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INGEN: A COBRA-NC Input Generator User's Manual

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Operated by
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Commission

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ABSTRACT

The INGEN (INput GENerator) computer program has been developed as a preprocessor to simplify input generation for the COBRA-NC computer program. INGEN uses several empirical correlations and geometric assumptions to simplify the data input requirements for the COBRA-NC computer code. The simplified input scheme is obtained at the expense of much flexibility provided by COBRA-NC. For more complex problems requiring additional flexibility however, INGEN may be used to provide a skeletal input file to which the more detailed input may be added. This report describes the input requirements for INGEN and describes the algorithms and correlations used to generate the COBRA-NC input.

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SUMMARY

INGEN is a computer program that functions as an input generator for the COBRA-NC computer code. A relatively simple data input scheme is employed to describe a desired simulation. Several empirical correlations and geometric assumptions are then used to generate input for COBRA-NC.

The simplified data input scheme reduces the model flexibility provided by COBRA-NC and therefore INGEN is best suited to simple problems or when scoping calculations are required. INGEN may also be used to generate a skeletal COBRA-NC input deck which may be expanded using a text editor.

This report describes the input requirements for INGEN and presents the correlations and assumptions used in creating the COBRA-NC input. Also, several enhancements to the COBRA-NC code that were accomplished during the development of INGEN are described. Finally, a high energy line break analysis is presented as an example demonstrating the utility of INGEN,

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1.0 INTRODUCTION

The COBRA-NC computer program is under development at PNL to provide a tool for modeling the time varying properties of mixtures of steam and noncondensible gases (Thurgood 1968). The program may be used to predict energy and species distribution in a compartment during large or small steam line break accidents. The code provides a two-fluid, three-field representation of two-phase flow, treating each field in three dimensions using compressible flow equations. The three fields are continuous gas, continuous liquid and entrained liquid. The continuous gas field is composed of steam vapor and up to 10 species of noncondensible gases.

COBRA-NC solves the conservation equations for continuous gas, continuous liquid, and entrained liquid fields using a semi-implicit finite-difference numerical technique on an Eulerian field. The same numerical technique is used to calculate heat transfer from and within the solid structures in contact with the fluid. This code features extremely flexible noding for both the hydrodynamic and transport solutions. This flexibility enables modeling of the wide variety of geometries encountered at nuclear reactor facilities. The high degree of flexibility and the diverse types of problems which can be analyzed, requires a very detailed model specification in the COBRA-NC input.

A simplified input scheme may be appropriate, especially for models which contain only a few rooms or for which upper-bound scoping calculations are desired. To aid the user in setting up scoping calculations, an input generator called INGEN was written. The input to INGEN consists of a simplified description of the desired geometry, selection of a few desired options, and the specification of initial and boundary conditions. The INGEN routine fleshes out this skeletal input using general assumptions about volume and area relationships, defaulted wall thicknesses, and various correlations. It then produces an output file which may be used as a COBRA-NC input file. The output file generated by INGEN can be used directly by COBRA-NC, or, for problems in which the defaulted values used by INGEN are insufficient, the file generated by INGEN can serve as a foundation to which the more specific COBRA-NC input can be incorporated.

2.0 GENERAL CONSIDERATIONS AND DEFINITIONS

The input required by INGEN is much simpler than that of COBRA-NC. However, this simplification was gained by reducing the flexibility which exists in COBRA-NC. In this section the rules and assumptions which govern the conversion of INGEN input to COBRA-NC input are discussed.

2.1 GEOMETRY

Two general types of geometry are required as input into COBRA-NC, the hydrodynamic geometry and the heat transfer geometry, The hydrodynamic input for a COBRA-NC computational cell consists of a vertical flow channel with flow area AN, a wetted perimeter PW, and an axial height DX. These cells are connected in the transverse plane by gaps having a width GAPN and a height DX. For momentum purposes, the length of the connection between transverse cells is LENGTH. In addition, areas for axial momentum calculations, defined as ABOT and ATOP, may be specified when the area connecting cells in the vertical direction is different from the continuity cell flow area.

The geometry input to INGEN includes the number of floors to be modeled, NFLOOR; the height of each floor, DX; the area or volume of each cell, A; the cell wall perimeters, P; and the flow areas between cells, AP. Table 1 shows the corresponding variable definitions used in COBRA-NC and INGEN.

TABLE 1. COBRA-NC and INGEN Variable Definitions

Variable Definition	COBRA-NC	INGEN
Vertical Flow Area	AN(I)	A(I)
Wetted Perimeter	PW(I)	P(I)
Axial Height	DX(I)	DX(I)
Axial Momentum Area (Upper)	ATOP(K,I)	AP(K,I) [a]
Axial Momentum Area (Lower)	ABOT(K,I)	AP(K,I) [b]
Gap Width	GAP(I)	AP(K,I)/DX(I)
Transverse Momentum Length	LENGTH(I)	(P(J)+P(K))/8.0 [c]

