  2124. 1505. 710. 279. 0.0
enth=0.0 1.2772e6 1.2787e6 1.2821e6 1.2831e6 1.2841e6 1.2854e6 1.2854e6 1.2846e6
1.2843e6 1.2844e6 1.2847e6 1.2853e6 1.2881e6 1.2902e6 1.2917e6 1.2934e6 1:2950e6
1.2948e6 1.2939e6 1.2937e6 1.2921e6 1.2907e6 1.2888e6 1.2888e6 1.2892e6 1.1798e6
1.0256e6 1.0225e6 1.0371e6 1.0553e6 1.0336e6 1.3352e6 1.5765e6 0.0
eoi

n2=2  iflag=1  && nitrogen from accumulators, 4300lbs, est. as step function

t= 35.0  55.0
mass=97. 0.0
temp= 322. 322.
eoi


condense

struc

&& containment wall, area=49,487ft2 stl=.375in conc=4.5ft, used about 1ft
name=cwall  type=wall   shape=slab   nslab=20
chrlen=10.  slarea= 4597.  tunif=322.
bcinner  mindepth=.0005 hpaint=1420.0 eoi
compound   && carbon stl, concrete
 crbstl crbstl crbstl crbstl crbstl
 plncon plncon plncon plncon plncon plncon
 plncon plncon plncon plncon plncon plncon plncon plncon plncon
 x=0.0  .002  .004  .006  .008  .00953
.014 .02 .025 .03 .035 .04 .05 .1 .15  0.2 .25 .3 .35 .4 .45
eoi  &&  for struc

&& containment dome, area=24,925ft2 stl=.5in conc=2.5ft, used about 1ft
name=dome  type=wall   shape=slab   nslab=21
chrlen=10.  slarea= 2316.  tunif=322.
bcinner  mindepth=.0005 hpaint=1420.0 eoi
```

```
compound   && carbon stl, concrete
 crbstl crbstl crbstl crbstl crbstl crbstl
 plncon plncon plncon plncon plncon plncon
 plncon plncon plncon plncon plncon plncon plncon plncon plncon
  x=0.0  .002  .004  .006  .008  .01 .0127
.016 .02 .025 .03 .035 .04 .05 .1 .15  0.2 .25 .3 .35 .4 .45
eoi  &&  for struc

&& concrete walls, area=7741ft2 th=.5ft
name=smwal  type=wall  shape=slab   nslab=17
chrlen=5.  slarea= 719. tunif=322.
bcinner  mindepth=.0005 hpaint=1420.0 eoi
compound   && concrete
 plncon plncon plncon plncon plncon
 plncon plncon plncon plncon plncon
 plncon plncon plncon plncon plncon
 plncon plncon
&& x=0.0   .004  .007 .01 .016 .025 .03 .04 .05 .1 .152
x= 0.0 0.0001 0.0003 0.0006 0.001 0.002 0.004 0.006 0.008
  0.01 0.015 0.02 0.03 0.04 0.05 0.07 0.1 0.152
eoi  &&  for struc

&& various concrete walls, area=131,589ft2 th=varies used about 1.0ft
name=lgwal  type=wall  shape=slab   nslab=23
chrlen=5.  slarea= 12225. tunif=322.
bcinner mindepth=.0005 hpaint=1420.0 eoi
compound   && concrete
 plncon plncon plncon plncon plncon plncon plncon
 plncon plncon plncon plncon plncon plncon plncon plncon plncon plncon
 plncon plncon plncon plncon plncon plncon
&& x=0.0   .004  .007 .01 .016 .025 .03 .04 .05 .075 .1 .15 .2 .25  .3 .35 .4 .45
x= 0.0 0 0001 0.0003 0.0006 0.001 0.002 0.004 0.006 0.008
  0.01 0.015 0.02 0.03 0.04 0.05 0.07 0.1 0.15 0.2 0.25
  0.3 0.35 0.4 0.45
eoi  &&  for struc

&& structural stl, th=0.397in area=145,054ft2
name=cstl   type=wall   shape=slab  nslab=5
chrlen=5.  slarea= 13476.  tunif=322.
bcinner mindepth=.0005 hpaint=1420.0 eoi
compound   && carbon stl
 crbstl crbstl crbstl crbstl crbstl
x=0.0  .002 .004 .006 .008 .0101
eoi  &&  for struc

&& stainless stl, th=0.407in area=10,220ft2
name=sstl   type=wall   shape=slab  nslab=5
chrlen=5.  slarea= 949.  tunif=322.
compound   && stainless stl
 stnstl  stnstl stnstl stnstl stnstl
x=0.0  .002 .004 .006 .008 .0103
eoi  &&  for struc
```

```
&& quench spray at 62.5 sec at 50f, 1800-2100gpm
engineer quensp 1 1 1 46.
source=1  h2ol=7  iflag=2
t= 0.0  62.4 62.5 800. 1400. 2000. 5350.
mass= 0.0 0.0 113.  120. 126.  132.  132.
temp= 0.0 0.0 283. 283. 283. 283. 283.
eoi
spray spdiam=0.0005 sphite=30.
eoi
eoi

&& recirc. spray + hex, inside pump  3,300gpm
engineer recirc  4 1 1 0.0
spray  sphite=25. spdiam=0.0005 spstpr=2.3e5 eoi
tank 3. 283. 0.01
hex shell 275. 285. 1. 1.8712e6
pump 209.
eoi

&& recirc. spray + hex, outside pump 3,640gpm(2880 from sump+760 chilled water)
engineer recirc  4 3 1 0.0
spray  sphite=25.  spdiam=0.0005 spstpr=2.3e5 eoi
tank 3. 283. 0.01
hex shell 275. 285. 1. 1.9239e6
pump 230.4
eoi

low-cell
 geometry 1092.  && cont. mat/subfloor fsar table, used default concrete
 bc 322.0
  concrete
   compos=1 conc=3.2e6  && about 1ft thick
   temp=322.0
  eoi
 pool
   compos=1 h2ol=0.0
   temp=0.0
   physics
    boil
   eoi
eoi
eoi

cell=2
control
    jpool=1
eoi

title
cell 2  &&  "dummy" volume to remove excess sump water
geometry  1.e6  1000
  atmos=3   tgas=322.  pgas=94388.  && 120f, 13.69 psia
```

```
  molefrac  n2=0.79  o2=0.21
  satrat=1.0    && hum=100%
eoi

ht-tran off off off off off
 low-cell
 geometry 1000.  bc=330.
 pool compos=1 h2ol  1.e-6 temp=330.0
 physics
 boil
 eoi
 eoi
 eoi

 cell=3
control
    nsopl=1  nsppl=2  jpool=1
eoi
title
cell 3  &&  second "dummy" volume to mix spray intake
geometry  1.e6  1000
  atmos=3   tgas=322.  pgas=94388.  && 120f, 13.69 psia
  molefrac  n2=0.79  o2=0.21
  satrat=1.0    && hum=100%
eoi

ht-tran off off off off off

 low-cell
 geometry 1000.  bc=330.
 pool compos=1 h2ol  1.e-6 temp=330.0
 physics
 boil
 source=1 h2ol=2 iflag=1 && 760gpm chilled water to mix w/sump water
t=303.   8000.
mass=48.1  0.0
temp=283. 283.
eoi
eoi
eoi
eoi

eof
```

Appendix E

Listing of Demonstration Decks for CONTAIN code used for Ice Condenser Short and Long-term Calculations

E.1	PWR Ice Condenser Plant – Short-term Demonstration Deck	E-2
E.2	PWR Ice Condenser Plant – Long-term Demonstration Deck	E-41
E.3	PWR Ice Condenser Plant – Secondary Containment Demonstration Deck	E-58

E.1 PWR Ice condenser plant – Short-term Demonstration Deck

```
cray
&& *************control block**********************
&&
control
ncells=22 ntitl=3 ntzone=1  nengv=46 && nac=1 nsectn=10
numtbg=5 maxtbg=10
mxnfpc=30
eoi
&&
&& *************material block**********************
&&
material
compound h2ol h2ov h2o n2 o2
userdef insul con3 cs5 ss4
&&
&& ***************title block*********************
&&
title
Watts Bar [FSAR]
Double-Ended Cold Leg Break
multi- cell deck (Base)
&&
&&
&& **************time zone************************
times 2000. 0.0
0.01 0.05 3.0
&& 0.05  1.0  10.0
&& 0.05  1.0  40.0
&& 0.1  2.0  200.
&& 1.0  10.  300.
&& 2.0  50.  5000.
&& 2.0  100. 10000.
&& 5.0  500. 1.0e5
&& ************************************************
longedt=10
shortedt=50
&&
prheat prlow-cl prengsys && praer
thermo
thermal
userdat
insul solid molew 50.0
 rho 2 260. 1.0
      600. 1.0
 cond 2 260. 0.363
      600. 0.363
 sph 2 260. 9.4e5
      600. 9.4e5
eoi
```

```
con3 solid molew 50.0
 rho 2 260. 2400.
     600. 2400.
 cond 2 260. 1.385
     600. 1.385
 sph 2 260. 804.7
     600. 804.7
eoi
ss4 solid molew 50.0
 rho 2 260. 8000.
     600. 8000.
 cond 2 260. 16.3
     600. 16.3
 sph 2 260. 472.78
     600. 472.78
eoi
cs5 solid molew 50.0
 rho 2 260. 8000.
     600. 8000.
 cond 2 260. 45.0
     600. 45.0
 sph 2 260. 472.78
     600. 472.78
eoi
eoi
&& aerosol
&& diam1=1.0e-7 diam2=2.5e-4
&& tgas2=3000.0 pgas2=1.5e6
&& trapovfl
&& h2ov=1.0e-8 0.405
flows implicit=8 && dropout
engvent

&& vent for refueling canal drains (gas flow)
&& from 1 to 2 varea=0.175 vavl=0.1 vcfc=0.75 velevb=6.47
&& velevf=6.47 resolvhd eoi

&& vent for refueling canal drains (liquid flow)
from 1 to 2 varea=0.175 vavl=0.1 vcfc=0.75 velevb=6.47
velevf=6.47 type=pool eoi

&& lower ice condenser doors
from 1 to 3 vavl=4.9 vcfc=0.58 type=gas
velevb=19.653 velevf=19.653 vcontra=0.7
resolvhd
 rvarea-p flag=2
  x=4 -1.0e7  0.0 142.7 1.0e7
&&  y=4 24.689 24.689 98.756 98.756
  y=4 0.0    0.0    98.756 98.756
 eoi
eoi
```

```
&& lower ice condenser drain
from 1 to 3 vavl=4.9 vcfc=0.7 type=pool
velevb=18.339 velevf=18.339
varea=98.756
&& resolvhd
eoi

&& ice bed junctions
from 3 to 4 vavl=39.92 vcfc=0.775 type=gas
velevb=20.3 velevf=20.3 varea=167.0 vcontra=0.7
resolvhd
eoi

&& ice bed junctions
from 4 to 5 vavl=34.25 vcfc=0.35 type=gas
velevb=23.95 velevf=23.95 varea=167.0 vcontra=0.7
resolvhd
eoi

&& ice bed junctions
from 5 to 6 vavl=34.25 vcfc=0.35 type=gas
velevb=27.6 velevf=27.6 varea=167.0 vcontra=0.7
resolvhd
eoi

&& ice bed junctions
from 6 to 7 vavl=34.25 vcfc=0.35 type=gas
velevb=31.25 velevf=31.25 varea=167.0 vcontra=0.7
resolvhd
eoi

&& ice bed junctions - intermediate doors
from 7 to 8 vavl=4.84 vcfc=0.675 type=gas
velevb=34.9 velevf=34.9 vcontra=0.7
rvarea-p flag=2
  x=4 -1.0e+7 28498. 37910. 1.0e+7
  y=4 0.0 0.0 21.18 21.18
 eoi
resolvhd
eoi

&& ice bed junction - intermediate doors
from 7 to 8 vavl=16.05 vcfc=0.675
velevb=34.9 velevf=34.9 vcontra=0.7
resolvhd
 rvarea-p flag=2
  x=4 -1.e+7 263. 28498. 1.0e+7
&&  y=4 1.86 1.86 70.24 70.24
  y=4 0.0 0.0 70.24 70.24
 eoi
eoi
```

```
&& top ice condenser doors
from 8 to 2 vavl=35.88 vcfc=0.5
velevb=40. velevf=40. vcontra=0.7
resolvhd
 rvarea-p flag=2
  x=4 -1.e+7 263. 28498. 1.0e+7
  y=4 1.86 1.86 91.5 91.5
 eoi
eoi

&& lower compartments
from 1 to 9 vavl=1.45 vcfc=0.66
velevb=10.0 velevf=10. varea=13.00632
resolvhd
eoi

&& lower compartments
from 1 to 9 vavl=9.6 vcfc=0.165
velevb=10.0 velevf=10. varea=51.09625
resolvhd
eoi

&& lower compartments
from 9 to 17 vavl=1.03 vcfc=0.75
velevb=10.0 velevf=10. varea=2.04385 vcontra=0.7
resolvhd
eoi

&& lower compartments
from 1 to 11 vavl=4.18 vcfc=2.1
velevb=10.0 velevf=10. varea=4.459309 vcontra=0.7
resolvhd
eoi

&& lower compartments
from 1 to 17 vavl=1.9 vcfc=0.75
velevb=10.0 velevf=10. varea=5.945745 vcontra=0.7
resolvhd
eoi

&& lower compartments
from 1 to 17 vavl=1.7 vcfc=0.75
velevb=10.0 velevf=10. varea=4.0877 vcontra=0.7
resolvhd
eoi

&& lower compartments
from 1 to 15 vavl=3.7 vcfc=2.1
velevb=10.0 velevf=10. varea=3.901895 vcontra=0.7
resolvhd
eoi
```

```
&& lower compartments
from 1 to 17 vavl=0.86 vcfc=0.75
velevb=10.0 velevf=10. varea=1.486436 vcontra=0.7
resolvhd
eoi

&& lower compartments
from 10 to 11 vavl=0.77 vcfc=1.35
velevb=10.0 velevf=10. varea=2.136752 vcontra=0.7
resolvhd
eoi

&& lower compartments
from 11 to 1 vavl=1.5 vcfc=2.1
velevb=10.0 velevf=10. varea=4.273504 vcontra=0.7
resolvhd
eoi

&& lower compartments
from 12 to 11 vavl=0.78 vcfc=1.35
velevb=10.0 velevf=10. varea=2.136752 vcontra=0.7
resolvhd
eoi

&& lower compartments
from 13 to 20 vavl=1.23 vcfc=1.5
velevb=10.0 velevf=10. varea=1.393534 vcontra=0.7
resolvhd
eoi

&& lower compartments
from 14 to 15 vavl=0.78 vcfc=1.35
velevb=10.0 velevf=10. varea=2.136752 vcontra=0.7
resolvhd
eoi

&& lower compartments
from 15 to 1 vavl=1.6 vcfc=2.1
velevb=10.0 velevf=10. varea=5.388331 vcontra=0.7
resolvhd
eoi

&& lower compartments
from 16 to 15 vavl=0.78 vcfc=1.35
velevb=10.0 velevf=10. varea=2.136752 vcontra=0.7
resolvhd
eoi

&& lower compartments
from 17 to 1 vavl=1.4 vcfc=0.75
velevb=10.0 velevf=10. varea=3.344482 vcontra=0.7
resolvhd
```

```
eoi

&& lower compartments
from 18 to 10 vavl=2.72 vcfc=0.75
velevb=10.0 velevf=10. varea=5.481234 vcontra=0.7
resolvhd
eoi

&& lower compartments
from 19 to 12 vavl=1.85 vcfc=0.75
velevb=10.0 velevf=10. varea=1.579339 vcontra=0.7
resolvhd
eoi

&& lower compartments
from 20 to 14 vavl=1.85 vcfc=0.75
velevb=10.0 velevf=10. varea=1.579339 vcontra=0.7
resolvhd
eoi

&& lower compartments
from 21 to 16 vavl=2.19 vcfc=0.75
velevb=10.0 velevf=10. varea=2.136752 vcontra=0.7
resolvhd
eoi

&& lower compartments
from 22 to 1 vavl=0.14 vcfc=0.75
velevb=10.0 velevf=10. varea=0.148644 vcontra=0.7
resolvhd
eoi

&& lower compartments
from 22 to 1 vavl=0.19 vcfc=0.75
velevb=10.0 velevf=10. varea=0.232256 vcontra=0.7
resolvhd
eoi

&& lower compartments
from 22 to 14 vavl=0.54 vcfc=0.75
velevb=10.0 velevf=10. varea=0.631735 vcontra=0.7
resolvhd
eoi

&& lower compartments
from 10 to 16 vavl=0.54 vcfc=0.8
velevb=10.0 velevf=10. varea=11.70569 vcontra=0.7
resolvhd
eoi

&& lower compartments
from 11 to 9 vavl=2.65 vcfc=2.1
```

```
velevb=10.0 velevf=10. varea=5.574136 vcontra=0.7
resolvhd
eoi

&& lower compartments
from 12 to 10 vavl=0.55 vcfc=0.25
velevb=10.0 velevf=10. varea=13.56373 vcontra=0.7
resolvhd
eoi

&& lower compartments
from 13 to 19 vavl=1.2 vcfc=1.5
velevb=10.0 velevf=10. varea=1.393534 vcontra=0.7
resolvhd
eoi

&& lower compartments
from 14 to 12 vavl=0.48 vcfc=0.8
velevb=10.0 velevf=10. varea=7.525084 vcontra=0.7
resolvhd
eoi

&& lower compartments
from 15 to 1 vavl=1.44 vcfc=2.1
velevb=10.0 velevf=10. varea=4.0877 vcontra=0.7
resolvhd
eoi

&& lower compartments
from 16 to 14 vavl=0.55 vcfc=0.25
velevb=10.0 velevf=10. varea=13.56373 vcontra=0.7
resolvhd
eoi

&& lower compartments
from 17 to 1 vavl=1.43 vcfc=0.75
velevb=10.0 velevf=10. varea=3.530286 vcontra=0.7
resolvhd
eoi

&& lower compartments
from 18 to 11 vavl=1.15 vcfc=1.5
velevb=10.0 velevf=10. varea=1.579339 vcontra=0.7
resolvhd
eoi

&& lower compartments
from 19 to 11 vavl=1.23 vcfc=1.5
velevb=10.0 velevf=10. varea=1.393534 vcontra=0.7
resolvhd
eoi
```

```
&& lower compartments
from 20 to 15 vavl=0.98 vcfc=1.5
velevb=10.0 velevf=10. varea=0.929023 vcontra=0.7
resolvhd
eoi

&& lower compartments
from 21 to 15 vavl=0.089 vcfc=1.5
velevb=10.0 velevf=10. varea=0.929023 vcontra=0.7
resolvhd
eoi