(a) K^{th} junction at top of cell I

(b) K^{th} junction at bottom of cell I

(c) For gap I connecting cells J and K

2.1.1 Loss Coefficient

Loss coefficients and friction multipliers are also required input for COBRA-NC. For intra-room junctions, INGEN sets the local loss coefficient to zero. For room-to-room connections the loss coefficient is estimated using a curve fit of the thick-walled orifice curve of Idel'chik[(a)] (Idel'Chik, 1966). In making the estimation it is assumed that form losses dominate (i.e., friction losses may be ignored), that the walls between rooms are 2-ft thick, and that the hydraulic diameter may be approximated by

$$D_H = \left(\frac{4AP}{\pi}\right)^{1/2}$$

The correlating parameter used by Idel'chik to characterize the form loss coefficient is the ratio of orifice thickness to hydraulic diameter:

$$\zeta = f(L/D_H)$$

Idel'chik gives the local form loss coefficient in both tabular and graphical form. The analytical expression used in INGEN to approximate the tabular function is

$$\zeta = \alpha \; F1 \; (L/D_H) + (1-\alpha) \; F2 \; (L/D_H)$$

where

$$\alpha = \begin{matrix} 0.5 \\ 1.0 \end{matrix} \quad \text{when } L/D_H \quad \begin{matrix} \leq 1.3 \\ > 1.3 \end{matrix}$$

$$F1 = 2.204 - 0.44 \; \text{Tan}^{-1} \; (9.556((L/D_H) - 0.6656))$$

$$F2 = 2.826 - 0.943 \; L/D_H$$

Loss coefficients for both vertical and transverse junctions are calculated using this correlation. For connections in the transverse direction, a friction multiplier term, FWALL(K), may also be input to COBRA-NC. INGEN defaults this term to 2.0 for all room-to-room and intra-room connections. This value is most appropriate for rooms that are square in the transverse direction.

(a) Assumes rooms are square with no internal walls when estimating momentum length.

2.1.2 Wall Heat Transfer Model

COBRA-NC parameters pertinent to the wall heat transfer model are the wall thickness, the outside and inside perimeters, and a multiplication factor which can be used to modify the effective heat transfer surface area. The general assumptions used by INGEN are:

- The wall is adiabatic on the outside.
- There are two wall types per hydrodynamic cell. The first wall type represents concrete walls and has a thickness of 2 ft. The second represents steel components and has a thickness of 0.5 in.
- Each wall is homogeneous with respect to material type.

Since the outside surface is assumed to be adiabatic, the outside heated perimeter is set to zero. The inside heated perimeter is estimated by the following expression

$$HPERMI(I) = (2A(I) - \Sigma\ AP(I,K))/DX(L) + P(I)$$

The heated perimeter, therefore, is set equal to the cell wetted perimeter plus the floor and ceiling surfaces minus any flow passages. The properties assumed for the two wall types are given in Table 2.

TABLE 2. INGEN Default Wall Type

Property	Type 1	Type 2
Material	Concrete	Steel
C_p (Btu/lbm°F)	0.22	0.113
ρ (lbm/ft^3)	139	487
k(Btu/hr-ft-°F)	0.867	30
Thickness (ft)	2	0.0417

Multiplying factors are used to specify the fraction of the total wall area made up of each wall type. INGEN normally defaults the perimeter multiplying factor to 1.0 for the concrete walls and to 0.0 for steel walls. When the multiplier is 0.0, COBRA-NC input for the wall is not generated as the wall is assumed to be nonexistent. The use of the multiplying factor to add or delete walls from the model is discussed further in the input description.

2.2 INITIAL AND BOUNDARY SPECIFICATIONS

Initial conditions specifying cell values for pressure, vapor and liquid enthalpy, vapor and liquid void fraction, and the partial pressure and enthalpy of the air initially in the building are required by COBRA-NC. The input to INGEN is limited to total pressure, atmospheric temperature, and atmospheric relative humidity. For initialization purposes, it is assumed that the pressure is uniform throughout the building and that the air and vapor are in thermal equilibrium. The saturation pressure at atmospheric temperature is calculated using the correlation from the ASME 1967 steam table (ASME Steam Tables, 1967):

$$\beta_K(\theta) = \exp\left[\frac{1}{\theta}\,\frac{\sum_{v=1}^{5} k_v(1-\theta)^v}{1 + k_6(1-\theta) + k_7(1-\theta)^2} - \frac{(1-\theta)}{k_8(1-\theta)^2 + k_9}\right]$$

where $\beta = P_{sat}/3207.4$

P_{sat} = saturation pressure at T_{atm} (psia)

$\theta = T_{atm}(°K)/647.3$

k_1 = -7.691234564	k_6 = 4.167117320
k_2 = -2.608023696E+1	k_7 = 2.097506760E+1
k_3 = -1.681706546E+2	k_8 = 1.E+9
k_4 = 6.423285504E+1	k_9 = 6.
k_5 = -1.189646225E+2	

The pressure of the vapor is calculated from:

$$P_v = \max(0.11,\ P_{sat}*\Psi)$$

where Ψ = relative humidity of the atmosphere.

The initial liquid volume fraction in the building is assumed to be negligible, and is therefore set to

$$\alpha_L = 0.000001$$

The vapor and gas volume fraction are calculated using Amagat's law of additive volumes for an ideal gas and the definition of relative humidity. INGEN calculates these volume fractions from

$$a_v = \text{vapor volume fraction} = P_v/P_{atm}$$

$$a_g = \text{air volume fraction} = 1\text{-}a_v\text{-}a_L$$

Steam enthalpy, compatible with the values of relative humidity and temperature, is calculated using the correlation given by Keenan and Keyes (Keenan and Keyes 1936)

$$h = f(P,T)$$

$$= F_0(14.696P) + \frac{F_1}{2}(14.696P)^2 + \frac{F_3}{4}(14.696P)^4 + \frac{F_{12}}{13}(14.696P)^{13} + F'$$

F_0, F_1, F_3 and F_{12} are defined as follows.