&& air return fans
from 2 to 1
 vflow-t flag=1
  x=3 0.0 600. 1.0e6
  y=3 0.0 18.88 18.88
 eoi
eoi

&& lower compartment
cell=1
control
jpool=1 jconc=1 && nsoatm=1 nspatm=383
 nsopl=1 nsppl=18
&& naensy=1
&& nsoeng=1 nspeng=4
nhtm=6 mxslab=21
numtbc=6 maxtbc=4
eoi
title
lower compartment
geometry
 gasvol=5881.917
 cellhist=1 5.17750   380.8298   20.6225
eoi
atmos=3
 tgas=310.93
 pgas=1.0342e5
 satrat=0.1
 molefrac
  n2=0.79 o2=0.21
eoi
condense
 ht-tran off off off off off


&& ***************structures*********************
struc

name=slab6 tunif=310.93
type=wall shape=slab nslab=18 chrlen=10.
```

```
slarea=2969.44
bcinner
 var-parm
 flag=2 name=forc1
 var-x=time
 x=4 0.0 2.0 24.0 50.0
 var-y=velocity
 y=4 0.0 0.0 0.0 0.0
 eoi
eoi
bcouter adiabat eoi
compound
con3 con3 con3 con3 con3 con3 con3 con3 con3 con3
con3 con3 con3 con3 con3 con3 con3 con3
x=
0.0 1.0e-3 2.0e-3 4.0e-3 6 0e-3 8.0e-3 0.01
0.012 0.014 0.017 0.02 0.03 0.04 0.06 0.1 0.2
0.3 0.35 0.435
eoi

name=slab7 tunif=310.93
type=wall shape=slab nslab=16   chrlen=10.
slarea=262.91
bcinner hpaint=377.9
 var-parm
 flag=2 name=forc2
 var-x=time
 x=4 0.0 2.0 24.0 50.0
 var-y=velocity
 y=4 0.0 0.0 0.0 0.0
 eoi
eoi
bcouter adiabat eoi
compound
con3 con3 con3 con3 con3 con3 con3 con3 con3 con3
con3 con3 con3 con3 con3 con3
x=
0.0 1.0e-3 2.0e-3 4.0e-3 6.0e-3 8.0e-3 0.01
0.012 0.014 0.017 0.02 0.03 0.04 0.06 0.1 0.2
0.305
eoi

name=slab8 tunif=310.93
type=wall shape=slab nslab=18   chrlen=10.
slarea=70.61
bcinner hpaint=944.87
 var-parm
 flag=2 name=forc3
 var-x=time
 x=4 0.0 2.0 24.0 50.0
 var-y=velocity
 y=4 0.0 0.0 0.0 0.0
```

```
 eoi
eoi
bcouter adiabat eoi
compound
con3 con3 con3 con3 con3 con3 con3 con3 con3 con3
con3 con3 con3 con3 con3 con3 con3 con3
x=
0.0 1.0e-3 2.0e-3 4.0e-3 6.0e-3 8.0e-3 0.01
0.012 0.014 0.017 0.02 0.03 0.04 0.06 0.1 0.2
0.30 0.4 0.534
eoi

name=slab9 tunif=310.93
type=wall shape=slab nslab= 21    chrlen=10.
slarea=257.34
bcinner
 var-parm
 flag=2 name=forc4
 var-x=time
 x=4 0.0 2.0 24.0 50.0
 var-y=velocity
 y=4 0.0 0.0 0.0 0.0
 eoi
eoi
bcouter adiabat eoi
compound
ss4 ss4 ss4 ss4 ss4 ss4
con3 con3 con3 con3 con3 con3 con3 con3 con3 con3
con3 con3 con3 con3 con3
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 5.0e-3 6.401e-3
8.0e-3 0.01 0.014 0.018 0.024 0.03 0.035 0.04 0.05
0.08 0.1 0.125 0.25 0.4 0.609
eoi

name=slab10 tunif=310.93
type=floor shape=slab nslab=19 chrlen=10.
slarea=1479.1 slhite=0.488 slelev=4.9335
bcinner hpaint=944.87
 var-parm
 flag=2 name=forc6
 var-x=time
 x=4 0.0 2.0 24.0 50.0
 var-y=velocity
 y=4 0.0 0.0 0.0 0.0
 eoi
eoi
bcouter adiabat eoi
compound
con3 con3 con3 con3 con3 con3 con3 con3 con3 con3
con3 con3 con3 con3 con3 con3 con3 con3 con3
x=
```

```
0.0 1.0e-3 3.0e-3 5.0e-3
8.0e-3 0.01 0.014 0.018 0.024 0.03 0.035 0.04 0.05
0.08 0.1 0.125 0.25 0.35 0.4 0.488
eoi

name=slab11 tunif=310.93
type=wall shape=slab nslab=11     chrlen=10.
slarea=2647.71
bcinner hpaint=1905.49
 var-parm
 flag=2 name=forc7
 var-x=time
 x=4 0.0 2.0 24.0 50.0
 var-y=velocity
 y=4 0.0 0.0 0.0 0.0
 eoi
eoi
bcouter adiabat eoi
compound
cs5 cs5 cs5 cs5 cs5 cs5 cs5 cs5 cs5 cs5
cs5
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 6.0e-3 8.0e-3
0.01 0.014 0.016 0.018 0.02
eoi

&& engineer lowsp 2 1 1 10.
&& source=1
&& h2ol=4
&& iflag=2
&&  t=0.0 45.0 45.01 3000.0
&&  mass= 0.0 0.0 12.6 12.6
&&  temp= 302.6 302.6 302.6 302.6
&& eoi
&& spray
&& sphite=50.
&& eoi
&& eoi

low-cell
geometry 0.01 bc=310.93
concrete
compos=1 con3 0.1
temp=310.93
eoi
pool
compos=1 h2ol 1.0e-4
temp=310.93
physics
boil
source=1
&& post-reflood water minimum SI
```

```
h2ol=18 iflag=2
t=
 1.95000E+02 2.00000E+02 3.00000E+02 3.05000E+02 3.10000E+02
 4.00000E+02 5.00000E+02 6.00000E+02 7.00000E+02 8.00000E+02
 9.00000E+02 1.00000E+03 1.20000E+03 1.40000E+03 1.60000E+03
 1.76500E+03 1.76501E+03 1.00000E+07
mass=
 1.67831E+02 1.67831E+02 1.68285E+02 1.68285E+02 2.35417E+02
 2.39499E+02 2.43128E+02 2.43128E+02 2.46303E+02 2.49025E+02
 2.49025E+02 2.52200E+02 2.55375E+02 2.57190E+02 2.59004E+02
 2.58550E+02 0.00000E+00 0.00000E+00
enth=
 4.58256E+05 4.58256E+05 4.57647E+05 4.57647E+05 4.57104E+05
 4.58122E+05 4.59963E+05 4.59963E+05 4.58317E+05 4.57545E+05
 4.57545E+05 4.55967E+05 4.58561E+05 4.59428E+05 4.56209E+05
 4.57010E+05 4.57010E+05 4.57010E+05
eoi
eoi
eoi
eoi


&& upper compartment
cell=2
control
jpool=1 jconc=1
naensy=3  && numtbc=1 maxtbc=4
nsoeng=1 nspeng=4
nhtm=5 mxslab=22
eoi
title
upper compartment
geometry
 gasvol=18434.62
 cellhist=1 20.662 369.74 70.52
eoi
atmos=3
 tgas=302.6
 pgas=1.0342e5
 satrat=0.1
 molefrac
  n2=0.79 o2=0.21
eoi
condense
 ht-tran off off off off off

&& spray starts recirc. from sump
engineer recirc1 4 1 2 15.
 spray
 sphite=30.
 spdiam=0.0007
 eoi
```

```
 tank 2.894 302.6 0.001
 hex shell 302.6 283. 1. 1.2903e6
 pump 253.0
eoi

&& RHR spray flow
engineer recirc2 4 1 2 15.
 spray
 sphite=30.
 spdiam=0.0007
 eoi
 tank 3.6 302.6 0.001
 hex shell 302.6 283. 1.0 8.4928e5
 pump 126.5
eoi

&& quench spray from outside tank
engineer quensp 1 1 1 20.
 source=1 h2ol=4 iflag=1
 t= 0.0 135. 2754. 1.0e6
 mass= 0.0 253.0 0.0 0.0
 temp= 302.6 302.6 302.6 302.6
 eoi
 spray spdiam=0.0007 sphite=30.
 eoi
eoi


&& ***************structures*****************
struc

name=slab1 tunif=302.59
type=wall shape=slab nslab=17    chrlen=10.
slarea=453.36
bcouter adiabat eoi
compound
con3 con3 con3 con3 con3 con3 con3 con3 con3 con3
con3 con3 con3 con3 con3 con3 con3
x=
0.0 1.0e-3 3.0e-3 5.0e-3
8.0e-3 0.01 0.014 0.018 0.024 0.03 0.035 0.04 0.05
0.08 0.1 0.125 0.25 0.335
eoi

name=slab2 tunif=302.6
type=wall shape=slab nslab=18    chrlen=10.
slarea=1698.25
bcinner hpaint=944.87 eoi
bcouter adiabat eoi
compound
con3 con3 con3 con3 con3 con3 con3 con3 con3 con3
con3 con3 con3 con3 con3 con3 con3 con3
```

```
x=
0.0 1.0e-3 3.0e-3 5.0e-3
8.0e-3 0.01 0.014 0.018 0.024 0.03 0.035 0.04 0.05
0.08 0.1 0.125 0.25 0.35 0.427
eoi

name=slab3 tunif=302.6
type=wall shape=slab nslab=19   chrlen=10.
slarea=70.61
bcinner hpaint=377.95 eoi
bcouter adiabat eoi
compound
con3 con3 con3 con3 con3 con3 con3 con3 con3 con3
con3 con3 con3 con3 con3 con3 con3 con3 con3
x=
0.0 1.0e-3 3.0e-3 5.0e-3
8.0e-3 0.01 0.014 0.018 0.024 0.03 0.035 0.04 0.05
0.08 0.1 0.125 0.25 0.35 0.4 0 458
eoi

name=slab4 tunif=302.6
type=wall shape=slab nslab= 22    chrlen=10.
slarea=356.74
bcouter adiabat eoi
compound
ss4 ss4 ss4 ss4 ss4 ss4
con3 con3 con3 con3 con3 con3 con3 con3 con3 con3
con3 con3 con3 con3 con3 con3
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 5.0e-3 6.34e-3
8.0e-3 0.01 0.014 0.018 0.024 0.03 0 035 0.04 0.05
0.08 0.1 0.125 0.25 0.35 0.4 0.46
eoi

name=slab5 tunif=302.6
type=wall shape=slab nslab=11     chrlen=10.
slarea=5233.28
bcinner hpaint=1905.49 eoi
bcouter adiabat eoi
compound
cs5 cs5 cs5 cs5 cs5 cs5 cs5 cs5 cs5 cs5
cs5
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 6.0e-3 8.0e-3
0.01 0.014 0.016 0.018 0.0244
eoi


low-cell
geometry 810. bc=302.6
concrete
compos=1 con3 0.1
```

```
temp=302.6
eoi
pool
compos=1 h2ol 1.0e-4
temp=302.6
physics
boil
eoi
eoi
eoi


cell=3
control
nhtm=1 mxslab=19
jpool=1 jconc=1
&& naensy=1
eoi
title
lower plenum
geometry
 gasvol=684.9
 cellhist=1 17.685 261.91 20.3
eoi
atmos=3
 tgas=273.71
 pgas=1.0342e5
 satrat=0.1
 molefrac
  n2=0.79 o2=0.21
eoi
condense
 ht-tran off off off off off

struc
name=slab15 tunif=273.
type=floor shape=slab nslab=14   chrlen=5.
slarea=309.92 slelev=17.63425 slhite=5.075e-2
bcinner hpaint=567.15 hydarea=260.  eoi
bcouter adiabat eoi
compound
con3 con3 con3 con3 con3 con3 con3 con3 con3 con3
con3 con3 con3 con3
x=
0.0 1.0e-3 3.0e-3 5.0e-3
8.0e-3 0.01 0.014 0.018 0.024 0.03 0.035 0.04 0.05
0.08 0.1015
eoi

low-cell
geometry 0.01 bc=273.71
```

```
concrete
compos=1 con3 0.1
temp=273.71
eoi
pool
compos=1 h2ol 1.0e-4
temp=273.71
physics
boil
eoi
eoi
eoi

cell=4
control
nhtm=5 mxslab=19
&& jpool=1 jconc=1
naensy=1
eoi
title
ice condenser #1
geometry
 gasvol=611.00
 cellhist=1 20.3 167.4 23.95
eoi
atmos=3
 tgas=273.71
 pgas=1.0342e5
 satrat=0.1
 molefrac
  n2=0.79 o2=0.21
eoi
condense
 ht-tran off off off off off

struc
name=slab12a tunif=273.
type=wall shape=slab nslab=3 chrlen=10.
slarea=4.1952e3
bcinner hydarea=125.8 hmxmul=5. eoi
bcouter adiabat eoi
compound
cs5 cs5 cs5
x=
0.0 5.0e-4 1.0e-3 2.0e-3
eoi

name=slab13a tunif=273.
type=wall shape=slab nslab=6 chrlen=10.
slarea=1.7802e3
bcinner hydarea=125.8 hmxmul=5. eoi
bcouter adiabat eoi
```

```
compound
cs5 cs5 cs5 cs5 cs5 cs5
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 5.0e-3 6.6e-3
eoi

name=slab14a tunif=273.
type=wall shape=slab nslab=6 chrlen=10.
slarea=6.6588e2
bcinner hydarea=125.8 hmxmul=5. eoi
bcouter adiabat eoi
compound
cs5 cs5 cs5 cs5 cs5 cs5
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 6.0e-3 8.1e-3
eoi


name=slab16a tunif=273.
type=wall shape=slab nslab=15 chrlen=10.
slarea=4.4361e2
bcinner hydarea=125.8 hmxmul=5. eoi
bcouter adiabat eoi
compound
cs5 cs5 cs5 cs5 cs5
insul insul insul insul insul insul insul
cs5 cs5 cs5
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 6.1e-3 0.01 0.04 0.08
0.16 0.24 0.28 0.3048 0.3080 0.31 0.32385
eoi

name=slab17a tunif=273.
type=wall shape=slab nslab=19 chrlen=10.
slarea=3.0321e2
bcinner hydarea=125.8 hmxmul=5. eoi
bcouter adiabat eoi
compound
cs5 cs5 cs5 cs5 cs5
insul insul insul insul insul insul insul
con3 con3 con3 con3 con3 con3 con3
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 6.1e-3 0.01 0.04 0.08
0.16 0.24 0.28 0.3048 0.32 0.34 0.38 0.44 0.5 0.56 0 6096
eoi


engineer ice_a 1 4 3
13.2
icecond
 hitici= 3.65
```

```
&& tmsici=1.11e6
 tmsici=2.4097e5
 ciarfl=167.
 ciflmx=5.e-6
 icllp=3
 arhtin=6.86e3
 cihtml=40.
&& citice=360.9
eoi
eoi

cell=5
control
nhtm=5 mxslab=19
&& jpool=1 jconc=1
naensy=1
eoi
title
ice condenser #2
geometry
 gasvol=611.00
 cellhist=1 23.95 167.4 27.6
eoi
atmos=3
 tgas=273.71
 pgas=1.0342e5
 satrat=0.1
 molefrac
  n2=0.79 o2=0.21
eoi
condense
 ht-tran off off off off off

struc
name=slab12b tunif=273.
type=wall shape=slab nslab=3 chrlen=10.
slarea=4.1952e3
bcinner hydarea=125.8 hmxmul=5. eoi
bcouter adiabat eoi
compound
cs5 cs5 cs5
x=
0.0 5.0e-4 1.0e-3 2.0e-3
eoi

name=slab13b tunif=273.
type=wall shape=slab nslab=6 chrlen=10.
slarea=1.7802e3
bcinner hydarea=125.8 hmxmul=5. eoi
bcouter adiabat eoi
compound
cs5 cs5 cs5 cs5 cs5 cs5
```

```
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 5.0e-3 6.6e-3
eoi

name=slab14b tunif=273.
type=wall shape=slab nslab=6 chrlen=10.
slarea=6.6588e2
bcinner hydarea=125.8 hmxmul=5. eoi
bcouter adiabat eoi
compound
cs5 cs5 cs5 cs5 cs5 cs5
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 6.0e-3 8.1e-3
eoi


name=slab16b tunif=273.
type=wall shape=slab nslab=15 chrlen=10.
slarea=4.4361e2
bcinner hydarea=125.8 hmxmul=5. eoi
bcouter adiabat eoi
compound
cs5 cs5 cs5 cs5 cs5
insul insul insul insul insul insul insul
cs5 cs5 cs5
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 6.1e-3 0.01 0.04 0.08
0.16 0.24 0.28 0.3048 0.3080 0.31 0.32385
eoi

name=slab17b tunif=273.
type=wall shape=slab nslab=19 chrlen=10.
slarea=3.0321e2
bcinner hydarea=125.8 hmxmul=5. eoi
bcouter adiabat eoi
compound
cs5 cs5 cs5 cs5 cs5
insul insul insul insul insul insul insul
con3 con3 con3 con3 con3 con3 con3
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 6.1e-3 0.01 0.04 0.08
0.16 0.24 0.28 0.3048 0.32 0.34 0.38 0.44 0.5 0.56 0.6096
eoi


engineer  ice_b 1 5 3
13.2
icecond
 hitici= 3.65
&& tmsici=1.11e6
 tmsici=2.4097e5
```

```
 ciarfl=167.
 ciflmx=5.e-6
 icllp=4
 arhtin=6.86e3
 cihtml=40.
&& citice=360.9
eoi
eoi

cell=6
control
nhtm=5 mxslab=19
&& jpool=1 jconc=1
naensy=1
eoi
title
ice condenser #3
geometry
 gasvol=611.00
 cellhist=1 27.6 167.4 31.25
eoi
atmos=3
 tgas=273.71
 pgas=1.0342e5
 satrat=0.1
 molefrac
  n2=0.79 o2=0.21
eoi
condense
 ht-tran off off off off off

struc
name=slab12c tunif=273.
type=wall shape=slab nslab=3 chrlen=10.
slarea=4.1952e3
bcinner hydarea=125.8 hmxmul=5. eoi
bcouter adiabat eoi
compound
cs5 cs5 cs5
x=
0.0 5.0e-4 1.0e-3 2.0e-3
eoi

name=slab13c tunif=273.
type=wall shape=slab nslab=6 chrlen=10.
slarea=1.7802e3
bcinner hydarea=125.8 hmxmul=5. eoi
bcouter adiabat eoi
compound
cs5 cs5 cs5 cs5 cs5 cs5
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 5.0e-3 6.6e-3
```