$$F_k = \frac{\partial}{\partial\tau}(B_k\tau) \text{ , } k = 0,1,3,12$$

where:

$$\tau = 1.8/T$$

$$B_0 = 1.89 - 2641.62\ \tau\ 10^{80870\tau^2}$$

$$B_1 = B_0^2\ (82.546\tau^2 - 1.6246(10)^5\tau^3)$$

$$B_3 = B_0^4\ (0.21828\tau^3 - 1.2697(10)^5\tau^5)$$

$$B_{12} = -B_0^{13}\ (3.635(10)^{-4}\ \tau^{12} - 6.768(10)^{64}\ \tau^{36})$$

The function **F'** is given by

$$F' = \int_{491.69}^{T} C_{p_o}\,dT + 1075.90$$

with

$$C_{p_o} = 0.3516 + 1.0028(10)^{-4}T + 11.427\tau$$

T is in °R, P is in psia, h is in Btu/lbm, and C_{p_o} is in Btu/lbm°R

Values for superheated vapor temperature are computed as functions of pressure and enthalpy using an iterative method described by McClintock and Silvestri (McClintock and Silvestri 1968). First, estimates for T and C_p are estimated using

$$T = A_1 + A_2h + A_3h^2 + A_4h^3 + A_5P + A_6P^2$$

$$+ A_7P^3 + P(A_8h + A_9h^2 + A_{10}h^3)$$

$$1/C_p = B_1 + B_2h + B_3h^2 + B_4h^3 + B_5 \ln P + B_6(\ln P)^2$$

$$+ B_7(\ln P)^3 + (\ln P)\ (B_8h + B_9h^2 + B_{10}h^3)$$

where T is in °F, P is in psia, h is in Btu/lbm, and C_p is in Btu/lbm-°F. When $P \leq 1000$ psia, or $P > 1000$ psia and $h \geq 1280$ Btu/lbm, the constants are

A_1 = -1.0659659E+4

A_2 = 2.0110905E+1

A_3 = -1.250954E-2

A_4 = 2.8274992E-6

A_5 = 4.9815820

A_6 = -7.7618225E-6

A_7 = 2.4391612E-10

A_8 = -9.8147341E-3

A_9 = 6.5824890E-6

A_{10} = -1.4749938E-9

$B_1 = -2.8557816$	$B_6 = -3.6261637E-2$
$B_2 = 1.3250230E-2$	$B_7 = 7.3529479E-4$
$B_3 = -1.0521514E-5$	$B_8 = 5.7703098E-3$
$B_4 = 2.5007955E-9$	$B_9 = -2.9972073E-6$
$B_5 = -3.4620214$	$B_{10} = 5.2037300E-10$

When $P > 1000$ psia and $h < 1280$ Btu/lbm, the constants are given by

$A_1 = -4.5298646E+3$	$A_6 = -9.1654905E-6$
$A_2 = 1.5358850E+1$	$A_7 = 2.7549766E-10$
$A_3 = -1.5655537E-2$	$A_8 = -1.1541553E-3$
$A_4 = 5.2687849E-6$	$A_9 = 1.2384560E-6$
$A_5 = 4.4185386E-10$	$A_{10} = -4.1724604E-10$
$B_1 = 1.2659960E+2$	$B_6 = 1.3424036$
$B_2 = -2.5611614E-1$	$B_7 = -4.9110372E-2$
$B_3 = 2.2270593E-4$	$B_8 = 2.7966370E-2$
$B_4 = -5.9928922E-8$	$B_9 = -2.4665012E-5$
$B_5 = -2.1818030E+1$	$B_{10} = 6.7723080E-9$

The estimated temperature is then used to compute an approximate enthalpy from

$$h' = f(P,T)$$

where the function $f(P,T)$ is that of Keenan and Keyes given above. Next, a temperature correction, AT, is computed from

$$AT = (1/C_p)\,(h - h')$$

and the new estimated temperature becomes

$$T' = T + \Delta T$$

A new approximate enthalpy, h", is computed using this temperature in the function $h = f(P,T)$ and the iteration is continued until $(h - h") < 0.5$ Btu/lbm. Iteration is not used in the specific heat calculation. The C_p value given previously is taken as the final value.

Liquid and vapor specific volumes as functions of pressure and enthalpy are computed using equations from Agee (1977). For the vapor

$$v = E_1 + E_2 P + E_3/P + E_4 h + E_5 Ph + E_6 h/P$$

and for the liquid

$$v = \exp\left\{\sum_{k=0}^{4}\sum_{n=0}^{2} C_{k,n} P^n h^k\right\}$$

where P is in psia, h is in Btu/lbm, and v is in ft^3/lbm. The constants for these equations are

E_1 = -0.81735849E-3	E_4 = -0.62941689E-5
E_2 = 0.12378514E-4	E_5 = -0.87292160E-8
E_3 = -0.10339904E+4	E_6 = 0.12460225E+1

$C_{0,0}$ = -0.41345E+1	$C_{0,1}$ = -0.59428E-5	$C_{0,2}$ = 0.15681E-8
$C_{1,0}$ = 0.13252E-4	$C_{1,1}$ = 0.63377E-7	$C_{1,2}$ = -0.40711E-10
$C_{2,0}$ = 0.15812E-5	$C_{2,1}$ = -0.39974E-9	$C_{2,2}$ = 0.25401E-12
$C_{3,0}$ = -0.21959E-8	$C_{3,1}$ = 0.69391E-12	$C_{3,2}$ = -0.52372E-15
$C_{4,0}$ = 0.21683E-11	$C_{4,1}$ = -0.36159E-15	$C_{4,2}$ = 0.32503E-18

Saturation enthalpies are calculated using EPRI curve fits (McFadden et al. 1980) defined by the following function:

$$h_f = \begin{cases} \sum_{i=0}^{8} a_1 \, (\ln(P))^i & \text{if } 0.1 < P \leq 950 \text{ psia} \\ \sum_{i=0}^{8} a_2 \, (\ln(P))^i & \text{if } 950 < P \leq 2550 \\ \sum_{i=0}^{8} a_3((P_{crit}-P)^{.41})^i & \text{if } 2550 < P \leq P_{cri} \end{cases}$$

and

$$h_g = \begin{cases} \sum_{i=0}^{11} b_1(\ln(P))^i & \text{if } 0.1 < P \leq 1500 \text{ psia} \\ \sum_{i=0}^{8} b_2 \, (\ln(P))^i & \text{if } 1500 < P \leq 2650 \\ \sum_{i=0}^{6} b_3 \, ((P_{crit}-P)^{.41})^i & \text{if } 2650 < P \leq P_{crit} \end{cases}$$

The coefficients for the saturation enthalpy equations are:

i	a_1	a_2	a_3
0	.6970887859 E+2	.8408618802 E+6	.9070030436 E+3
1	.3337529994 E+2	.3637413208 E+6	-.1426813520 E+2
2	.2318240735 E+1	-.4634506669 E+6	.1522233257 E+1
3	.1840599513 E+0	.1130306339 E+6	-.6973992961 E+0
4	-.5245502284 E-2	-.4350217298 E+3	.1743091663 E+0
5	.2878007027 E-2	-.3898988188 E+4	-.2319717696 E-1
6	.1753652324 E-2	.6697399434 E+3	.1694019149 E-2
7	-.4334859629 E-3	-.4730726377 E+2	-.6454771710 E-4
8	.3325699282 E-4	.1265125057 E+1	.1003003098 E-5

i	b_1	b_2	b_3
0	.1105836875 E+4	-.2234264997 E+7	.9059978254 E+3
1	.1436943768 E+2	.1231247634 E+7	.5561957539 E+1
2	.8018288621 E+0	-.1978847871 E+6	.3434189609 E+1
3	.1617232913 E-1	.1859988044 E+2	-.6406390628 E+0
4	-.1501147505 E-2	-.2765701318 E+1	.5918579484 E-1
5	.0000000000 E+0	.1036033878 E+4	-.2725378570 E-2
6	.0000000000 E+0	-.2143423131 E+3	.5006336938 E-4
7	.0000000000 E+0	.1690507762 E+2	
8	.0000000000 E+0	-.4864322134 E+0	
9	-.1237675562 E-4		
10	.3004773304 E-5		
11	-.2062390734 E-6		

Air enthalpy is calculated assuming constant specific heat, from

$$h_{air} = 126.66 + 24 * (T_{atm} - 70.3) \text{ [Btu/lbm]}$$

COBRA-NC requires a reference pressure for the top cell of the model. A gravitational head based on the total height of the system being modeled is calculated by INGEN. This pressure head is subtracted from the initial pressure specified for INGEN to give the desired COBRA-NC reference pressure. This calculation affects only the value of the reference pressure as input to COBRA and is transparent to the user when he specifies the desired initial pressure in the INGEN input.

3.0 INGEN INPUT INSTRUCTIONS

This section describes the format and content of the INGEN input. An asterisk, "*", following the format specification indicates the card is required in the input stream and a double asterisk, "**", indicates the card is required but may be blank. If there is no asterisk following the format specification the card may be omitted.

1. Title Card: Format (17A4)**

Columns	Variable	Description
1-64	TITLE	Alphanumeric job title

2. Operation Parameter Card: Format (2110, F10.3)

Columns	Variable	Description
1-10	NBOUND	Number of boundary specifications to be supplied. Each boundary specification defines a location where flow enters or leaves the calculation domain. Inflow from pipe breaks and vents to the atmosphere require boundary specifications.
11-20	MCRIT	Critical flow parameter. Valid entries are: Blank = no critical flow calculation 1 = Moody critical flow model 2 = Henry-Fauske subcooled (extended) model 3 = Henry-Fauske (original) model
21-30	TOTTRN	Total simulation time for transient (sec)

3. Restart Data: Format (110, F10.3)**

Columns	Variable	Description
1-10	IDSTEP	Time step number of dump to be used for restarting.
10-20	TIMET	Restart time for problem (seconds).

For normal runs (no restart) Card 3 is input as a blank card.

4. Containment Initialization Card: Format (3F10.2)**

Columns	Variable	Description
0-10	PATM	Initial pressure in containment building (psia).
11-20	TATM	Initial temperature in containment building (°F)
21-30	RHUMID	Initial relative humidity

The above variables will take on default values of 14.696 psia, 92°F, and 0.5 respectively if their field is left blank. A blank card must be supplied if default values are desired.

5. Geometry Input Group

5a. Format (3I10)*

Columns	Variable	Description
1-10	NFLOOR	Number of floors to be modeled.
11-20	NCRITC	Number of axial junctions to be checked for critical flow
21-30	NCRITK	Number of transverse junctions to be checked for critical flow

Cards 5b and 5c are read in sets. Card 5b is read NFLOOR times (where NFLOOR is specified on card 5a) and each card 5b is immediately followed by NCELL(L) of card 5c (where NCELL(L) is specified on card 5b).

5b. Format (110, F10.3,2I10)*

Columns	Variable	Description
1-10	NCELL(L)	Number of cells on Lth floor.
11-20	DX(L)	Height of Lth floor (ft).
21-30	NODESF(L)	Number of axial nodes on the Lth floor
31-40	IAORV	Flag to select volume or input to variable A(I) of card 5c. If IAORV is not blank (or zero) then when reading card 5c the cell area will be set to A(I)/DX.