```
eoi

name=slab14c tunif=273.
type=wall shape=slab nslab=6 chrlen=10.
slarea=6.6588e2
bcinner hydarea=125.8 hmxmul=5. eoi
bcouter adiabat eoi
compound
cs5 cs5 cs5 cs5 cs5 cs5
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 6.0e-3 8.1e-3
eoi


name=slab16c tunif=273.
type=wall shape=slab nslab=15 chrlen=10.
slarea=4.4361e2
bcinner hydarea=125.8 hmxmul=5. eoi
bcouter adiabat eoi
compound
cs5 cs5 cs5 cs5 cs5
insul insul insul insul insul insul insul
cs5 cs5 cs5
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 6.1e-3 0.01 0.04 0.08
0.16 0.24 0.28 0.3048 0.3080 0.31 0.32385
eoi

name=slab17c tunif=273.
type=wall shape=slab nslab=19 chrlen=10.
slarea=3.0321e2
bcinner hydarea=125.8 hmxmul=5. eoi
bcouter adiabat eoi
compound
cs5 cs5 cs5 cs5 cs5
insul insul insul insul insul insul insul
con3 con3 con3 con3 con3 con3 con3
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 6.1e-3 0.01 0.04 0.08
0.16 0.24 0.28 0.3048 0.32 0.34 0.38 0.44 0.5 0.56 0.6096
eoi


engineer  ice_c 1 6 3
13.2
icecond
 hitici= 3.65
&& tmsici=1.11e6
 tmsici=2.4097e5
 ciarfl=167.
 ciflmx=5.e-6
```

```
icllp=5
arhtin=6.86e3
cihtml=40.
&& citice=360.9
eoi
eoi

cell=7
control
nhtm=5 mxslab=19
&& jpool=1 jconc=1
naensy=1
eoi
title
ice condenser #4
geometry
gasvol=611.00
cellhist=1 31.25 167.4 34.9
eoi
atmos=3
tgas=273.71
pgas=1.0342e5
satrat=0.1
molefrac
n2=0.79 o2=0.21
eoi
condense
ht-tran off off off off off

struc
name=slab12d tunif=273.
type=wall shape=slab nslab=3 chrlen=10.
slarea=4.1952e3
bcinner hydarea=125.8 hmxmul=5. eoi
bcouter adiabat eoi
compound
cs5 cs5 cs5
x=
0.0 5.0e-4 1.0e-3 2.0e-3
eoi

name=slab13d tunif=273.
type=wall shape=slab nslab=6 chrlen=10.
slarea=1.7802e3
bcinner hydarea=125.8 hmxmul=5. eoi
bcouter adiabat eoi
compound
cs5 cs5 cs5 cs5 cs5 cs5
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 5.0e-3 6.6e-3
eoi
```

```
name=slab14d tunif=273.
type=wall shape=slab nslab=6 chrlen=10.
slarea=6.6588e2
bcinner hydarea=125.8 hmxmul=5. eoi
bcouter adiabat eoi
compound
cs5 cs5 cs5 cs5 cs5 cs5
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 6.0e-3 8.1e-3
eoi

name=slab16d tunif=273.
type=wall shape=slab nslab=15 chrlen=10.
slarea=4.4361e2
bcinner hydarea=125.8 hmxmul=5. eoi
bcouter adiabat eoi
compound
cs5 cs5 cs5 cs5 cs5
insul insul insul insul insul insul insul
cs5 cs5 cs5
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 6.1e-3 0.01 0.04 0.08
0.16 0.24 0.28 0.3048 0.3080 0.31 0.32385
eoi

name=slab17d tunif=273.
type=wall shape=slab nslab=19 chrlen=10.
slarea=3.0321e2
bcinner hydarea=125.8 hmxmul=5. eoi
bcouter adiabat eoi
compound
cs5 cs5 cs5 cs5 cs5
insul insul insul insul insul insul insul
con3 con3 con3 con3 con3 con3 con3
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 6.1e-3 0.01 0.04 0.08
0.16 0.24 0.28 0.3048 0.32 0.34 0.38 0.44 0.5 0.56 0.6096
eoi


engineer  ice_d 1 7 3
13.2
icecond
 hitici= 3.65
&& tmsici=1.11e6
 tmsici=2.4097e5
 ciarfl=167.
 ciflmx=5.e-6
 icllp=6
arhtin=6.86e3
```

```
 cihtml=40.
&& citice=360.9
eoi
eoi

cell=8
control
&& nhtm=1 mxslab=19
&& jpool=1 jconc=1
&& naensy=1
eoi
title
upper plenum
geometry
 gasvol=1330.
 cellhist=1 34.9 260.78 40.0
eoi
atmos=3
 tgas=273.71
 pgas=1.0342e5
 satrat=0.1
 molefrac
  n2=0.79 o2=0.21
eoi
overflow 3

&& break room
cell=9
control
jpool=1 jconc=1
nsoatm=1 nspatm=383
&& naensy=1
&& nsoeng=1 nspeng=4
eoi
title
deadended compartment
geometry
 gasvol=812.7088
 cellhist=1 5.17750   52.61954   20.6225
eoi
atmos=3
 tgas=310.93
 pgas=1.0342e5
 satrat=0.1
 molefrac
  n2=0.79 o2=0.21
eoi
condense

source=1
h2ol=383 iflag=2
t=
```

0.00000E+00 1.01000E-03 2.01000E-03 3.01000E-03 4.01000E-03
5.01000E-03 6.01000E-03 7.01000E-03 8.01000E-03 9.00000E-03
1.00100E-02 1.10100E-02 1.20200E-02 1.30100E-02 1.40300E-02
1.50300E-02 1.60200E-02 1.70000E-02 1.80300E-02 1.90300E-02
2.00400E-02 2.10100E-02 2.20500E-02 2.30000E-02 2.40200E-02
2.50400E-02 2.60600E-02 2.70200E-02 2.80600E-02 2.90200E-02
3.00300E-02 3.10100E-02 3.20200E-02 3.30400E-02 3.40100E-02
3.50100E-02 3.60100E-02 3.70300E-02 3.80100E-02 4.01200E-02
4.10100E-02 4.20100E-02 4.30000E-02 4.40100E-02 4.50100E-02
4.60000E-02 4.70000E-02 4.80000E-02 4.90000E-02 5.00000E-02
5.10000E-02 5.20000E-02 5.30200E-02 5.40100E-02 5.50100E-02
5.60100E-02 5.70000E-02 5.80000E-02 5.90200E-02 6.00000E-02
6.10100E-02 6.20200E-02 6.30000E-02 6.40300E-02 6.50200E-02
6.61100E-02 6.70300E-02 6.80200E-02 6.90200E-02 7.00400E-02
7.10200E-02 7.20300E-02 7.30400E-02 7.40200E-02 7.50100E-02
7.60500E-02 7.70600E-02 7.80300E-02 7.90500E-02 8.01400E-02
8.10100E-02 8.23700E-02 8.33900E-02 8.40400E-02 8.70100E-02
8.80000E-02 8.90300E-02 9.00500E-02 9.10100E-02 9.20700E-02
9.30500E-02 9.41200E-02 9.51000E-02 9.60800E-02 9.70800E-02
9.80600E-02 9.90300E-02 1.09006E-01 1.09514E-01 1.10120E-01
1.15110E-01 1.20010E-01 1.25140E-01 1.30140E-01 1.35110E-01
1.40040E-01 1.45120E-01 1.50070E-01 1.55190E-01 1.60030E-01
1.65050E-01 1.70020E-01 1.75000E-01 1.80100E-01 1.85090E-01
1.90070E-01 1.95080E-01 2.00010E-01 2.10030E-01 2.20040E-01
2.30080E-01 2.40140E-01 2.50110E-01 2.60850E-01 2.70070E-01
2.80130E-01 2.90150E-01 3.00090E-01 3.10080E-01 3.40210E-01
3.50120E-01 3.60010E-01 3.70090E-01 3.80060E-01 3.90100E-01
4.00100E-01 4.10100E-01 4.20120E-01 4.30000E-01 4.40120E-01
4.50080E-01 4.60100E-01 4.70120E-01 4.80110E-01 4.90180E-01
5.00000E-01 5.10090E-01 5.20160E-01 5.30040E-01 5.40120E-01
5.50660E-01 5.60120E-01 5.70150E-01 5.80010E-01 5.90120E-01
6.00220E-01 6.10170E-01 6.20170E-01 6.30180E-01 6.40170E-01
6.50150E-01 6.60170E-01 6.70130E-01 6.80160E-01 6.90530E-01
7.00130E-01 7.10150E-01 7.20020E-01 7.30080E-01 7.40140E-01
7.50050E-01 7.60080E-01 7.70120E-01 7.80120E-01 8.10110E-01
8.20140E-01 8.30110E-01 8.40010E-01 8.50120E-01 8.56170E-01
8.70040E-01 8.80050E-01 8.90120E-01 9.00130E-01 9.10180E-01
9.20030E-01 9.30030E-01 9.40060E-01 9.50040E-01 9.68050E-01
9.70190E-01 9.80170E-01 9.90160E-01 1.00013E+00 1.01003E+00
1.02009E+00 1.03008E+00 1.04013E+00 1.05007E+00 1.06002E+00
1.07002E+00 1.08015E+00 1.09014E+00 1.10008E+00 1.11016E+00
1.12013E+00 1.13009E+00 1.14014E+00 1.15001E+00 1.16016E+00
1.17009E+00 1.18005E+00 1.19012E+00 1.20014E+00 1.21009E+00
1.22016E+00 1.23000E+00 1.24005E+00 1.25005E+00 1.28004E+00
1.29005E+00 1.31000E+00 1.31001E+00 1.32002E+00 1.33004E+00
1.34011E+00 1.35008E+00 1.36005E+00 1.37017E+00 1.38018E+00
1.39004E+00 1.40005E+00 1.41010E+00 1.42010E+00 1.43011E+00
1.44001E+00 1.45008E+00 1.46010E+00 1.47017E+00 1.48013E+00
1.49012E+00 1.50012E+00 1.51013E+00 1.52018E+00 1.53011E+00
1.54014E+00 1.55011E+00 1.56014E+00 1.57010E+00 1.58010E+00
1.59014E+00 1.61010E+00 1.61016E+00 1.62016E+00 1.63013E+00
1.64018E+00 1.65012E+00 1.66000E+00 1.67014E+00 1.68057E+00

1.69009E+00 1.70017E+00 1.71018E+00 1.75021E+00 1.76009E+00
1.77019E+00 1.78019E+00 1.79014E+00 1.80016E+00 1.81014E+00
1.82015E+00 1.83015E+00 1.84003E+00 1.85001E+00 1.86011E+00
1.87003E+00 1.88007E+00 1.89010E+00 1.90007E+00 1.91019E+00
1.92010E+00 1.93016E+00 1.94013E+00 1.95012E+00 1.96015E+00
1.97008E+00 1.98019E+00 1.99010E+00 2.00009E+00 2.01004E+00
2.02017E+00 2.03017E+00 2.04017E+00 2.05012E+00 2.06017E+00
2.07014E+00 2.08012E+00 2.09012E+00 2.10000E+00 2.11005E+00
2.12005E+00 2.13015E+00 2.14013E+00 2.15015E+00 2.16011E+00
2.17006E+00 2.18002E+00 2.22006E+00 2.23010E+00 2.24010E+00
2.25007E+00 2.26016E+00 2.27009E+00 2.28000E+00 2.29019E+00
2.30004E+00 2.31012E+00 2.32009E+00 2.33002E+00 2.34022E+00
2.35007E+00 2.36008E+00 2.37011E+00 2.38011E+00 2.39013E+00
2.40008E+00 2.41016E+00 2.42012E+00 2.43004E+00 2.44010E+00
2.45013E+00 2.46012E+00 2.47009E+00 2.48011E+00 2.49010E+00
2.50017E+00 2.51015E+00 2.52017E+00 2.53002E+00 2.54011E+00
2.55004E+00 2.56011E+00 2.57012E+00 2.58007E+00 2.59017E+00
2.60012E+00 2.61012E+00 2.62017E+00 2.63012E+00 2.64017E+00
2.65000E+00 2.69015E+00 2.70015E+00 2.71015E+00 2.72001E+00
2.73007E+00 2.74011E+00 2.75004E+00 2.76011E+00 2.77002E+00
2.78011E+00 2.78012E+00 2.80007E+00 2.81011E+00 2.82007E+00
2.83021E+00 2.84003E+00 2.85010E+00 2.86006E+00 2.87012E+00
2.88011E+00 2.89003E+00 2.90000E+00 2.91008E+00 2.92007E+00
2.93019E+00 2.94006E+00 2.95006E+00 2.96010E+00 2.97010E+00
2.98015E+00 2.99002E+00 3.00006E+00
mass=
4.35907E+03 1.96408E+04 2.56282E+04 2.78962E+04 2.85313E+04
2.83498E+04 2.78509E+04 2.71251E+04 2.63993E+04 2.57190E+04
2.50839E+04 2.46757E+04 2.44035E+04 2.43582E+04 2.44489E+04
2.46303E+04 2.47664E+04 2.49025E+04 2.50386E+04 2.51746E+04
2.52654E+04 2.53561E+04 2.54468E+04 2.54922E+04 2.55829E+04
2.56736E+04 2.57643E+04 2.58097E+04 2.59004E+04 2.59911E+04
2.60365E+04 2.61272E+04 2.61725E+04 2.62633E+04 2.63540E+04
2.63993E+04 2.64447E+04 2.65354E+04 2.65808E+04 2.67169E+04
2.67622E+04 2.68529E+04 2.68983E+04 2.69890E+04 2.70797E+04
2.71705E+04 2.72612E+04 2.73973E+04 2.76694E+04 2.79416E+04
2.82591E+04 2.85313E+04 2.88034E+04 3.78300E+04 3.31579E+04
3.65146E+04 3.74671E+04 3.80114E+04 3.78300E+04 3.82382E+04
3.84197E+04 3.81021E+04 3.82382E+04 3.82836E+04 3.83743E+04
3.84650E+04 3.87825E+04 3.90093E+04 3.87372E+04 3.88733E+04
3.93722E+04 3.94176E+04 3.95083E+04 3.95537E+04 3.95083E+04
3.95537E+04 3.96897E+04 3.98258E+04 3.99619E+04 4.00980E+04
4.02341E+04 4.03701E+04 4.49968E+04 4.50422E+04 4.05516E+04
4.08237E+04 4.09598E+04 4.10505E+04 4.11413E+04 4.08237E+04
4.08691E+04 4.13227E+04 4.13227E+04 4.13680E+04 4.14134E+04
4.14588E+04 4.15495E+04 4.15948E+04 4.19124E+04 4.19124E+04
4.18216E+04 4.21392E+04 4.15948E+04 4.15495E+04 4.15948E+04
4.17763E+04 4.20031E+04 4.21392E+04 4.22752E+04 4.24113E+04
4.25474E+04 4.27288E+04 4.29103E+04 4.30010E+04 4.30917E+04
4.30917E+04 4.30010E+04 4.28649E+04 4.25928E+04 4.24113E+04
4.22299E+04 4.21392E+04 4.21845E+04 4.22299E+04 4.23206E+04
4.24113E+04 3.79661E+04 4.25020E+04 4.24113E+04 4.20031E+04

4.20484E+04 4.20484E+04 4.20031E+04 4.19124E+04 4.18670E+04
4.17763E+04 4.16402E+04 4.15495E+04 4.14134E+04 4.13227E+04
4.13680E+04 4.13227E+04 4.13680E+04 4.13227E+04 4.12773E+04
4.12320E+04 4.11413E+04 4.10505E+04 4.09598E+04 4.08237E+04
4.53143E+04 4.52690E+04 4.52236E+04 4.52236E+04 4.51783E+04
4.50875E+04 4.50422E+04 4.49515E+04 4.48607E+04 4.47700E+04
4.24113E+04 4.45886E+04 4.45432E+04 4.44525E+04 3.98712E+04
3.98258E+04 3.97805E+04 3.96897E+04 3.95990E+04 3.95083E+04
3.93722E+04 3.92815E+04 3.91908E+04 3.91001E+04 3.88733E+04
3.87825E+04 3.86918E+04 3.86465E+04 3.86465E+04 3.86465E+04
3.86465E+04 3.86465E+04 3.86465E+04 3.85557E+04 3.85104E+04
3.84650E+04 3.83743E+04 3.82382E+04 3.81475E+04 3.81021E+04
3.80568E+04 3.79661E+04 3.79661E+04 3.79207E+04 3.78754E+04
3.78300E+04 3.77393E+04 3.76939E+04 3.76032E+04 3.75125E+04
3.74218E+04 3.73764E+04 3.72857E+04 3.72403E+04 3.71496E+04
3.71042E+04 3.70135E+04 3.69228E+04 3.68321E+04 3.67414E+04
3.66053E+04 3.65146E+04 3.64238E+04 3.62878E+04 3.61970E+04
3.61063E+04 3.60156E+04 3.58795E+04 3.57888E+04 3.57888E+04
3.53352E+04 3.52445E+04 3.51084E+04 3.50177E+04 3.49270E+04
3.48363E+04 3.47455E+04 3.47002E+04 3.45641E+04 3.44734E+04
3.43827E+04 3.43373E+04 3.42466E+04 3.41559E+04 3.45187E+04
3.40198E+04 3.39744E+04 3.39744E+04 3.39291E+04 3.38383E+04
3.37476E+04 3.36569E+04 3.35662E+04 3.34755E+04 3.35208E+04
3.33394E+04 3.32487E+04 3.32033E+04 3.31126E+04 3.30219E+04
3.29311E+04 3.28404E+04 3.27951E+04 3.27497E+04 3.27043E+04
3.26590E+04 3.26590E+04 3.25683E+04 3.25229E+04 3.24775E+04
3.23868E+04 3.23415E+04 3.22507E+04 3.19786E+04 3.19332E+04
3.18425E+04 3.17972E+04 3.17518E+04 3.17064E+04 3.16611E+04
3.16157E+04 3.15704E+04 3.15250E+04 3.14796E+04 3.14343E+04
3.14343E+04 3.13889E+04 3.13436E+04 3.12982E+04 3.12528E+04
3.12075E+04 3.11621E+04 3.11168E+04 3.10714E+04 3.10260E+04
3.09807E+04 3.09353E+04 3.08900E+04 3.08446E+04 3.07539E+04
3.07539E+04 3.07085E+04 3.06632E+04 3.06632E+04 3.06178E+04
3.05724E+04 3.05271E+04 3.04817E+04 3.04364E+04 3.03456E+04
3.03003E+04 3.02252E+04 3.01642E+04 3.00735E+04 3.00281E+04
2.99828E+04 2.98920E+04 2.97106E+04 2.96652E+04 2.96199E+04
2.95292E+04 2.95292E+04 2.94838E+04 2.94384E+04 2.93931E+04
2.93024E+04 2.92570E+04 2.92116E+04 2.91663E+04 2.91209E+04
2.90756E+04 2.90302E+04 2.89848E+04 2.88941E+04 2.88488E+04
2.88034E+04 2.87581E+04 2.87127E+04 2.86673E+04 2.86220E+04
2.85766E+04 2.85313E+04 3.30219E+04 3.29311E+04 3.28858E+04
3.28404E+04 2.83045E+04 2.82591E+04 2.82137E+04 2.81684E+04
2.81684E+04 2.81230E+04 2.80777E+04 2.80323E+04 2.80101E+04
2.79869E+04 2.79416E+04 2.78962E+04 2.78055E+04 2.77601E+04
2.77148E+04 2.74880E+04 2.74426E+04 2.73973E+04 2.73519E+04
2.73065E+04 2.72612E+04 2.71705E+04 2.71251E+04 2.70797E+04
2.70344E+04 2.69890E+04 2.69437E+04 2.68983E+04 2.68529E+04
2.68076E+04 2.68076E+04 2.67622E+04 2.67169E+04 2.66715E+04
2.66261E+04 2.65808E+04 2.65354E+04 2.64901E+04 2.64447E+04
2.63993E+04 2.63540E+04 2.63086E+04 2.62633E+04 2.62179E+04
2.61725E+04 2.61272E+04 2.60818E+04
enth=

1.30550E+06 1.29427E+06 1.29431E+06 1.29415E+06 1.29387E+06
1.29348E+06 1.29299E+06 1.29250E+06 1.29208E+06 1.29185E+06
1.29180E+06 1.29196E+06 1.29224E+06 1.29257E+06 1.29285E+06
1.29303E+06 1.29313E+06 1.29317E+06 1.29322E+06 1.29324E+06
1.29329E+06 1.29334E+06 1.29341E+06 1.29350E+06 1.29359E+06
1.29366E+06 1.29376E+06 1.29382E+06 1.29389E+06 1.29396E+06
1.29403E+06 1.29408E+06 1.29413E+06 1.29417E+06 1.29422E+06
1.29427E+06 1.29431E+06 1.29438E+06 1.29443E+06 1.29457E+06
1.29469E+06 1.29487E+06 1.29506E+06 1.29524E+06 1.29543E+06
1.29557E+06 1.29571E+06 1.29669E+06 1.29701E+06 1.29720E+06
1.29727E+06 1.29734E+06 1.29736E+06 1.30592E+06 1.29780E+06
1.30076E+06 1.29862E+06 1.29903E+06 1.29859E+06 1.29876E+06
1.29848E+06 1.29787E+06 1.29815E+06 1.29829E+06 1.29810E+06
1.29822E+06 1.29836E+06 1.29834E+06 1.29841E+06 1.29834E+06
1.29827E+06 1.29827E+06 1.29829E+06 1.29824E+06 1.29820E+06
1.29824E+06 1.29831E+06 1.29836E+06 1.29843E+06 1.29850E+06
1.29855E+06 1.29857E+06 1.29857E+06 1.29857E+06 1.29862E+06
1.29401E+06 1.29634E+06 1.29641E+06 1.29643E+06 1.29641E+06
1.29638E+06 1.29636E+06 1.29634E+06 1.29634E+06 1.30564E+06
1.29636E+06 1.30101E+06 1.29869E+06 1.29857E+06 1.29848E+06
1.29829E+06 1.29817E+06 1.29815E+06 1.29831E+06 1.29859E+06
1.29892E+06 1.29915E+06 1.29929E+06 1.29938E+06 1.29945E+06
1.29952E+06 1.29959E+06 1.29964E+06 1.29966E+06 1.29964E+06
1.29957E+06 1.29945E+06 1.29936E+06 1.29915E+06 1.29903E+06
1.29903E+06 1.29913E+06 1.29924E+06 1.29934E+06 1.29938E+06
1.29945E+06 1.29948E+06 1.29943E+06 1.29936E+06 1.29922E+06
1.29929E+06 1.29929E+06 1.29924E+06 1.29924E+06 1.29922E+06
1.29917E+06 1.29913E+06 1.29908E+06 1.29903E+06 1.29903E+06
1.29908E+06 1.29913E+06 1.29915E+06 1.29915E+06 1.29913E+06
1.29910E+06 1.29908E+06 1.29903E+06 1.29899E+06 1.29897E+06
1.29897E+06 1.29899E+06 1.29901E+06 1.29901E+06 1.29903E+06
1.29901E+06 1.29901E+06 1.29899E+06 1.29897E+06 1.29897E+06
1.29894E+06 1.29894E+06 1.29894E+06 1.29897E+06 1.29899E+06
1.29899E+06 1.29901E+06 1.29899E+06 1.29899E+06 1.29897E+06
1.29897E+06 1.29897E+06 1.29897E+06 1.29899E+06 1.29903E+06
1.29903E+06 1.29906E+06 1.29913E+06 1.29922E+06 1.29927E+06
1.29934E+06 1.29938E+06 1.29941E+06 1.29943E+06 1.29948E+06
1.29950E+06 1.29952E+06 1.29952E+06 1.29957E+06 1.29962E+06
1.29969E+06 1.29976E+06 1.29983E+06 1.29990E+06 1.29997E+06
1.30001E+06 1.30006E+06 1.30010E+06 1.30015E+06 1.30022E+06
1.30029E+06 1.30036E+06 1.30043E+06 1.30052E+06 1.30062E+06
1.30069E+06 1.30078E+06 1.30085E+06 1.30092E+06 1.30099E+06
1.30106E+06 1.30115E+06 1.30122E+06 1.30131E+06 1.30138E+06
1.30148E+06 1.30157E+06 1.30166E+06 1.30176E+06 1.30204E+06
1.30215E+06 1.30224E+06 1.30231E+06 1.30238E+06 1.30248E+06
1.30257E+06 1.30264E+06 1.30273E+06 1.30283E+06 1.30292E+06
1.30299E+06 1.30308E+06 1.30315E+06 1.30324E+06 1.30334E+06
1.30345E+06 1.30357E+06 1.30366E+06 1.30373E+06 1.30383E+06
1.30390E+06 1.30399E+06 1.30406E+06 1.30415E+06 1.30424E+06
1.30434E+06 1.30443E+06 1.30455E+06 1.30466E+06 1.30476E+06
1.30485E+06 1.30494E+06 1.30506E+06 1.30518E+06 1.30529E+06
1.30541E+06 1.30552E+06 1.30566E+06 1.30578E+06 1.30590E+06