5c. Format (I5,2F5.0,6(I5,F5.0))*

Columns	Variable	Description
1-5	I	Cell designation number
6-10	A(I)	Floor area of cell (ft^2), or cell volume (ft^3), if depending on flag IAORV of card 5b.
11-15	P(I)	Perimeter of cell wall (ft) will default to 4* $\sqrt{\text{cell floor area}}$ if blank.
16-20	JC(K,I)	Designation number of cell connected to cell I. Only cells having designation numbers greater than I are input. A negative JC(K,I) indicates that local loss coefficients should not be computed for the connection defined by JC(K,I). This would be used typically when the connection is an intra-room connection. The number of connections is limited to six.
21-25	AP(K,I)	Flow area of junction connecting cells I and JC(K,I) (ft^2).

If NCRITC >0 then card 5d is read NCRITC times (where NCRITC is specified on card 5a), otherwise card 5d is omitted from the input stream.

5d. Format (2I5)

Columns	Variable	Description
1-5	ICRIT(1,L)	Enter the cell number of either cell connected by the Lth axial junction.
6-10	TORB	Enter a zero (or blank) if the junction is at the bottom of the cell. Enter a 1 if it is at the top of the cell.

If NCRITK >0 then card 5e is read NCRITK times (where NCRITK is specified on card 5a), otherwise it is omitted from the input stream.

5e. Format (2I5)

Columns	Variable	Description
1-5	KCRIT(1,L)	Enter the cell number of the lower-numbered cell connected by the Lth transverse junction.
6-10	KCRIT(2,L)	Enter the cell number of the higher-numbered cell connected by the Lth transverse junction.

6. Wall Conduction Input

INGEN generates a wall heat transfer surface area for each cell (I) which is defined by

$$AS(I) = P(I)*DX(L) + 2\,A(I) - \sum_{k=1}^{Np} AP(K,I)$$

where

AS(I) is the wall surface area (ft^2)

P(I), A(I), and AP(K,I) are defined by card 5c

DX(L) is defined by card 5b

Np is the number of junctions in cell I.

The heated perimeter of each cell is defined as

HPERIMI(I) = AS(I)/DX(L) (ft)

Two walls, each having the heated perimeter as defined above, are generated for each cell. The first is assigned properties and dimensions which are representative of concrete walls. The default properties for concrete walls are:

Density	= 139 lbm/ft^3
Specific heat	= 0.22 Btu/lbm °F
Thermal conductivity	= 0.867 Btu/hr- ft°F
Wall thickness	= 2 ft

The second is assigned properties representative of steel panels. The default properties for steel walls are:

Density	= 487 lbm/ft^3
Specific heat	= 0.113 Btu/lbm-°F
Thermal conductivity	= 30 Btu/hr-ft-°F
Wall thickness	= 0.5 in.

The concrete wall is assigned a wall number designation equal to the cell number and the steel wall is assigned a wall number equal to the cell number plus the total number of cells, The fraction of each wall allowed to interact with the cell is specified by RMULS(I). RMULS for the concrete wall is defaulted to 1, while RMULS for the steel wall is defaulted to 0.

This assignment is valid only at the time of input. If walls are deleted or added in the wall conduction input card group, then the wall numbers are automatically reassigned such that the wall numbers run sequentially from 1 to the total number of walls.

The input in the following section consists of information which modifies the default values discussed above.

6a. Format (I10)**

Columns	Variable	Description
1-10	NMOD	Number of walls for which the heated perimeter, interaction fraction, or thickness is to be modified. If no modifications are desired a blank card must be supplied.

6b. Format (I10,3F10.3)

Columns	Variable	Description
1-10	N	Wall designatipn number of cell which is to have its heated perimeter, multiplier, or thickness modified.
11-20	HPERIMI(N)	New heated perimeter (ft). If HPERIMI(N) is input as zero then it is set to the default value as calculated above.
21-30	RMULS(N)	Fraction of wall surface which is allowed to interact with the cell adjacent to it. RMULS(N) must be defined; a value of zero would be specified to remove a defaulted wall from the COBRA-NC input.
31-40	DIN(N)	Thickness of the modified wall in feet, If no value is specified, DIN(N) defaults to 2 ft for the concrete wall and 0.5 in, (0.0417 ft) for the steel wall.

If NMOD is greater then 0 then NMOD cards of the type 6b must be supplied.

7. Boundary Specification Group

NBOUND card sets are required. NBOUND was previously specified on the operation parameter card.

7a. Format (2I10,4F10.0)*

Columns	Variable	Description
1-10	IBOUND(J)	The cell number to which this boundary is applied.
11-20	ISPEC(J)	Boundary specification type. Valid options are: 1 = pressure and enthalpy 2 = flow and enthalpy 3 = flow only 4 = mass source 5 = pressure sink and enthalpy See COBRA input instructions for complete discussion of these options.
21-30	XVALUE(J)	Boundary pressure (psia)
31-40	ASINK(J)	The flow area through which the flow defined by the boundary specification enters the cell (ft^2). This value is required for all pressure boundary specifications. It is also required if the local loss coefficient is to be defaulted.
41-50	SSINK(J)	Local flow loss coefficient (dimensionless) at the boundary. If blank, the code calculates a value using Idel'Chik (Idel'Chik, 1966) and the specified cell flow area (ASINK).
51-60	DXSINK	Length of the momentum control volume for the sink. This variable is needed for a type 5 specification; however, if blank a value equal to $\sqrt{(A(I))}$ will be supplied.

7b. Format (3I10)**

This card specifies the number of points to be supplied for the time-varying boundary specification table and the wall condensation heat transfer time-varying multiplication factor. Three values are supplied. If the boundary type is either 1 or 5, the first value is the number of pressure-time coordinates specified in the table. If the boundary type is 2, 3, or 4, this first value is the number of flow rate-time coordinates specified in the table. The second value is the number of enthalpy-time coordinates to be supplied. If either or both of these values is zero, then that particular boundary specification will remain constant in time. The third value specifies the number of points (pairs of values) to be applied as a time-varying multiplicative factor for modeling the wall condensation heat transfer coefficient.

Columns	Variable	Description
1-10	NPTS1	Number of points (pairs of values) in the pressure or flow forcing function table.
11-20	NPTS2	Number of points (pairs of values) in the enthalpy forcing function table.
21-30	NPHTCF	Number of points (pairs of values) in the condensation heat transfer coefficient modifier table. A maximum of 40 points may be specified. The wall condensation heat transfer coefficient is calculated using the Uchida correlation (Second Austrilian Heat Conference, 1977)

The card (7b) must be included as a blank card if no tables are to be input.

7c. Flow or Pressure Specifications Table

Two options are available in this group. If NPTS1 is zero or blank then only a single value of flow or pressure is input.

Format (F10.2)**

Columns	Variable	Description
1-10	PVALUE(J)	Either boundary pressure (psia) or flow rate (lbm/sec), whichever is called for by 7a.

If NPTS1 is not zero or blank, then a tabular forcing function containing NPTS1 pairs of points is supplied.

Format (5(F5.0,F10.0))**

Columns	Variable	Description
1-5,16-20 etc.	ABSCIS(K,J)	Enter the time, in seconds, at which to apply the factor.
6-15,21-30 etc.	ORDINT(K,J)	Enter the forcing pressure or flow rate to be applied at time ABSCIS(K,J) (psia or lbm/sec).

7d. Enthalpy Specification

As above, two options are available. If NPTS2 is 0 or blank, only a single value of boundary enthalpy is input.

Format (F10.2)**

Columns	Variable	Description
1-10	HVALUE(J)	Constant boundary cell enthalpy Btu/lbm.

If NPTS2 is greater than 0, then a tabular forcing function containing NPTS2 pair of points is supplied.

Format (5(F5.0,F10.0))**

Columns	Variable	Description
1-5,16-20 etc.	ABSCIS(K,J)	Enter the time, in seconds, at which to apply the enthalpy.
6-15,21-30 etc.	ORDINT(K,J)	Enter the forcing enthalpy to be applied at time ABSCIS(K,J) (Btu/lb).

Cards 7a, 7b, 7c, and 7d are required for each boundary from which flow enters or leaves the computational region. Each boundary is completely specified before information concerning other boundaries is input. When the boundary is a pressure type boundary and the pressure is specified by XVALUE on card 7a, card 7c may be left blank for the constant pressure option. In addition, if the flow is always out of the system then 7d may also be left blank. The boundary specification is limited to two specifications per cell. If more boundary conditions are required to define the physical problems, then the cell may be divided into more than one cell.

7e. Wall Heat Transfer Specification Table

If NPHTCF is blank or zero card group 7e is omitted from the input stream. If NPHTCF is nonzero then a tabular forcing function is supplied. This card is supplied after all boundary specifications have been input.

Format (5(F5.0,F10.0)).

Columns	Variable	Description
1-5,16-20 etc.	ABSCIS(K,J)	Enter the time, in seconds, at which to apply the wall heat transfer multiplier.
6-15,21-30 etc.	ORDINT(K,J)	Enter the wall heat transfer multiplier to be applied at time ABSCIS(K,J) (dimensionless).

8. Output Information

This card is required, but if the standard printed output of all cells is desired, then it may be blank. The standard output consists of a description of the input and the calculated cell pressure, temperature, relative humidity, and liquid volume fraction as functions of time. This information is printed for all output options.

8a. Format (5I10)**

Columns	Variable	Description
1-10	N1	Enter the general vessel output option. Valid entries are: 1 = print cells only 2 = print cells and junctions only 3 = print walls only 4 = print walls and cells only 5 = print cells, junctions, and walls (This entry applies to the microfiche COBRA output only)
11-20	NOUT1	Enter the number of cells to be printed (used if N1=1, 2, or 5). If NOUT1 = 0, all channel will be printed. If NOUT1 > 0, an array of channels numbers will be entered on card 8b.
21-30	NOUT4	Enter number of walls to be printed (used if N1 ≥ 3). If NOUT4 = 0, all walls will be printed. If NOUT4 > 0, an array of wall numbers to be printed will be entered on card 8c.
31-40	NCGRAF	Graphics dump option. If NCGRAF is zero then no plot file will be generated. If NCGRAF is > 0 then the standard COBRA-NC files for generating graphs of pressure, relative humidity, and temperature will be produced for the cells specified by the NOUT1 option.

Columns	Variable	Description
41-50	MFICHE	Option for printing complete COBRA output to microfiche. If MFICHE > 0 then the comlete output is printed on microfiche. This includes all of the output described in the COBRA User's Manual (Thurgood 1986).

8b. Format (1215)

Omit card 8b if NOUT1=0

Columns	Variable	Description
1-5,. ..	PRINTC(I)	Enter the index numbers of channels to be printed. Twelve (12) values are entered per card, Repeat this card until NOUT1 values have been entered.