```
1.30601E+06 1.30613E+06 1.30624E+06 1.30673E+06 1.30685E+06
1.30699E+06 1.30713E+06 1.30741E+06 1.30755E+06 1.30769E+06
1.30780E+06 1.30794E+06 1.30808E+06 1.30822E+06 1.30834E+06
1.30848E+06 1.30859E+06 1.30873E+06 1.30885E+06 1.30897E+06
1.30908E+06 1.30920E+06 1.30932E+06 1.30943E+06 1.30955E+06
1.30966E+06 1.30976E+06 1.30985E+06 1.30994E+06 1.31004E+06
1.31013E+06 1.31022E+06 1.31029E+06 1.31029E+06 1.31036E+06
1.31043E+06 1.31050E+06 1.31055E+06 1.31062E+06 1.31066E+06
1.31073E+06 1.31078E+06 1.31083E+06 1.31087E+06 1.31092E+06
1.31097E+06 1.31101E+06 1.31118E+06 1.31120E+06 1.31125E+06
1.31129E+06 1.31132E+06 1.31136E+06 1.31139E+06 1.31143E+06
1.31145E+06 1.31150E+06 1.31152E+06 1.31157E+06 1.31162E+06
1.31166E+06 1.31171E+06 1.31173E+06 1.31178E+06 1.31183E+06
1.31190E+06 1.31194E+06 1.31199E+06 1.31204E+06 1.31208E+06
1.31213E+06 1.31220E+06 1.31225E+06 1.31229E+06 1.31236E+06
1.31241E+06 1.31248E+06 1.31252E+06 1.31259E+06 1.31264E+06
1.31271E+06 1.31276E+06 1.31283E+06 1.31290E+06 1.31294E+06
1.31301E+06 1.31308E+06 1.31315E+06 1.31322E+06 1.31329E+06
1.31336E+06 1.31364E+06 1.31373E+06 1.31380E+06 1.31387E+06
1.31394E+06 1.31404E+06 1.31411E+06 1.31418E+06 1.31425E+06
1.31434E+06 1.31441E+06 1.31448E+06 1.31455E+06 1.31462E+06
1.31471E+06 1.31478E+06 1.31485E+06 1.31492E+06 1.31501E+06
1.31508E+06 1.31518E+06 1.31525E+06 1.31534E+06 1.31541E+06
1.31550E+06 1.31559E+06 1.31569E+06 1.31578E+06 1.31590E+06
1.31599E+06 1.31611E+06 1.31620E+06
eoi

low-cell
geometry 0.01 bc=310.93
concrete
compos=1 con3 0.1
temp=310.93
eoi
pool
compos=1 h2ol 1.0e-4
temp=310.93
physics
boil
eoi
eoi
eoi

overflow 1
&& lower compartment
cell=10
control
jpool=1 jconc=1
&& naensy=1
&& nsoeng=1 nspeng=4
eoi
title
deadended compartment
```

```
geometry
 gasvol=332.3134
 cellhist=1 5.17750   21.4517   20.6225
eoi
atmos=3
 tgas=310.93
 pgas=1.0342e5
 satrat=0.1
 molefrac
  n2=0.79 o2=0.21
eoi
condense
low-cell
geometry 0.01 bc=310.93
concrete
compos=1 con3 0.1
temp=310.93
eoi
pool
compos=1 h2ol 1.0e-4
temp=310.93
physics
boil
eoi
eoi
eoi

overflow 1

&& lower compartment
cell=11
control
jpool=1 jconc=1
&& naensy=1
&& nsoeng=1 nspeng=4
eoi
title
deadended compartment
geometry
 gasvol=506.8811
 cellhist=1 5.17750   32.81846   20.6225
eoi
atmos=3
 tgas=310.93
 pgas=1.0342e5
 satrat=0.1
 molefrac
  n2=0.79 o2=0.21
eoi
condense
low-cell
geometry 0.01 bc=310 93
```

```
concrete
compos=1 con3 0.1
temp=310.93
eoi
pool
compos=1 h2ol 1.0e-4
temp=310.93
physics
boil
eoi
eoi
eoi
overflow 1

&& lower compartment
cell=12
control
jpool=1 jconc=1
&& naensy=1
&& nsoeng=1 nspeng=4
eoi
title
deadended compartment
geometry
 gasvol=317.1547
 cellhist=1 5.17750   20.53446   20.6225
eoi
atmos=3
 tgas=310.93
 pgas=1.0342e5
 satrat=0.1
 molefrac
  n2=0.79 o2=0.21
eoi
condense
low-cell
geometry 0.01 bc=310.93
concrete
compos=1 con3 0.1
temp=310.93
eoi
pool
compos=1 h2ol 1.0e-4
temp=310.93
physics
boil
eoi
eoi
eoi
overflow 1

&& lower compartment
```

```
cell=13
control
jpool=1 jconc=1
&& naensy=1
&& nsoeng=1 nspeng=4
eoi
title
deadended compartment
geometry
 gasvol=529.535
 cellhist=1 5.17750   34.28521   20.6225
eoi
atmos=3
 tgas=310.93
 pgas=1.0342e5
 satrat=0.1
 molefrac
  n2=0.79 o2=0.21
eoi
condense
low-cell
geometry 0.01 bc=310.93
concrete
compos=1 con3 0.1
temp=310.93
eoi
pool
compos=1 h2ol 1.0e-4
temp=310.93
physics
boil
eoi
eoi
eoi
overflow 1

&& lower compartment
cell=14
control
jpool=1 jconc=1
&& naensy=1
&& nsoeng=1 nspeng=4
eoi
title
deadended compartment
geometry
 gasvol=317.1547
 cellhist=1 5.17750   20.53446   20.6225
eoi
atmos=3
 tgas=310.93
 pgas=1.0342e5
```

```
 satrat=0.1
 molefrac
  n2=0.79 o2=0.21
eoi
condense
low-cell
geometry 0.01 bc=310.93
concrete
compos=1 con3 0.1
temp=310.93
eoi
pool
compos=1 h2ol 1.0e-4
temp=310.93
physics
boil
eoi
eoi
eoi
overflow 1

&& lower compartment
cell=15
control
jpool=1 jconc=1
&& naensy=1
&& nsoeng=1 nspeng=4
eoi
title
deadended compartment
geometry
 gasvol=509.7129
 cellhist=1 5.17750   33.0018   20.6225
eoi
atmos=3
 tgas=310.93
 pgas=1.0342e5
 satrat=0.1
 molefrac
  n2=0.79 o2=0.21
eoi
condense
low-cell
geometry 0.01 bc=310.93
concrete
compos=1 con3 0.1
temp=310.93
eoi
pool
compos=1 h2ol 1.0e-4
temp=310.93
physics
```

```
boil
eoi
eoi
eoi
overflow 1

&& lower compartment
cell=16
control
jpool=1 jconc=1
&& naensy=1
&& nsoeng=1 nspeng=4
eoi
title
deadended compartment
geometry
 gasvol=286.0056
 cellhist=1 5.17750   18.51768   20.6225
eoi
atmos=3
 tgas=310.93
 pgas=1.0342e5
 satrat=0.1
 molefrac
  n2=0.79 o2=0.21
eoi
condense
low-cell
geometry 0.01 bc=310.93
concrete
compos=1 con3 0.1
temp=310.93
eoi
pool
compos=1 h2ol 1.0e-4
temp=310.93
physics
boil
eoi
eoi
eoi
overflow 1

&& lower compartment
cell=17
control
jpool=1 jconc=1
&& naensy=1
&& nsoeng=1 nspeng=4
eoi
title
deadended compartment
```

```
geometry
 gasvol=433.2559
 cellhist=1 5.17750   28.05153   20.6225
eoi
atmos=3
 tgas=310.93
 pgas=1.0342e5
 satrat=0.1
 molefrac
  n2=0.79 o2=0.21
eoi
condense
low-cell
geometry 0.01 bc=310.93
concrete
compos=1 con3 0.1
temp=310.93
eoi
pool
compos=1 h2ol 1.0e-4
temp=310.93
physics
boil
eoi
eoi
eoi
overflow 1

&& lower compartment
cell=18
control
jpool=1 jconc=1
&& naensy=1
&& nsoeng=1 nspeng=4
eoi
title
deadended compartment
geometry
 gasvol=368.126
 cellhist=1 5.17750   23.83464   20.6225
eoi
atmos=3
 tgas=310.93
 pgas=1.0342e5
 satrat=0.1
 molefrac
  n2=0.79 o2=0.21
eoi
condense
low-cell
geometry 0.01 bc=310.93
concrete
```

```
compos=1 con3 0.1
temp=310.93
eoi
pool
compos=1 h2ol 1.0e-4
temp=310.93
physics
boil
eoi
eoi
eoi
overflow 1

&& lower compartment
cell=19
control
jpool=1 jconc=1
&& naensy=1
&& nsoeng=1 nspeng=4
eoi
title
deadended compartment
geometry
 gasvol=124.5965
 cellhist=1 5.17750   8.067108   20.6225
eoi
atmos=3
 tgas=310.93
 pgas=1.0342e5
 satrat=0.1
 molefrac
  n2=0.79 o2=0.21
eoi
condense
low-cell
geometry 0.01 bc=310.93
concrete
compos=1 con3 0.1
temp=310.93
eoi
pool
compos=1 h2ol 1.0e-4
temp=310.93
physics
boil
eoi
eoi
eoi
overflow 1

&& lower compartment
cell=20
```

```
control
jpool=1 jconc=1
&& naensy=1
&& nsoeng=1 nspeng=4
eoi
title
deadended compartment
geometry
 gasvol=124.5965
 cellhist=1 5.17750   8.067108   20.6225
eoi
atmos=3
 tgas=310.93
 pgas=1.0342e5
 satrat=0.1
 molefrac
  n2=0.79 o2=0.21
eoi
condense
low-cell
geometry 0.01 bc=310.93
concrete
compos=1 con3 0.1
temp=310.93
eoi
pool
compos=1 h2ol 1.0e-4
temp=310.93
physics
boil
eoi
eoi
eoi
overflow 1

&& lower compartment
cell=21
control
jpool=1 jconc=1
&& naensy=1
&& nsoeng=1 nspeng=4
eoi
title
deadended compartment
geometry
 gasvol=263.3516
 cellhist=1 5.17750   17.05093   20.6225
eoi
atmos=3
 tgas=310.93
 pgas=1.0342e5
 satrat=0.1
```

```
 molefrac
  n2=0.79 o2=0.21
eoi
condense
low-cell
geometry 0.01 bc=310.93
concrete
compos=1 con3 0.1
temp=310.93
eoi
pool
compos=1 h2ol 1.0e-4
temp=310.93
physics
boil
eoi
eoi
eoi
overflow 1

&& lower compartment
cell=22
control
jpool=1 jconc=1
&& naensy=1
&& nsoeng=1 nspeng=4
eoi
title
deadended compartment
geometry
 gasvol=39.64433
 cellhist=1 5.17750   2.566807   20.6225
eoi
atmos=3
 tgas=310.93
 pgas=1.0342e5
 satrat=0.1
 molefrac
  n2=0.79 o2=0.21
eoi
condense
low-cell
geometry 0.01 bc=310.93
concrete
compos=1 con3 0.1
temp=310.93
eoi
pool
compos=1 h2ol 1.0e-4
temp=310.93
physics
boil
```

eoi
eoi
eoi
overflow 1

eof

E.2 PWR Ice Condenser Plant – Long-term Demonstration Deck

```
cray
&& *************control block**********************
&&
&& single cell ice condenser input deck
&&
control
ncells=7 ntitl=3 ntzone=7  nengv=10 && nac=1 nsectn=10
numtbg=5 maxtbg=10
eoi
&&
&& *************material block**********************
&&
material
compound h2ol h2ov h2o n2 o2
userdef insul con3 cs5 ss4
&&
&& ****************title block**********************
&&
title
Watts Bar [FSAR]
Double-Ended Pump Suction Break
single cell ice condenser deck (Base)
&&
&&
&& ***************time zone************************
times 3000. 0.0
0.01 0.05 1.0
0.1  1.0  10.0
0.5  1.0  60.0
 0.5  2.0  180.
 1.0  10.  300.
 2.0  50.  5000.
 2.0  100. 20000.
&& 5.0  500. 1.0e5
&& ***************************************************
longedt=10
shortedt=50
&&
prheat prlow-cl prengsys prflow && praer
thermo
thermal
userdat
insul solid molew 50.0
  rho 2 260. 1.0
      600. 1.0
 cond 2 260. 0.363
      600. 0.363
  sph 2 260. 9.4e5
      600. 9.4e5
```