8c. Format (1215)

Omit Card 8c if NOUT4 = 0.

Columns	Variable	Description
1-5, ...	PRINTS(I)	Enter the index numbers of walls to be printed. Twelve (12) values are entered per card. Repeat this card until NOUT4 values have been entered.

4.0 COBRA MODIFICATIONS

The COBRA-NC code has been modified to provide more useful output as requested by the Nuclear Regulatory Commission's Auxiliary Systems Branch (NRC/ASB). An interim version of the code was created, designated COBRA-NC/ASB, which included the modifications described in this section. These changes have since been incorporated into Cycle 15 of COBRA-NC. In the following discussion it is assumed that the reader is familiar with COBRA-NC input definitions (Thurgood 1986).

4.1 GENERAL DESCRIPTION OF COBRA-NC MODIFICATIONS

The following modifications to the COBRA-NC code were made to meet specific needs of the NRC/ASB:

- If English units are to be used in the input, feet, rather than inches, may be selected for the basic length unit.

- The output edit option definitions were changed such that the complete COBRA-NC output which was printed may now be output to a computer file every EDINT seconds.

- A new printed output option was added which prints cell values of pressure, vapor temperature, relative humidity, and cell liquid volume fraction at user-specified intervals.

- A choked flow option was added which limits flow rate at pressure boundaries and internal junctions.

Each of the above modifications is discussed further in the following sections.

The edit options generated by INGEN are prescripted, and except for the total running time and the option of outputting microfiche, the user has no control over the generated edit options. However, should these hardwired options be unacceptable then the user may edit the INGEN output file before submitting it as COBRA-NC input.

The generated edit and time domain output consists of four time domains. The first is an initialization regime extending 0.1 sec into the simulation. During this regime the maximum time step is set to 0.001 sec and the print interval is set to 0.02 sec. The second time regime extends through the first second of the simulation, This domain sets a maximum time step of 0.05 sec and a print interval of 0.1 sec. The third regime extends 100 sec into the simulation or to the end of the simulation, whichever comes first. The maximum time step in this regime is 1.0 sec and the print interval is 1.0 sec. The final regime extends to the end of the simulation with a maximum time step of 1.0 sec and a print interval of 10.0 sec.

When microfiche output is desired, MFICHE is input with a value greater than 0. The dump interval to the microfiche file is then set to 1.0 sec by INGEN. Likewise, when NCGRAF is greater than zero, all pressure, temperature, relative humidity, and liquid volume fractions are saved on file 'tape11' at each dump interval. Since plots are not drawn as part of the COBRA-NC run, tape11 must be saved after the completion of COBRA-NC execution. Plots can then be generated by running a separate plotting routine.

Another major change to COBRA-NC is the modification of the wall condensation heat transfer package. The existing correlations were removed and replaced with the Uchida (Second Austrilian Heat Conference, 1977) correlation in the following form,

$$H = MIN(280, 79.33*(\rho_{vap}/\rho_{air})^{.8}*f_1)$$

where H = condensation heat transfer coefficient (Btu/hr-ft^2-°F)
ρ_{vap} = steam density (lbm/ft^3)
ρ_{air} = air density (lbm/ft^3)
f_1 = user input time varying multiplication factor

At the present time there is a large uncertainty in estimating condensation heat transfer. The above expression is known to be incomplete in that the heat transfer coefficient should also contain local temperature and velocity effects. However, since work is currently underway at PNL and other institutions throughout the world to develop universal condensation heat transfer coefficients, it is recommended that for the interim the multiplication factor f_1 be set in the range 1-3 for small breaks, and 3-6 for large breaks during blowdown, and set to 1 after blowdown for both large and small breaks. To perform a conservative analysis, f_1 should be set equal to 1.

The final modification to COBRA-NC is the addition of a choked flow model. The approach taken is the historic approach where correlations are used to calculate limiting flow rates. Three different correlations are available in tabular form; they are Moody, Henry-Fauske and Henry-Fauske subcooled. The tabular form of these correlations were taken from a code listing of RELAP 4 (Moore and Rettig 1975). Once a model is chosen it must be used until the problem is finished or until it is dumped and then restarted. The calculation is implemented by checking the flow calculated by COBRA-NC against that calculated with the chosen model.

When making the critical flow calculation it is assumed that the enthalpy of the upstream continuity cell is the stagnation enthalpy. This assumption is valid for containment geometries where rooms are large compared to connecting flow areas. If the calculated critical flow is less than the tentative flow, then the tentative flow is set to the critical value and the local derivatives of flow with respect to pressure are set to zero. The relative distributions of vapor and liquid flows will not necessarily be the same for the tentative and critical flow calculations. The most consistent approach is to define the vapor-liquid distribution consistently with the assumption used in development of the critical flow model. Therefore, when the critical flow rate is used, **it** is assumed that the continuous liquid and droplet fields have the same velocity and that the slip ratio between vapor and liquid is defined to be:

$S = (\rho_f/\rho_g)^{1/3}$ for Moody model
$S = 1.6$ for Henry-Fauske model (original and subcooled)

where $S = V_g/V_f$

V_g = vapor velocity
V_f = liquid velocity
ρ_f = liquid density
ρ_g = density of vapor and gas combined.

The expanded capabilities of cycle 15 of COBRA-NC have resulted in some modification to the COBRA-NC input instructions (Thurgood 1986). The input cards that have been added or modified are listed in Table 3.