```
eoi
con3 solid molew 50.0
 rho 2 260. 2400.
      600. 2400.
 cond 2 260. 1.385
      600. 1.385
 sph 2 260. 804.7
      600. 804.7
eoi
ss4 solid molew 50.0
 rho 2 260. 8000.
      600. 8000.
 cond 2 260. 16.3
      600. 16.3
 sph 2 260. 472.78
      600. 472.78
eoi
cs5 solid molew 50.0
 rho 2 260. 8000.
      600. 8000.
 cond 2 260. 45.0
      600. 45.0
 sph 2 260. 472.78
      600. 472.78
eoi
eoi
&& aerosol
&& diam1=1.0e-7 diam2=2.5e-4
&& tgas2=3000.0 pgas2=1.5e6
&& trapovfl
&& h2ov=1.0e-8 0.405
flows implicit=7  dropout
engvent

&& vent for refueling canal drains (gas flow)
&& from 1 to 2 varea=0.175 vavl=0.1 vcfc=0.75 velevb=6.47
&& velevf=6.47 resolvhd eoi

&& vent for refueling canal drains (liquid flow)
from 1 to 2 varea=0.175 vavl=0.1 vcfc=0.75 velevb=6.47
velevf=20.68 type=pool eoi

&& vent to dead-ended compartment
from 1 to 6 varea=27.685 vavl=1.73 vcfc=0.7 velevb=15.0
velevf=15.0 type=gas resolvhd
eoi

&& pool flow to dead-ended compartment
from 1 to 6 varea=2.0 vavl=0.1 vcfc=0.7 velevb=5.3
velevf=5.3 type=pool
eoi
```

```
&& lower ice condenser doors
from 1 to 3 vavl=4.9 vcfc=0.58 type=gas
velevb=19.653 velevf=19.653
resolvhd
 rvarea-p flag=2
  x=4 -1.0e7  0.0 142.7 1.0e7
&&  y=4 24.689 24.689 98.756 98.756
  y=4 0.0    0.0    98.756 98 756
 eoi
eoi

&& lower ice condenser drain
 from 1 to 3 vavl=13.3 vcfc=0.7 type=pool
 velevb=18.339 velevf=18.339
 varea=98.756
&& varea=1.0e-10
&& resolvhd
 eoi

&& ice bed junction
from 3 to 4 vavl=19.4 vcfc=1.3 type=gas
velevb=20.3 velevf=20.3 varea=167.0
resolvhd
eoi


&& ice bed junctions - intermediate doors
from 4 to 5 vavl=2.15 vcfc=1.2 type=gas
velevb=35.3 velevf=35.3
rvarea-p flag=2
  x=4 -1.0e+7 28498. 37910.  1.0e+7
  y=4 0.0 0.0 21.18 21.18
 eoi
resolvhd
eoi

&& ice bed junction - intermediate doors
from 4 to 5 vavl=7.13 vcfc=1.2
velevb=35.3 velevf=35.3
resolvhd
 rvarea-p flag=2
  x=4 -1.e+7 263. 28498. 1.0e+7
&&  y=4 1.86 1.86 70.24 70.24
  y=4 0.0 0.0 70.24 70.24
 eoi
eoi

&& top ice condenser doors
from 5 to 2 vavl=35.88 vcfc=0.5
velevb=40. velevf=40.
resolvhd
 rvarea-p flag=2
```

```
 x=4 -1.e+7 263. 28498. 1.0e+7
 y=4 1.86 1.86 91.5 91.5
 eoi
eoi

&& air return fans
from 2 to 1
 vflow-t flag=1
 x=3 0.0 600. 1.0e6
 y=3 0.0 18.88 18.88
 eoi
eoi

&& lower compartment
cell=1
control
jpool=1 jconc=20 nsoatm=4 nspatm=48
nsopl=1 nsppl=18
naensy=2
&& nsoeng=1 nspeng=4
nhtm=6 mxslab=21
numtbc=6 maxtbc=4
eoi
title
lower compartment
geometry
 gasvol=6694.6
 cellhist=2 5.17750   800. 7.0264 383.6 20.6225
eoi
atmos=3
 tgas=310.93
 pgas=1.0342e5
 satrat=0.1
 molefrac
  n2=0.79 o2=0.21
eoi
condense
 ht-tran on on on on on
&& **************injection source****************

source=4
h2ov=48 iflag=2
t=
 1.00000E-08  2.50330E-02  1.25220E-01  2.50280E-01  3.50280E-01
 4.50330E-01  5.75500E-01  7.25480E-01  8.75460E-01  1.07550E+00
 1.35030E+00  1.65020E+00  1.90020E+00  2.75010E+00  4.25040E+00
 5.75030E+00  7.25080E+00  8.75090E+00  1.02500E+01  1.20020E+01
 1.37520E+01  1.52510E+01  1.67510E+01  1.82510E+01  1.97500E+01
 2.15010E+01  2.32510E+01  2.40060E+01  2.40110E+01  2.50800E+01
 2.52100E+01  2.60100E+01  3.10100E+01  3.20100E+01  3.20150E+01
 3.60100E+01  4.70100E+01  5.00000E+01  5.40100E+01  6.40100E+01
 6.40150E+01  7.40100E+01  8.40100E+01  1.00000E+02  1.44010E+02
```

```
 1.95000E+02  1.95050E+02  1.95060E+02
mass=
 3.18030E+04  3.18030E+04  3.51320E+04  3.75560E+04  3.61460E+04
 3.32630E+04  3.18500E+04  3.04510E+04  2.91030E+04  2.74830E+04
 2.56920E+04  2.35660E+04  2.15720E+04  1.75240E+04  1.43230E+04
 1.31070E+04  1.18320E+04  1.04450E+04  9.31930E+03  8.00440E+03
 6.63490E+03  5.64340E+03  4.62090E+03  3.30350E+03  1.88670E+03
 1.02940E+03  2.94390E+02  4.25250E+01  0.00000E+00  2.02010E+02
 1.07270E+02  1.63560E+02  4.40990E+02  4.78390E+02  4.79870E+02
 4.62440E+02  4.20860E+02  4.10260E+02  3.98430E+02  3.27760E+02
 3.27440E+02  2.78300E+02  2.46510E+02  2.31080E+02  1.92810E+02
 1.83090E+02  6.86760E+01  0.
enth=
 1.30197E+06  1.30197E+06  1.30509E+06  1.31342E+06  1.32281E+06
 1.33607E+06  1.35038E+06  1.36587E+06  1.37793E+06  1.38734E+06
 1.39873E+06  1.41472E+06  1.42869E+06  1.46369E+06  1.71388E+06
 1.49750E+06  1.50715E+06  1.57519E+06  1.59863E+06  1.62766E+06
 1.66791E+06  1.68155E+06  1.63813E+06  1.54103E+06  1.60720E+06
 1.35884E+06  1.33955E+06  6.72557E+05  0.00000E+00  3.01648E+06
 3.01642E+06  3.01640E+06  3.01151E+06  3.00910E+06  3.00874E+06
 3.00086E+06  2.97869E+06  2.97254E+06  2.96578E+06  2.94930E+06
 2.94923E+06  2.93760E+06  2.92817E+06  2.91505E+06  2.88555E+06
 2.85731E+06  2.85683E+06  2.85677E+06
eoi

&& Decay heat steam
h2ov=5 iflag=2
t=
 1.76600E+03  5.00000E+03  1.00000E+04
 2.00000E+04  1.00000E+06
mass=
&& 3.48610E+01  2.65900E+01  2.18070E+01
&& 1.79280E+01  5.44290E+00
  19.163      14.969      12.624
  10.582      3.15
enth=
 2.84110E+06  2.82534E+06  2.80959E+06
 2.79134E+06  2.70314E+06
eoi

&& post-reflood steam, minimum SI
h2ov=18 iflag=2
t=
 1.95000E+02 2.00000E+02 3.00000E+02 3.05000E+02 3.10000E+02
 4.00000E+02 5.00000E+02 6.00000E+02 7.00000E+02 8.00000E+02
 9.00000E+02 1.00000E+03 1.20000E+03 1.40000E+03 1.60000E+03
 1.76500E+03 1.76501E+03 1.00000E+07
mass=
 1.34718E+02 1.34718E+02 1.34718E+02 1.34718E+02 6.75860E+01
 6.35036E+01 5.94212E+01 5.94212E+01 5.62460E+01 5.35244E+01
 5.35244E+01 5.08029E+01 4.76277E+01 4.53597E+01 4.38175E+01
 4.40443E+01 0.00000E+00 0.00000E+00
```

```
enth=
 2.77223E+06 2.76440E+06 2.69392E+06 2.69392E+06 2.68488E+06
 2.67473E+06 2.69870E+06 2.69870E+06 2.68223E+06 2.68064E+06
 2.70035E+06 2.67888E+06 2.68027E+06 2.69799E+06 2.69664E+06
 2.68275E+06 2.68275E+06 2.68275E+06
eoi

&& nitrogen from accumulator
n2=3 iflag=1
t= 15.5 55.0 1.0e6
mass= 25.47 0.0 0.0
temp= 450.0 450.0 450.
eoi


&& ***************structures*********************
struc

name=slab6 tunif=310.93
type=wall shape=slab nslab=18 chrlen=10.
slarea=2969.44
bcinner
 var-parm
 flag=2 name=forc1
 var-x=time
 x=4 0.0 24.0 30.0 50.0
 var-y=velocity
 y=4 0.0 20.0 0.0 0 0
 eoi
eoi
bcouter adiabat eoi
compound
con3 con3 con3 con3 con3 con3 con3 con3 con3 con3
con3 con3 con3 con3 con3 con3 con3 con3
x=
0.0 1.0e-3 2.0e-3 4.0e-3 6.0e-3 8.0e-3 0.01
0.012 0.014 0.017 0.02 0.03 0.04 0.06 0.1 0.2
0.3 0.35 0.435
eoi

name=slab7 tunif=310.93
type=wall shape=slab nslab=16   chrlen=10.
slarea=262.91
bcinner hpaint=377.9
 var-parm
 flag=2 name=forc2
 var-x=time
 x=4 0.0 24.0 30.0 50.0
 var-y=velocity
 y=4 0.0 20.0 0.0 0.0
 eoi
eoi
```

```
bcouter adıabat eoi
compound
con3 con3 con3 con3 con3 con3 con3 con3 con3 con3
con3 con3 con3 con3 con3 con3
x=
0.0 1.0e-3 2.0e-3 4.0e-3 6.0e-3 8.0e-3 0.01
0.012 0.014 0.017 0.02 0.03 0.04 0.06 0.1 0.2
0.305
eoi

name=slab8 tunif=310.93
type=wall shape=slab nslab=18   chrlen=10.
slarea=70.61
bcinner hpaint=944.87
 var-parm
 flag=2 name=forc3
 var-x=time
 x=4 0.0 24.0 30.0 50.0
 var-y=velocity
 y=4 0.0 20.0 0.0 0.0
 eoi
eoi
bcouter adiabat eoi
compound
con3 con3 con3 con3 con3 con3 con3 con3 con3 con3
con3 con3 con3 con3 con3 con3 con3 con3
x=
0.0 1.0e-3 2.0e-3 4.0e-3 6.0e-3 8.0e-3 0.01
0.012 0.014 0.017 0.02 0.03 0.04 0.06 0.1 0.2
0.30 0.4 0.534
eoi

name=slab9 tunif=310.93
type=wall shape=slab nslab= 21    chrlen=10.
slarea=257.34
bcinner
 var-parm
 flag=2 name=forc4
 var-x=time
 x=4 0.0 24.0 30.0 50.0
 var-y=velocity
 y=4 0.0 20.0 0.0 0.0
 eoi
eoi
bcouter adiabat eoi
compound
ss4 ss4 ss4 ss4 ss4 ss4
con3 con3 con3 con3 con3 con3 con3 con3 con3 con3
con3 con3 con3 con3 con3
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 5.0e-3 6.401e-3
8.0e-3 0.01 0.014 0.018 0.024 0.03 0.035 0.04 0.05
```

```
0.08 0.1 0.125 0.25 0.4 0.609
eoi

name=slab10 tunif=310.93
type=floor shape=slab nslab=19 chrlen=10.
&& slarea=1479.1 slhite=0.488 slelev=4.9335
slarea=1.0e-10
bcinner hpaint=944.87
 var-parm
 flag=2 name=forc6
 var-x=time
 x=4 0.0 24.0 30.0 50.0
 var-y=velocity
 y=4 0.0 20.0 0.0 0.0
 eoi
eoi
bcouter adiabat eoi
compound
con3 con3 con3 con3 con3 con3 con3 con3 con3 con3
con3 con3 con3 con3 con3 con3 con3 con3 con3
x=
0.0 1.0e-3 3.0e-3 5.0e-3
8.0e-3 0.01 0.014 0.018 0.024 0.03 0.035 0.04 0.05
0.08 0.1 0.125 0.25 0.35 0.4 0.488
eoi

name=slab11 tunif=310.93
type=wall shape=slab nslab=11     chrlen=10.
slarea=2647.71
bcinner hpaint=1905.49
 var-parm
 flag=2 name=forc7
 var-x=time
 x=4 0.0 24.0 30.0 50.0
 var-y=velocity
 y=4 0.0 20.0 0.0 0.0
 eoi
eoi
bcouter adiabat eoi
compound
cs5 cs5 cs5 cs5 cs5 cs5 cs5 cs5 cs5 cs5
cs5
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 6.0e-3 8.0e-3
0.01 0.014 0.016 0.018 0.02
eoi


engineer lowsp 4 3 1 0.0
 spray
  sphite=10. spdiam=0.0007
```

```
eoi
tank 0.01 300. 1000.
hex user=0.1
&& pump 10000.
pump 1.0e-8
eoi

engineer overfl 1 1 7 0.0
overflow 1 7 1.8489
eoi

low-cell
geometry 800.0 bc=310.93
concrete
compos=1 con3 3.84e6
temp=310.93
eoi
pool
compos=1 h2ol 1.0e-4
temp=310.93
physics
boil
source=1
&& post-reflood water minimum SI
h2ol=18 iflag=2
t=
 1.95000E+02 2.00000E+02 3.00000E+02 3.05000E+02 3.10000E+02
 4.00000E+02 5.00000E+02 6.00000E+02 7.00000E+02 8.00000E+02
 9.00000E+02 1.00000E+03 1.20000E+03 1.40000E+03 1.60000E+03
 1.76500E+03 1.76501E+03 1.00000E+07
mass=
 1.67831E+02 1.67831E+02 1.68285E+02 1.68285E+02 2.35417E+02
 2.39499E+02 2.43128E+02 2.43128E+02 2.46303E+02 2.49025E+02
 2.49025E+02 2.52200E+02 2.55375E+02 2.57190E+02 2.59004E+02
 2.58550E+02 0.00000E+00 0.00000E+00
enth=
 4.58256E+05 4.58256E+05 4.57647E+05 4.57647E+05 4.57104E+05
 4.58122E+05 4.59963E+05 4.59963E+05 4.58317E+05 4.57545E+05
 4.57545E+05 4.55967E+05 4.58561E+05 4.59428E+05 4.56209E+05
 4.57010E+05 4.57010E+05 4.57010E+05
eoi
eoi
eoi
eoi


&& upper compartment
cell=2
control
jpool=1 jconc=1
naensy=3  && numtbc=1 maxtbc=4
nsoeng=1 nspeng=5
```

```
nhtm=5 mxslab=22
eoi
title
upper compartment
geometry
 gasvol=18434.62
 cellhist=1 20.662 369.74 70.52
eoi
atmos=3
 tgas=302.6
 pgas=1.0342e5
 satrat=0.1
 molefrac
  n2=0.79 o2=0.21
eoi
condense
 ht-tran on off on on on

&& spray starts recirc. from sump
engineer recirc1 4 1 2 15.
 spray
 sphite=30.
 spdiam=0.0007
 eoi
 tank 2.894 302.6 0.001
 hex shell 302.6 454. 1. 1.2903e6
 pump 253.0
eoi

&& RHR spray flow
engineer recirc2 4 1 2 15.
 spray
 sphite=30.
 spdiam=0.0007
 eoi
 tank 3.6 302.6 0.001
 hex shell 302.6 454. 1.0 8.4928e5
 pump 126.5
eoi

&& quench spray from outside tank
engineer quensp 1 2 2 20.
 source=1 h2ol=5 iflag=2
 t= 55. 190. 2754. 2755. 1.0e6
 mass= 0.0 253.0 253. 0.0 0.0
 temp= 302.6 302.6 302.6 302.6 302.6
 eoi
 spray spdiam=0.0007 sphite=30.
 eoi
eoi
```

```
&& ***************structures*****************
struc

name=slab1 tunif=302.59
type=wall shape=slab nslab=17    chrlen=10.
slarea=453.36
bcouter adiabat eoi
compound
con3 con3 con3 con3 con3 con3 con3 con3 con3 con3
con3 con3 con3 con3 con3 con3 con3
x=
0.0 1.0e-3 3.0e-3 5.0e-3
8.0e-3 0.01 0.014 0.018 0.024 0.03 0.035 0.04 0.05
0.08 0.1 0.125 0.25 0.335
eoi

name=slab2 tunif=302.6
type=wall shape=slab nslab=18    chrlen=10.
slarea=1698.25
bcinner hpaint=944.87 eoi
bcouter adiabat eoi
compound
con3 con3 con3 con3 con3 con3 con3 con3 con3 con3
con3 con3 con3 con3 con3 con3 con3 con3
x=
0.0 1.0e-3 3.0e-3 5.0e-3
8.0e-3 0.01 0.014 0.018 0.024 0.03 0.035 0.04 0.05
0.08 0.1 0.125 0.25 0.35 0.427
eoi

name=slab3 tunif=302.6
type=wall shape=slab nslab=19   chrlen=10.
slarea=70.61
bcinner hpaint=377.95 eoi
bcouter adiabat eoi
compound
con3 con3 con3 con3 con3 con3 con3 con3 con3 con3
con3 con3 con3 con3 con3 con3 con3 con3 con3
x=
0.0 1.0e-3 3.0e-3 5.0e-3
8.0e-3 0.01 0.014 0.018 0.024 0.03 0.035 0.04 0.05
0.08 0.1 0.125 0.25 0.35 0.4 0.458
eoi

name=slab4 tunif=302.6
type=wall shape=slab nslab= 22    chrlen=10.
slarea=356.74
bcouter adiabat eoi
compound
ss4 ss4 ss4 ss4 ss4 ss4
con3 con3 con3 con3 con3 con3 con3 con3 con3 con3
con3 con3 con3 con3 con3 con3
```

```
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 5.0e-3 6.34e-3
8.0e-3 0.01 0.014 0.018 0.024 0.03 0.035 0.04 0.05
0.08 0.1 0.125 0.25 0.35 0.4 0.46
eoi

name=slab5 tunif=302.6
type=wall shape=slab nslab=11     chrlen=10.
slarea=5233.28
bcinner hpaint=1905.49 eoi
bcouter adiabat eoi
compound
cs5 cs5 cs5 cs5 cs5 cs5 cs5 cs5 cs5 cs5
cs5
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 6.0e-3 8.0e-3
0.01 0.014 0.016 0.018 0 0244
eoi


low-cell
geometry 369.74 bc=302.6
concrete
compos=1 con3 0.1
temp=302.6
eoi
pool
compos=1 h2ol 1.0e-4
temp=302.6
physics
boil
eoi
eoi
eoi



cell=3
control
nhtm=1 mxslab=19
jpool=1 jconc=1 && naensy=1
eoi
title
lower plenum
geometry
 gasvol=684.9
 cellhist=1 17.685 260.418250951 20.3136
eoi
atmos=3
 tgas=273.71
 pgas=1.0342e5
 satrat=0.1
```

```
molefrac
 n2=0.79 o2=0.21
eoi
condense
 ht-tran on off on on on

struc
name=slab15 tunif=273.
type=floor shape=slab nslab=14   chrlen=5.
slarea=309.92 slelev=17.63425 slhite=5.075e-2
bcinner hpaint=567.15 hydarea=80. eoi
bcouter adiabat eoi
compound
con3 con3 con3 con3 con3 con3 con3 con3 con3 con3
con3 con3 con3 con3
x=
0.0 1.0e-3 3.0e-3 5.0e-3
8.0e-3 0.01 0.014 0.018 0.024 0.03 0.035 0.04 0.05
0.08 0.1015
eoi

&& engineer ovfl 4 3 1 5.
&& overflow 3 1 0.2
&& eoi

low-cell
geometry 0.01 bc=273.71
concrete
compos=1 con3 0.1
temp=273.71
eoi
pool
compos=1 h2ol 1.0e-4
temp=273.71
physics
boil
eoi
eoi
eoi

cell=4
control
nhtm=5 mxslab=19
&& jpool=1 jconc=1
naensy=1
eoi
title
ice condenser #1
geometry
gasvol=2444.
&& gasvol=3444.
cellhist=1 20.3 162.93333 35.3
```

```
&& cellhist=1 20.3 229.6 35.3
eoi
atmos=3
 tgas=273.71
 pgas=1.0342e5
 satrat=0.1
 molefrac
  n2=0.79 o2=0.21
eoi
condense
 ht-tran on off on on on

struc
name=slab12a tunif=273.
type=wall shape=slab nslab=3 chrlen=10.
slarea=1.6781e4
bcinner hydarea=80. eoi
bcouter adiabat eoi
compound
cs5 cs5 cs5
x=
0.0 5.0e-4 1.0e-3 2.0e-3
eoi

name=slab13a tunif=273.
type=wall shape=slab nslab=6 chrlen=10.
slarea=7.1208e3
bcinner hydarea=80. eoi
bcouter adiabat eoi
compound
cs5 cs5 cs5 cs5 cs5 cs5
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 5.0e-3 6.6e-3
eoi

name=slab14a tunif=273.
type=wall shape=slab nslab=6 chrlen=10.
slarea=2.6635e3
bcinner hydarea=80. eoi
bcouter adiabat eoi
compound
cs5 cs5 cs5 cs5 cs5 cs5
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 6.0e-3 8.1e-3
eoi


name=slab16a tunif=273.
type=wall shape=slab nslab=15 chrlen=10.
slarea=1.7744e3
bcinner hydarea=80. eoi
bcouter adiabat eoi
```

```
compound
cs5 cs5 cs5 cs5 cs5
insul insul insul insul insul insul insul
cs5 cs5 cs5
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 6.1e-3 0.01 0.04 0.08
0.16 0.24 0.28 0.3048 0.3080 0.31 0.32385
eoi

name=slab17a tunif=273.
type=wall shape=slab nslab=19 chrlen=10.
slarea=1.2128e3
bcinner hydarea=80. eoi
bcouter adiabat eoi
compound
cs5 cs5 cs5 cs5 cs5
insul insul insul insul insul insul insul
con3 con3 con3 con3 con3 con3 con3
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 6.1e-3 0.01 0.04 0.08
0.16 0.24 0.28 0.3048 0.32 0.34 0.38 0.44 0.5 0.56 0.6096
eoi


engineer ice_a 1 4 3
13.2
icecond
 hitici= 14.6
&& tmsici=1.11e6
 tmsici=9.6388e5
 ciarfl=167.0
 ciflmx=5.e-6
 icllp=3
&& arhtin=2.48e4
&& cihtml=10.
 arhtin=2.744e4
 cihtml=10.
 citice=264.
eoi
eoi


cell=5
control
&& nhtm=1 mxslab=19
&& jpool=1 jconc=1
&& naensy=1
eoi
title
upper plenum
```

```
geometry
 gasvol=1330.
 cellhist=1 35.1850 275.362318841 40.0150
eoi
atmos=3
 tgas=273.71
 pgas=1.0342e5
 satrat=0.1
 molefrac
  n2=0.79 o2=0.21
eoi
overflow 3

&& lower compartment
cell=6
control
jpool=1 jconc=10
&& naensy=1
&& nsoeng=1 nspeng=4
eoi
title
deadended compartment
geometry
 gasvol=4111.7
 cellhist=1 5.17750   381.0  15.969
eoi
atmos=3
 tgas=310.93
 pgas=1.0342e5
 satrat=0.1
 molefrac
  n2=0.79 o2=0.21
eoi
condense
ht-tran on on on on on
low-cell
geometry 381.0 bc=310.93
concrete
compos=1 con3 1.83e6
temp=310.93
eoi
pool
compos=1 h2ol 1.0e-4
temp=310.93
physics
boil
eoi
eoi
eoi

&& overflow cell for excess water
cell=7
```

```
control
jpool=1 jconc=1
eoi
title
dummy cell
geometry
 gasvol=1.0e10
 cellhist=1 0.0 1000. 1.0e7
eoi
atmos=3
 tgas=310.93
 pgas=1.0342e5
 satrat=0.1
 molefrac
  n2=0.79 o2=0.21
eoi
ht-tran off off off off off
low-cell
geometry 0.1 bc=310.93
concrete
compos=1 con3 0.1
temp=310.93
eoi
pool
compos=1 h2ol 1.0e-4
temp=310.93
physics
boil
eoi
eoi
eoi

eof
```

E.3 PWR Ice Condenser Plant – Secondary Containment Demonstration Deck

```
cray
&& Demonstration calculation for secondary containment analysis
&& (Additional information required for audit use)
&&
&& ice condenser plant input for secondary containment
&& analysis
&&
&& Nodalization:
&& cell #    description
&&  1        secondary containment (dome region)
&&  2        secondary containment (ice condenser region)
&&  3        secondary containment (lower compartment region)
&&  4        secondary containment (bottom region, pool compression)
&&  5        dummy environ cell (pool reservoir)
&&  6        dummy environ cell (inleakage source and exhaust reservoir)
&&
&& secondary containment volume change due to pressure and temperature
&& expansion of primary cell based on ice condenser long-term LOCA
&& calculation (Appendix E)
&&
&& exhaust and inleakage volumetric flow rate representative of the
&& Watts Bar secondary containment analysis present in the Watts Bar
&& FSAR
&&
&& specification primary containment outer boundary conditions based
&& on Watts Bar long-term LOCA calculation and FSAR heat transfer coef.
&& specification
&&
&& secondary containment free convection and structure-to-structure
&& thermal radition based on FSAR specification for convective heat
&& transfer coefficient (free convection) and thermal emissivity of
&& structure surfaces
&&
&&
&&
&& ----------------control block-------------
control
ncells=6 ntitl=2 ntzone=4
nengv=8 numtbg=4 maxtbg=54
eoi
material
compound n2 o2 h2ov h2ol h2o
userdef
con3 cs5
&&
title
Secondary containment demonstration calc.
Ventilation case
&& -------------time zone--------------
times 1000.0 0.0
```

```
0.1 0.5 50.0
0.5 1.0 100.0
1.0 5.0 500 0
2.0 10.0 2400.0
&& ----------------------------------
longedt=10
shortedt=20
prheat prflow prlow-cl
thermo
thermal
userdat
con3 solid molew 50.0
 rho 2 260.0 2400.0
      600.0 2400.0
 cond 2 260.0 1.385
      600.0 1.385
 sph 2 260.0 804.7
      600.0 804.7
eoi
cs5 solid molew 50.0
 rho 2 260.0 8000.0
      600.0 8000.0
 cond 2 260.0 45.0
      600.0 45.0
 sph 2 260.0 472.78
      600.0 472.78
eoi
eoi
&&
flows implicit=6
engvent

&& stack exhaust
 from 1 to 6
  type=gas
   vflow-t
    flag=2
   x=31
   0.0000E+00  1.0000E+01  8.8274E+01  1.0221E+02  1.0686E+02
   1.2312E+02  1.3009E+02  1.4635E+02  1.5796E+02  1.7423E+02
   1.9746E+02  2.2301E+02  2.4392E+02  2.8573E+02  3.3219E+02
   3.6704E+02  4.0653E+02  4.5299E+02  5.0874E+02  5.4823E+02
   5.9701E+02  6.0631E+02  1.0000E+03  1.0001E+03  1.7004E+03
   1.7167E+03  1.8003E+03  1.9049E+03  1.9931E+03  2.0698E+03
   2.0977E+03
   y=31
   0.0000E+00  0.0000E+00  1.6831E+00  1.6897E+00  1.2049E+00
   1.2661E+00  1.3014E+00  1.3305E+00  1.3499E+00  1.3532E+00
   1.3470E+00  1.3119E+00  1.2672E+00  1.1616E+00  1.0400E+00
   9.3440E-01  8.3845E-01  7.0725E-01  5.8578E-01  5.1871E-01
   4.5816E-01  3.5000E-01  3.5000E-01  4.0178E-02  5.0178E-02
   9.3156E-02  9.3586E-02  1.0175E-01  1.0175E-01  1.0246E-01
```

```
  1.0269E-01
 eoi
eoi

&& inleakage through shield wall
 from 6 to 3
  type=gas
  vvflow=0.11799
 eoi

&& EGTS start-up effect
&& at constant temp. of approx. 300 K (estimate)
 from 6 to 3
  type=gas
   mflow-t flag=2
    x=5
    0.0 200.0 201.0 600.0 601.0
    y=5
    0.0 0.5   0.6   0.4   0.0
   eoi
 eoi

&& redistributed air from secondary containment
 from 1 to 3
  type=gas
   vflow-t
    flag=2
   x=31
   0.0000E+00  1.0000E+01  8.8274E+01  1.0221E+02  1.0686E+02
   1.2312E+02  1.3009E+02  1.4635E+02  1.5796E+02  1.7423E+02
   1.9746E+02  2.2301E+02  2.4392E+02  2.8573E+02  3.3219E+02
   3.6704E+02  4.0653E+02  4.5299E+02  5.0874E+02  5.4823E+02
   5.9701E+02  6.0631E+02  1.0000E+03  1.0001E+03  1.7004E+03
   1.7167E+03  1.8003E+03  1.9049E+03  1.9931E+03  2.0698E+03
   2.0977E+03
   y=31
   1.8878E+00  1.8878E+00  2.0468E-01  1.9812E-01  6.8285E-01
   6.2169E-01  5.8634E-01  5.5727E-01  5.3792E-01  5.3457E-01
   5.4075E-01  5.7586E-01  6.2061E-01  7.2618E-01  8.4775E-01
   9.5337E-01  1.0493E+00  1.1805E+00  1.3020E+00  1.3691E+00
   1.4296E+00  1.5370E+00  1.5370E+00  1.77E+00    1.77E+00
   1.77E+00    1.77E+00    1.77E+00    1.77E+00    1.77E+00
   1.77E+00
   eoi
 eoi

&& pool flow for volume compression
 from 5 to 4
  type=pool
   vflow-t
    flag=1
   x=54
```

```
 0.0000E+00  5.3650E-01  3.3070E+00  6.1858E+00  9.9004E+00
 1.2426E+01  1.3413E+01  1.5518E+01  1.7494E+01  1.8747E+01
 2.1445E+01  2.3816E+01  2.5726E+01  2.8617E+01  3.3340E+01
 3.8591E+01  4.4960E+01  4.9296E+01  6.1253E+01  7.5617E+01
 9.0727E+01  1.0535E+02  1.1901E+02  1.2902E+02  1.3511E+02
 1.3997E+02  1.5266E+02  1.6704E+02  1.8191E+02  1.9265E+02
 1.9850E+02  2.1100E+02  2.2634E+02  2.4029E+02  2.6823E+02
 2.9476E+02  3.4237E+02  5.9506E+02  6.2583E+02  6.7756E+02
 7.5861E+02  8.4382E+02  9.0388E+02  9.8628E+02  1.0229E+03
 1.2075E+03  1.5404E+03  1.7502E+03  1.7950E+03  1.8650E+03
 1.9546E+03  2.1364E+03  2.3574E+03  2.4860E+03

 y=54
 3.8316E+01  5.5773E-01  5.3793E-01  5.9834E-01
 9.1103E-01  8.5124E-03  6.1951E-02 -5.0443E-01 -8.9033E-01
-1.1674E-01 -4.1900E-01 -4.6320E-01  4.7587E-01  1.1291E+00
 9.0925E-01  7.1563E-01  5.5388E-01  3.4150E-01  1.8789E-01
 8.3596E-02  4.4169E-02  2.0500E-03 -4.9256E-02  1.5382E-01
 2.1296E-01  1.0149E-02  5.2020E-02  2.9670E-02 -7.5190E-03
-8.5567E-02 -3.2985E-02  2.6854E-02  1.4817E-02 -1.0873E-02
-3.7310E-03 -5.1527E-02  5.3380E-04 -2.9844E-02 -2.5621E-02
-1.6305E-02 -8.2910E-03 -6 6950E-03 -7.3320E-03 -1.3390E-03
-1.9370E-03 -1.6600E-04  5.7110E-04 -1.6809E-02 -9.3700E-03
-4.1190E-03 -9.2400E-04  9.7710E-04  8.5580E-04  0.0
   eoi
 eoi

&& secondary containment volume connections
 from 4 to 3
 varea=177.022 vavl=100.0 vcfc=0 01 type=gas
 velevb=1.0 velevf=1.0
 resolvhd
 eoi

 from 3 to 2
 varea=177.022 vavl=100.0 vcfc=0.01 type=gas
 velevb=10.0 velevf=10.0
 resolvhd
 eoi

 from 2 to 1
 varea=177.022 vavl=100.0 vcfc=0.01 type=gas
 velevb=34.0 velevf=34.0
 resolvhd
 eoi
&&
&& dome region
cell=1
control
nhtm=2 mxslab=20
numtbc=2 maxtbc=13
eoi
```

```
title
dome region
geometry
 gasvol=5212.26
 cellhist=1 34.0 297.84 51.5
eoi
atmos=2
tgas=283.15 pgas=9.876e4
molefrac
n2=0.79 o2=0.21
eoi
condense
ht-tran on on on on on
struc

&& primary dome shell (upper compartment short-term temperature
&& response base on short-term LOCA calculation, and long-term
&& temperature profile based on long-term LOCA calculation)
name=slab1 tunif=302.6
type=wall shape=slab nslab=14 chrlen=10.0
slarea=1924.23
bcinner hpaint=1.0e4 hmxmul=1.0 hydarea= 1.0e6 eoi
bcouter hcoef=2271.0
 var-parm
  flag=2 name=tup
  var-x=time
  x=8 0.0 20.0 60.0 120.0 250.0 500.0 1000.0 2500.0
  var-y=tgas
  y=8 302.6 302.0 302.48 303.85 305.71 302.85 302.63
     301.17
 eoi
eoi
compound
cs5 cs5 cs5 cs5 cs5 cs5 cs5
cs5 cs5 cs5 cs5 cs5 cs5 cs5
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 6.0e-3 8.0e-3
0.01 0.012 0.014 0.016 0.017 0.018 0.019 0.02
eoi

&& shield wall
name=slab2 tunif=283.15
type=wall shape=slab nslab=20 chrlen=10.0
slarea=2273.96
bcinner hmxmul=1.0 hydarea= 1.0e6 eoi
bcouter adiabat eoi
compound
con3 con3 con3 con3 con3 con3 con3 con3 con3 con3
con3 con3 con3 con3 con3 con3 con3 con3 con3 con3
x=
0.0 1.0e-3 3.0e-3 5.0e-3 8.0e-3 0.01 0.014 0.018
0.024 0.03 0.035 0.04 0.05 0.08 0.1 0.125 0.25
```

```
0.35 0.5 0.7 1.0
eoi
&&
rad-heat
 emsvt 0.9 0.9
 enclos
  vufac 0.0 1.0
      0.1538
 eoi
eoi

&& ice bed region
&& insulated primary containment wall
cell=2
control
nhtm=2 mxslab=20
numtbc=2 maxtbc=13
eoi
title
ice bed region
geometry
 gasvol=4248.52
 cellhist=1 10.0 177.022 34.0
eoi
atmos=2
tgas=283.15 pgas=9.876e4
molefrac
n2=0.79 o2=0.21
eoi
condense
ht-tran on on on on on
struc

&& primary shell
name=slab3 tunif=283.15
type=wall shape=slab nslab=14 chrlen=10.0
slarea=2638.94
bcinner hpaint=1.0e4 hmxmul=1.0 hydarea=1.0e6 eoi
bcouter adiabat eoi
compound
cs5 cs5 cs5 cs5 cs5 cs5 cs5
cs5 cs5 cs5 cs5 cs5 cs5 cs5
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 6.0e-3 8.0e-3
0.01 0.012 0.014 0.016 0.017 0.018 0.019 0.02
eoi

&& shield wall
name=slab4 tunif=283.15
type=wall shape=slab nslab=20 chrlen=10.0
slarea=2868.75
bcinner hmxmul=1.0 hydarea=1.0e6 eoi
```

```
bcouter adiabat eoi
compound
con3 con3 con3 con3 con3 con3 con3 con3 con3 con3
con3 con3 con3 con3 con3 con3 con3 con3 con3 con3
x=
0.0 1.0e-3 3.0e-3 5.0e-3 8.0e-3 0.01 0.014 0.018
0.024 0.03 0.035 0.04 0.05 0.08 0.1 0.125 0.25
0.35 0.5 0.7 1.0
eoi
&&
rad-heat
 emsvt 0.9 0.9
  enclos
   vufac 0.0 1.0
       0.08011
  eoi
eoi

&& low compartment region
cell=3
control
nhtm=2 mxslab=20
numtbc=2 maxtbc=13
eoi
title
lower compartment region
geometry
 gasvol=1593.2
 cellhist=1 1.0 177.022 10.0
eoi
atmos=2
tgas=283.15 pgas=9.876e4
molefrac
n2=0.79 o2=0.21
eoi
condense
ht-tran on on on on on
struc

&& primary shell
&& dead-ended lower compartment temperatures obtained
&& from long-term LOCA calculation
name=slab5 tunif=310.92
type=wall shape=slab nslab=14 chrlen=10.0
slarea=549.78
bcinner hpaint=1.0e4 hmxmul=1.0 hydarea=1.0e6 eoi
bcouter hcoef=2271.0
 var-parm
  flag=2 name=tlow
  var-x=time
  x=13 0.0 0.6 10.0 25.0 40.0 60.0 100.0 132.0
      170.0 200.0 1000.0 2000.0 2500.0
```

```
 var-y=tgas
 y=13 310.92 374.7 359.47 345.25 369.59 374.22
    367.76 363.5 369.16 366.46 360.01 359.33 359.73
eoi
eoi
compound
cs5 cs5 cs5 cs5 cs5 cs5 cs5
cs5 cs5 cs5 cs5 cs5 cs5 cs5
x=
0.0 1.0e-3 2.0e-3 3.0e-3 4.0e-3 6.0e-3 8.0e-3
0.01 0.012 0.014 0.016 0.017 0.018 0.019 0.02
eoi

&& shield wall
name=slab6 tunif=283.15
type=wall shape=slab nslab=20 chrlen=10.0
slarea=1195.31
bcinner hmxmul=1.0 hydarea=1.0e6 eoi
bcouter adiabat eoi
compound
con3 con3 con3 con3 con3 con3 con3 con3 con3 con3
con3 con3 con3 con3 con3 con3 con3 con3 con3 con3
x=
0.0 1.0e-3 3.0e-3 5.0e-3 8.0e-3 0.01 0.014 0.018
0.024 0.03 0.035 0.04 0.05 0.08 0.1 0.125 0.25
0.35 0.5 0.7 1.0
eoi
&&
rad-heat
 emsvt 0.9 0.9
  enclos
    vufac 0.0 1.0
      0.54005
  eoi
eoi

&& volume displacement cell
cell=4
control
jpool=1
eoi
title
pool cell
geometry
 gasvol=177.022
 cellhist=1 0.0 177.022 1.0
eoi
atmos=2
tgas=283.15 pgas=9.876e4
molefrac
n2=0.79 o2=0.21
eoi
```

```
&& turn off all heat transfer
&& no thermal interaction with pool surface
ht-tran off off off off off
low-cell
 geometry 177.022 bc=292.0
 pool
  compos=1 h2ol=1.0e-10 temp=292.0
 eoi
eoi

&& dummy cell for pool transfers
&&
cell=5
control
jpool=1
eoi
title
dummy cell
geometry
 gasvol=1.0e10
 cellhist=1 0.0 1.9417e8 51.5
eoi
atmos=2
tgas=283.0 pgas=1.0e5
molefrac
n2=0.79 o2=0.21
eoi
ht-tran off off off off off
low-cell
 geometry 100.0 bc=292.0
 pool
  compos=1 h2ol=1.0e5 temp=292.0
 eoi
eoi

&& environment cell for inleakage and exhaust
cell=6
control
eoi
title
environment
geometry
 gasvol=1.0e10
 cellhist=1 0.0 1.9417e8 51.5
eoi
atmos=2
tgas=300.0 pgas=1.0e5
molefrac
n2=0.79 o2=0.21
eoi

eof
```

Appendix F

Representation of Heat Transfer Coefficients: CONTEMPT versus CONTAIN

In discussions of containment heat transfer, there have been a variety of meanings associated to wall heat transfer coefficients. Before a quantitative comparative study can be initiated, the various meanings need to be put into a common understanding. This appendix addresses the issues of heat transfer coefficient representation for the CONTEMPT and CONTAIN codes. The appendix does not consider, per se, the detailed modeling differences; rather, the discussion is directed simply toward variations in the representation of coefficients that are referred to in the respective code literature and output file listings. In the following two sections, the definitions of coefficients as used in each code are presented. The third section presents formula for establishing a common basis for comparative study of heat transfer coefficients.

F.1 CONTEMPT Heat Transfer Coefficient

Shown in Figure F-1 is a sketch of the CONTEMPT wall heat transfer nodalization model. Beginning with the "wall structure," the model divides the wall into regions that represent various material types. In this figure, region 1 is used to define the paint layer, and region 2 represents the substrate material. The CONTEMPT heat conduction algorithm is formulated such that temperatures are calculated at the grid lines that divide each region. Therefore, region boundary temperatures are explicitly computed. In this model, temperature T_0 is the surface temperature of the "wall" that includes the paint layer and substrate. T_w is the surface temperature of only the substrate material.

Within the atmosphere, two temperatures are defined. The temperature T_b refers to the <u>bulk</u> atmospheric temperature, and T_v is defined as the atmospheric <u>vapor</u> temperature. In reality there is only one atmospheric temperature. However, in CONTEMPT, two definitions are required to for implementation of an empirical modeling method that may include heat transfer in saturated as well as superheated atmospheres. In this modeling, the bulk temperature often refers to the saturation temperature of the atmosphere, and the vapor temperature refers to the "actual" temperature of the atmospheric gas mixture, which may be superheated; therefore, we can have two conditions:

$T_b = T_v$ for saturated atmospheres; and,

$T_v > T_b$ for superheated atmospheres.

So, why two temperatures? The use of two atmospheric temperatures in the CONTEMPT heat

transfer modeling is rooted in the empirical representation used to obtain heat transfer coefficients. In the CONTEMPT code, heat transfer coefficients have been developed from condensation experiments for natural and forced convective condensation. These tests were conducted with saturated air/steam mixtures, where the heat transfer coefficient was defined as

$$h'' = \frac{q}{(T_b - T_0)}, \qquad \text{F-1}$$

where q is the measured heat flux to the wall surface, and $T_b = T_v$. (In the tests, the walls were unpainted, therefore we also have $T_0 = T_w$.) A concern arose in the development of the CONTEMPT code as to how to extend the implementation of these empirical correlations for saturated conditions to situations where substantial superheating has occurred. To treat superheated conditions, it was determined that one approach was to maintain the same definition as developed for the tests, i.e., continue using the bulk temperature as the saturation temperature in the atmosphere, i.e., using Eq. F-1. As a result, two atmospheric temperatures were used in the code: the vapor temperature is used in the atmospheric energy equation, and the saturation or bulk temperature is used in the condensation modeling.[1] In Section 2.1.3, Minimum Pressure Analysis in this report, the CONTEMPT predictions during the rapid pressurization phase of the accident show superheated conditions; these conditions are calculated using the bulk temperature for determining wall condensation. The heat transfer coefficient listed in the CONTEMPT output is defined as in Equation F-1.

We note that the heat transfer coefficient represented by the empirical correlations are the *total* heat transfer coefficients for energy transfer to the wall. That is, the heat transfer coefficient includes atmospheric process such as latent heat transfers (condensation), convection, and thermal radiation. Additionally, the definition for heat transfer implicitly includes a liquid film resistance (not shown in Figure F-1). Due to the small scales of the test facilities used for the correlation databases, with short wall lengths, the liquid film thickness is also very small and the resistance is typically insignificant under most containment conditions. Also, because the bulk temperatures in the tests are relatively low (350 - 400 K), and in many cases bulk to wall temperature differentials are also reasonably small (< 50 K), the convective and thermal radiation contributions are also insignificant. Condensation is therefore the main contributor for energy transfers in the containment steam/air atmospheric mixtures. As a result, heat transfer coefficients are often referred to as condensation coefficients.

---

[1] In the CONTEMPT code, the user may override the use of bulk temperature with vapor temperature in some cases. However, the common usage is to use bulk temperature for condensation heat transfer.

F.2 CONTAIN Heat Transfer Coefficient

The heat transfer processes modeled in the CONTAIN code at a wall surface are shown in Figure F-2. Each energy transport phenomenon (q_c, convection; q_{cond}, condensation; q_{rad}, thermal radiation; q_{aer}, aerosol deposition) is determined separately. Figure F-3 shows the configuration of atmosphere and wall geometry that is described in the modeling, similarly described for CONTEMPT except that 1) substrate conduction modeling is implemented with temperatures at the mid-point of nodes bounded by grid lines, 2) paint, liquid film, and half node wall thickness are treated as lumped thermal resistances in the modeling, and 3) only a single atmospheric temperature is defined, the actual atmospheric vapor or gas temperature. Since the surface node thickness, Δx_s, is normally quite small, we take T_w to be equivalent to the wall surface temperature, i.e., the first node temperature in the substrate is the wall surface temperature.

Since these are physically based models each phenomenon that determines the energy transfer fluxes for the processes in Figure F-2, the code does not implement the wall energy transfer modeling with a total "heat transfer coefficient" correlation as with the CONTEMPT empirical models. As a result, the code does not explicitly report heat transfer coefficients. Rather, these coefficients must be derived from the cumulative total wall energy, gas and structure node temperature vectors written to the CONTAIN plot file. In a consistent fashion, with other condensation modeling and experimental reporting methods, we define the heat transfer coefficient for CONTAIN as

$$h' = \frac{q_{cond} + q_c + q_{rad} + q_{aer}}{\left(T_{gas} - T_w\right)}, \qquad \text{F-2}$$

and refer to the vapor temperature simply as the gas temperature, T_{gas}.

We note that in most cases of interest (as mentioned for CONTEMPT modeling), $q_{cond} >> q_c + q_{rad} + q_{aer}$, such that the heat transfer coefficient h' is also referred to as the CONTAIN condensation coefficient.

To simplify the determination of the CONTAIN condensation coefficient, we have developed a POSTCON modification that allows rate quantities to be determined from cumulative vector output, such as the cumulative surface energy transfer vector. This modification is described in Appendix G.[2]

---

[2] If the user does not have an implementation of the POSTCON modification for determining rate quantities, heat transfer coefficients can be determined through post-processing of the POSTCON cumulative surface energy transfer vectors.

F.3 Comparison of CONTEMPT and CONTAIN Heat Transfer Coefficients

A direct comparison of CONTEMPT and CONTAIN heat transfer coefficients is possible only for a restricted class of structure models and atmospheric conditions. In all other cases, an equivalent comparison must include some manipulation of each heat transfer coefficient. The simplest method of comparison is to derive the coefficients for each code based on a common equation that defines the "heat transfer coefficient." For example, one such equation for defining the heat transfer equation (consistently used in containment heat transfer literature) is

$$h = \frac{q_w}{T_g - T_w}, \qquad \text{F-3}$$

where q_w is the total energy flux to the structure surface, T_g is the atmosphere temperature ($T_g = T_v = T_{gas}$), and T_w is the wall surface temperature as defined above for both the CONTAIN and CONTEMPT heat transfer models.

This method has been used in this report where CONTAIN and CONTEMPT outputs are available for comparison. There are other situations where the CONTAIN (Eq. F-2) and CONTEMPT empirical coefficients (Eq. F-1) must be compared. For instance, in the cases where CONTAIN output must be modeled to approximate procedures described in the USNRC SRPs for Minimum Pressure Analysis.[3] In these instances, the empirical correlations represented in the CONTEMPT code are the comparative quantities. Therefore, we must be able to translate the various empirical coefficient inputs in the CONTEMPT code (based on SRP recommendations) to CONTAIN derived coefficients, as defined in Section F.2. We describe a number of comparative techniques for specific cases:

1) Unpainted structure, saturated atmospheric conditions –

$$h' \sim h'', \qquad \text{F-4}$$

where the liquid film resistance is included in each representation of the coefficient.

2) Unpainted structure, superheated atmospheric conditions –

$$h' \sim h''\left(\frac{T_b - T_w}{T_{gas} - T_w}\right), \qquad \text{F-5}$$

where it is assumed that heat transfer in CONTEMPT is being calculated using T_b.

---

[3] USNRC Standard Review Plan (Subsection 6.2.1.5-6), NUREG-0800, Rev. 2, July 1981.

3) Painted structure, saturated atmospheric conditions –

$$h' \sim \frac{h'' h_{paint}}{h'' + h_{paint}}, \qquad \text{F-6}$$

where h_{paint} is the paint layer conductance.

4) Painted structure, superheated atmospheric conditions –

$$h' \sim \left(\frac{h'' h_{paint}}{h'' + h_{paint}} \right) \left(\frac{T_b - T_w}{T_{gas} - T_w} \right). \qquad \text{F-7}$$

In the SRPs, there are references to empirical correlations developed by Uchida and Tagami. These correlations are recommended for the coefficient h'' under conditions that establish a conservative estimate for passive heat sink energy transfers. We can readily convert these correlations to the respective CONTAIN coefficients h' using Equations F-4 through F-7. To show equivalency or bounding modeling, we may compare directly the converted empirical coefficients to the CONTAIN derived values.

Shown in Figure F-4 are the Uchida coefficients based on CONTEMPT data. In the case of the unpainted surface, and saturated conditions (dashed line), the CONTAIN and CONTEMPT coefficients can be compared directly, from Eq. F-4. This direct comparison assumes that a liquid film thickness is small and the film resistance is insignificant. The figure also shows the effect of paint on reducing the heat transfer coefficient, and the reducing effect of superheating (for a constant $T_b - T_w$ differential temperature). In Figure F-5 a similar comparison for the Tagami heat transfer coefficient is shown.[4] In this case, we plot the Tagami coefficients as a function of time during the reactor depressurization phase of a postulated accident. The reduction of the heat transfer coefficient h' is shown for painted surfaces and superheating. It should be noted that the coefficients in Figures F-4 and F-5 are based on specified assumptions regarding paint thickness and temperature differentials between atmosphere and wall surface; the figures are intended to demonstrate how painting and atmospheric superheating changes the values of comparative coefficients, i.e., those coefficients that may be compared to the CONTAIN coefficients.

[4] The representation of 4 X Tagami corresponds to USNRC's SRP minimum pressure analysis recommendation.

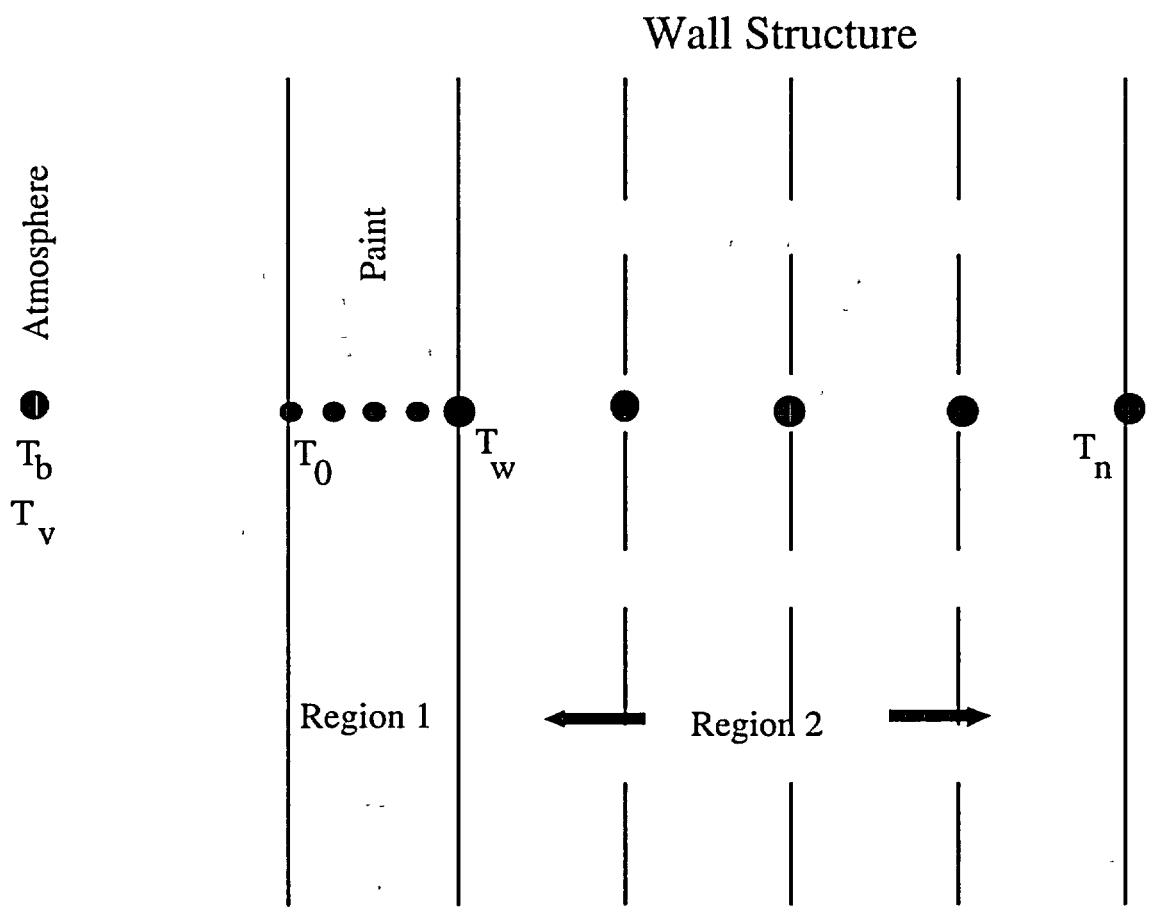

Figure F-1 Sketch of the wall heat transfer model for the CONTEMPT code.

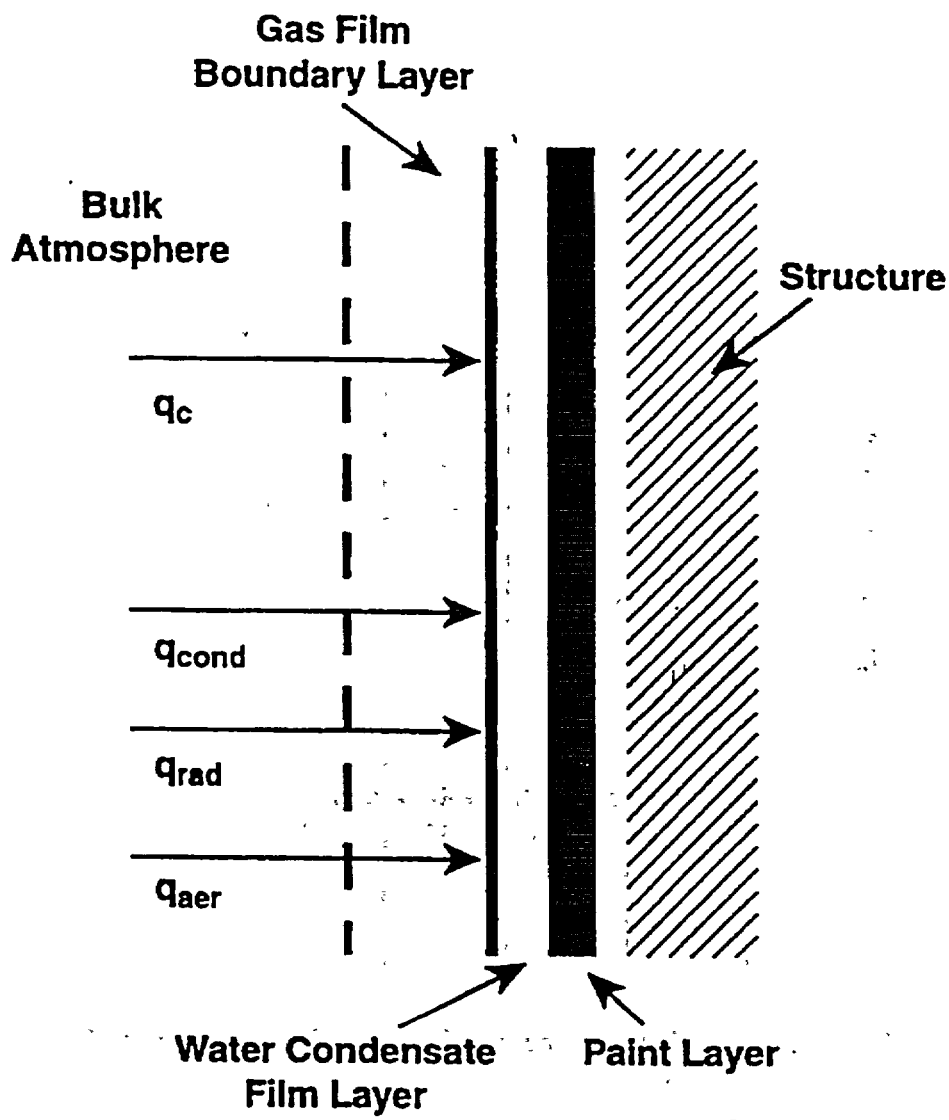

Figure F-2 Heat transfer processes modeled at a gas structure interface with the CONTAIN code (stagnant film flow).

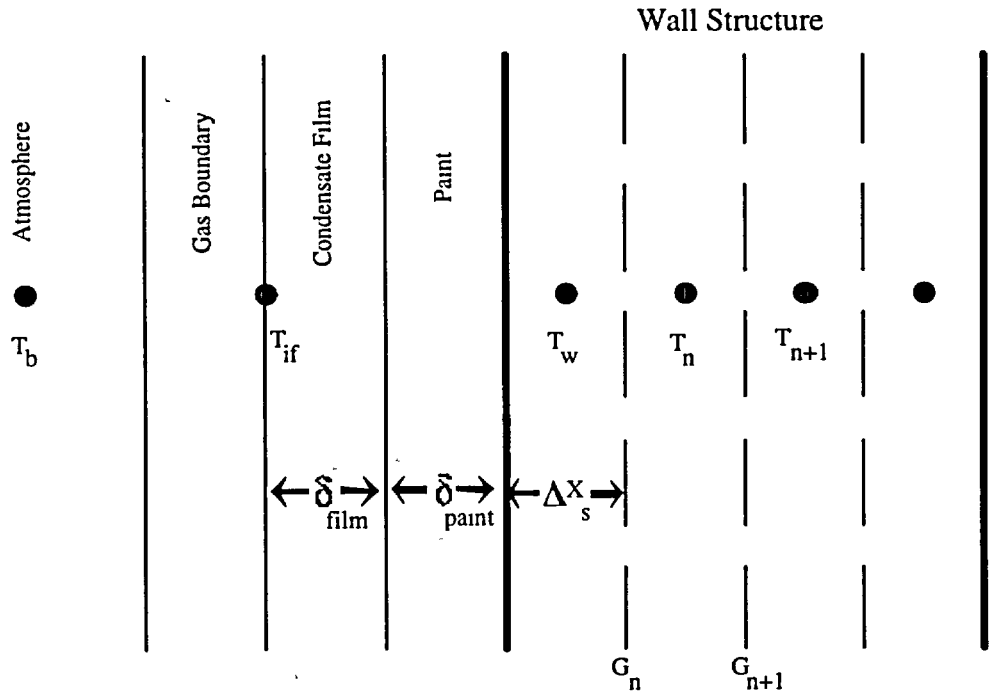

Figure F-3 Sketch of the wall heat transfer model for the CONTAIN code.

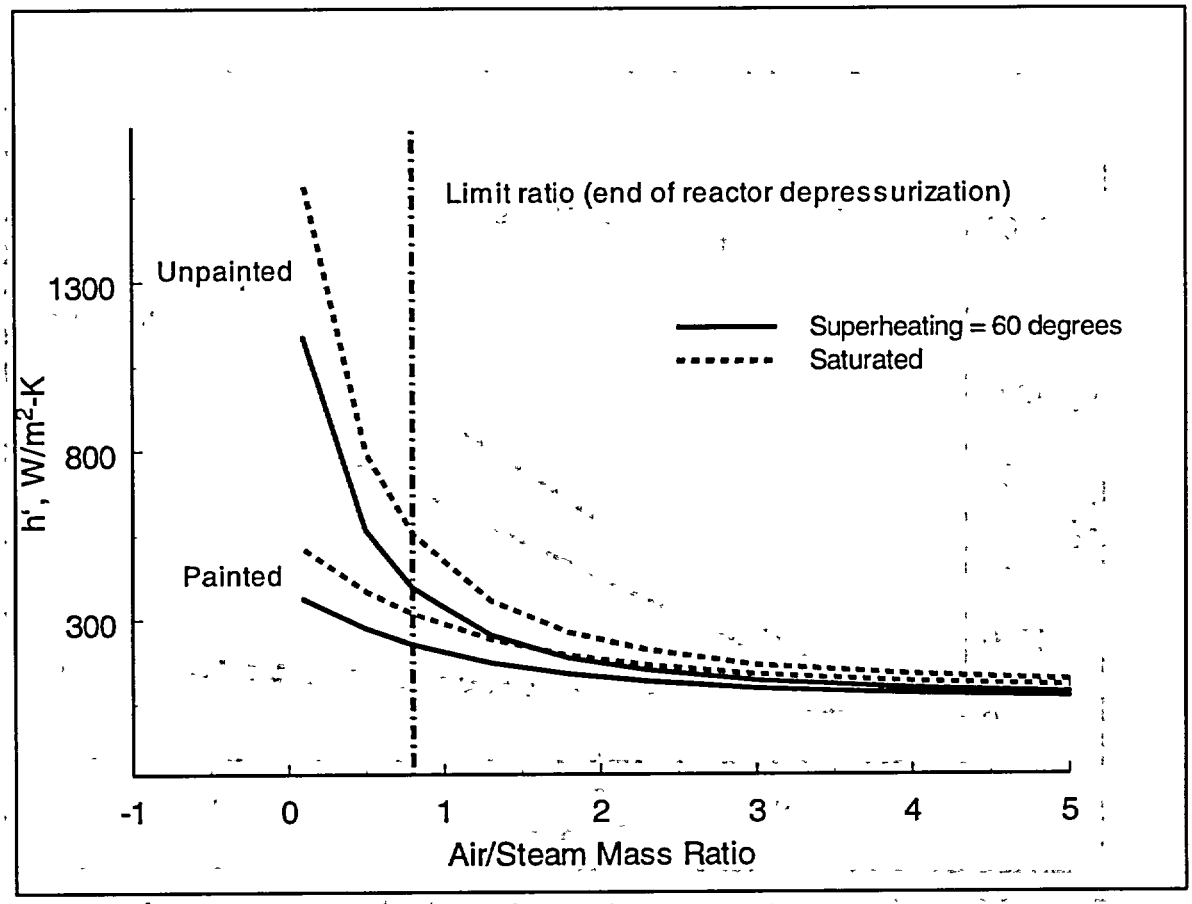

Figure F-4 Comparative curves for the Uchida heat transfer coefficient showing the affect of painting and superheating on the effective heat transfer coefficient. The curves are for a paint conductance of 750 W/m2-K, and atmosphere to wall surface temperature differential of 150 degrees.

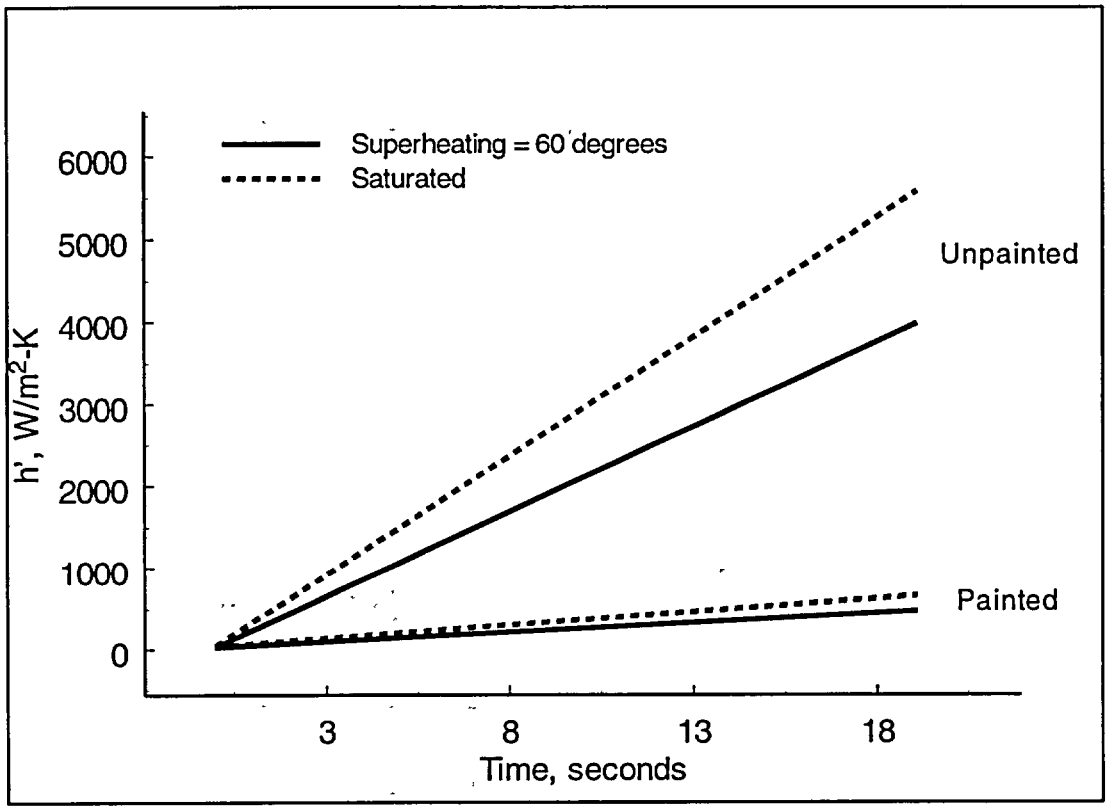

Figure F-5 Comparative curves for 4 X Tagami heat transfer coefficient showing the affect of painting and superheating on the effective heat transfer coefficient. The curves are for a paint conductance of 750 W/m2-K, and atmosphere to wall surface temperature differential of 150 degrees.

Appendix G

Post-processing CONTAIN results using the POSTCON Code

The POSTCON computer program is a post-processing code that can be used to process CONTAIN output that is written to the plot file, PLTFIL. A description of this program and its use is provided in Section 16 of the CONTAIN Code Manual.[1] In this appendix, we extend the discussion in the manual to methods the user can apply to derive rate quantities from two categories of vector output written to the plot file; incremental and cumulative data. In the case of the incremental data, the output quantity during a cell time-step (e.g., engineered safety systems, FLAG 810) can be converted to rate quantities by dividing the quantity by the "step-size" in the PMIX block section. However, there is no documented method for converting cumulative data to rate quantities. For these cases, the user may include a time derivative function into the POSTCON code to effect this conversion, as allowed for in the program coding and noted in the program documentation. In the following sections, guidance is provided on how to convert incremental and cumulative data to rate quantities in the framework of the POSTCON code.

G.1 Incremental data processing

Engineering safety system vapor and liquid mass and energy transferred during a cell time-step are obtained using the 810 flag in POSTCON. These incremental quantities may be converted to rate quantities by dividing the resulting vector quantities by the cell time-step. For example, we can determine the fan cooler vapor energy removal rate "qfan" using the POSTCON input:

```
...
340 && timestep
type=stepsize vector=dt endcurve
...
810
engname=fan type=envmssor vector=fenv endcurve
...
mix
vector qfan=fenv/dt
```

[1] K. K. Murata, et al., "Code Manual for CONTAIN 2.0: A Computer Code for Nuclear Reactor Containment Analysis," NUREG/CR-6533, SAND97-1735, December 1997.

G.2 Cumulative data processing

One type of post-processing that is of interest to a user of the CONTAIN code is the derivation of heat transfer coefficients from data written to the CONTAIN plot file. According to the POSTCON description (Chapter 16, CONTAIN 2.0 Code Manual), a user may modify function subroutines (operu, opervv, and opersv) to accommodate processing functions or expressions not included in the program. To enable the processing of structural heat transfer coefficients, the subroutine OPERU is modified to include a time derivative function operator, DIFV. This operator is used to obtain energy rates from the cumulative energy vectors processed with flag 611. Once the time derivative function is available, a heat transfer coefficient array may be formulated in the MIX block of the POSTCON input. The modifications to the OPERU function are shown in Section G.2.1. Additionally, the argument list for the OPERU subroutine must be modified to include the time vector, and the calling program DOMIX is therefore modified accordingly; modification to the DOMIX subroutine is also described in Section G.2.1. A sample input file for processing heat transfer coefficient data is given in Section G.2.2.

Note that in cases where the energy exchange between the structure and atmosphere is occurring as a result of condensation, primarily, the heat transfer coefficient may commonly be referred to as a condensation coefficient, or in the case of evaporation, as an evaporation coefficient. In these two examples, the coefficients are typically defined as follows:

$$h_{cond,evap} = \frac{q}{A*(T_{gas} - T_{surf})};$$

where

q = energy exchange rate at a structure surface -- this includes contributions from mass exchange (condensation/evaporation and aerosol deposition) and sensible heat transfer (convection, film advection, thermal radiation). These contributions are contained in the plot file cumulative energy quantity, QINNER or QOUTER – POSTCON flag 611;

A = structure surface area (must be included in an expression in the MIX block);

T_{gas} = atmospheric temperature – POSTCON flag 101; and,

T_{surf} = structure surface temperature – first surface node temperature obtained using POSTCON flag 610.

It is also possible to develop coefficients based on specific energy exchange types, that is, for convection, mass exchange, radiation, etc. using the POSTCON flag 613.

G.2.1 Addition of an Unary Function, DIFV

In the following subroutine listing, the additions to the subroutines are indicated by bold print. Subroutine "operu" is the user subroutine where the function DIFV is added. Subroutine "domix" is modified to include the additional time array that is required for calculating the time derivative. The derivative function is a simple backward difference for the vector elements greater than the first element. For the first element, the derivative is a simple forward difference formula. The user may select other difference schemes by changing the formulas coded in the "operu" subroutine.

Changes to the subroutine "operu" for adding time derivative function:

```
      subroutine operu(oper,xpts,ypts,numpts)
c
c     added time array xpts to argument list, jlt 12/9/98
c
cccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccc
c
c subroutine operu:  Performs a unary operation on a vector
c
cccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccc
CMP$ COMDECK /IMPLIC/ CALLED FROM M-OPERU.8
      implicit real (a-h,p-z)
      implicit integer (i-n)
      implicit character*8 (o)
c note: flag 100 is included in the mflcnt count but
c       it is not included in the ncflag or ndflag count
      parameter (mflcnt=110)
      parameter (ndflag=81)
      parameter (ncflag=28)
c
CMP$ END COMDECK /IMPLIC/
CMP$ COMDECK /TAPE/ CALLED FROM M-OPERU.9
c
c *** input and output device numbers ***
c
      common /tapei/ nin,nout,in,nerr,nvec,nmix,ntapes,ifnum,
     +          ina(7),jtimes(7),nzones,ltdel,ltend
      parameter (jitape=25)
      integer  itapes(jitape)
      equivalence (itapes(1),nin)
c
      common /tapec/ ofnam(4),opltnm(7)
```

```
      parameter (jctape=11)
      character*8 otapes(jctape),ofnam
      equivalence (otapes(1),ofnam(1))
c
      common /tapel/ rddbl,rdipd
      logical rddbl,rdipd
      parameter (jltape=2)
      logical  ltapes(jltape)
      equivalence (ltapes(1),rddbl)
c
CMP$ END COMDECK /TAPE/
      integer numpts
      character*8 oper,orout
      real xpts(1),ypts(1),dum(numpts)
      data orout/'operu'/
      if(oper.eq.'$difv')then
          do 10 i=1,numpts
            dum(i)=ypts(i)
10          continue
          do 15 i=1,numpts
            if(i.eq.1)then
             ypts(i)=(dum(i+1)-dum(i))/(xpts(i+1)-xpts(i))
            else
             ypts(i)=(dum(i)-dum(i-1))/(xpts(i)-xpts(i-1))
            endif
15          continue
      endif
c
c     write (nerr,1001) oper
c     call abrt1(orout)
      return
1001  format(1x,'>>>>> unary operator <',a8,'> not implemented')
      end
```

Changes to subroutine "domix" are as follows:

```
.
.
.
          addra = popi(vecstk,vecndx)
          if (addra .eq. irflag) then
             write(nerr,1005) ostrng
             succes = .false.
```

```
          goto 200
        end if
c       add xpts(1) to argument list (jlt, 12/9/98)
        call operu(ostrng,xpts(1),ypts(addra),numpts)
        call pushi(vecstk,vecnum,vecndx,addra)
      else
        write (nerr,1006) ostrng
        succes = .false.
        goto 200
      end if
```

G.2.2 Sample Input for POSTCON showing the input for processing heat transfer coefficient arrays

(Required input indicated in bold print)

```
control
double
maxsize=500 maxflg=50 maxcrv=300
maxmix=300
timeopt 0.0 0.0 1.0e6
eoi
101 && containment temperature
cell=1 vector=t1 endcurve
endflag
610 && first node temperature
cell=1 struc=dome node=1 vector=tdome endcurve
endflag
611 && structure cumulative energy
cell=1 struc=dome type=qinner vector=qdome endcurve
endflag
mix
&& heat transfer coefficient for "dome" structure, area=7399.3 m2
vector dq=$difv(qdome)
vector delt=t1-tdome
vector hdome=dq/(7399.3*delt)
eoi
eof
```