TABLE 3. COBRA-NC Input Cards that Require Modification to Input Instructions

Card	Disposition
INPUT. 1	Modify input instructions
CARD1.l	Modify input instructions
CARD13.1	Modify input instructions
CARD13.10	Add to input instructions
CARD13.11	Add to input instructions
CARD14.1	Modify input instructions
TIME. 1B	Add to input instructions

The input instructions for card INPUT.l is replaced by:

INPUT.l: ICOBRA,IAPENK,ENGUNI FORMAT (3114)

Columns	Variable	Description
1-14	ICOBRA	Enter input units option: 0 = use English units (default) 1 = use metric units; code will convert the data to English units.
15-28	IAPENK	Leave blank.
29-42	ENGUNI	For English units only, enter the number of inches to use for the basic length unit, i.e., enter 12 if input data is to have feet as the basic unit of length. The default value of ENGUNI is 1.

The input instructions for card CARD1.l is replaced by:

CARD1.l: NGROUP, NGAS, IREF, NTGAS, NAL, NHF, NLE, NZS,MCRIT FORMAT (915)

Columns	Variable	Description
1-5	NGROUP	Enter one (1).
6-10	NGAS	Enter the total number of noncondensable gas species to be used in the calculation.
11-15	IREF	Flag to specify if a uniform initial gas or if a uniform initial steam pressure is to be assumed. Enter 0 if a uniform initial steam pressure is desired. Enter 1 if a uniform initial gas pressure is desired.
16-20	NTGAS	Enter the number of initial gas temperature tables to be read.
21-25	NAL	Enter the number of initial liquid volume fraction tables to be read.
26-30	NHF	Enter the number of fluid heat flux tables to be read.
31-35	NLE	Enter the number of initial liquid enthalpy tables to be read.

Columns	Variable	Description
36-40	NZS	Enter the number of slab zero heat flux tables to be read.
41-45	MCRIT	If critical flow calculations are to be performed input a 1. Otherwise enter a 0, or leave blank.

The input instructions for card CARD13.1 is replaced by:

CARD13.1 NGROUP,NIBND,NKBND,NFUNCT,NGBND,ICONVB,NCRITC I T FORMAT(8I5)

Columns	Variable	Description
1-5	NGROUP	Enter thirteen (13).
6-10	NIBND	Enter the total number of vertical mesh cell boundary conditions.
11-15	NKBND	Enter the total number of transverse momentum cells for which crossflow will be set to zero.
16-20	NFUNCT	Enter the number of forcing functions for the boundary conditions,
21-25	NGBND	Enter the number of groups of contiguous transverse momentum tells for which crossflows will be set to zero.
26-30	ICONVB	Momentum convection flag for type 1 boundary conditions specified on CARD13.4, If INCONVB=0 convect zero momentum into mesh. If INCOVB>0 convect downstream momentum into mesh.
31-35	NCRITC	Enter the number of axial junctions to be checked for critical flow.
36-40	NCRITK	Enter the number of transverse junctions to be checked for critical flow.

Add new card to input instructions as follows:

CARD13.10 is read NCRITC times.

CARD13.10 ICRIT(1,L),ICRIT(2,L) FORMAT(2I5)

Columns	Variable	Description
1-5	ICRIT(1,L)	Enter the channel number of channel with axial junction to be checked for critical flow.

Columns	Variable	Description
6-10	ICRIT(2,L)	Enter the vertical node with the axial junction to be checked for critical flow. (Note: if the junction is at the bottom of the channel enter a 1, if it is at the top of the channel enter 1 plus the number of vertical levels in the section containing channel ICRIT(1,L).

Add new card to input instructions as follows:

CARD13.11 is read NCRITK times.

CARD13.11 KCRIT(1,L),KCRIT(2,L) FORMAT(2I5)

Columns	Variable	Description
1-5	KCRIT(1,L)	Enter the identification number of the lower-numbered channel of the pair connected by the transverse junction to be checked for critical flow.
6-10	KCRIT(2,L)	Enter the identification number of the higher-numbered channel of the pair connected by the transverse junction to be checked for critical flow.

The input instructions for CARD14.1 is replaced by:

CARD14.1 NGROUP, N1,NOUT1,NOUT2,NOUT3,NOUT4,IPROPP, IOPT,ASBINT FORMAT(9I5)

Columns	Variable	Description
1-5	NGROUP	Enter fourteen (14).
6-10	N1	Enter the general output option. Valid entries are: 1 = print channels only 2 = print channels and gaps only 3 = print thermal conductors only 4 = print thermal conductors and channels only 5 = print channels, gaps, and thermal conductors

Columns	Variable	Description
11-15	NOUT1	Enter the number of channels to be printed (used if N1 = 1, 2, 4, or 5) If NOUT1 = 0, all channels will be printed. If NOUT1 > 0, an array of NOUT1 channel numbers must be entered on CARD14.2.
16-20	NOUT2	Leave blank.
21-25	NOUT3	Enter the number of gaps to be printed (used if N1 = 2 or 5). If NOUT3 = 0, all gaps will be printed. If NOUT3 > 0, an array of NOUT3 gap numbers must be entered on CARD14.3.
26-30	NOUT4	Enter the number of thermal conductor to be printed (used if N1 > 2). If NOUT4 = 0, all unheated conductors will be printed. If NOUT4 > 0, an array of NOUT4 thermal conductor numbers must be entered on CARD14.5.
31-35	IPROPP	Enter the property table print option. Valid entries: 0 = do not print the property table 1 = print the property table
36-40	IOPT	Enter the debug print option, Valid entries are: 0 = normal printout only 1 = debug printout (print extra data for channels, conductors, and gaps)
41-45	ASBINT	Flag to specify abbreviated output option. IF ASBINT > 0 abbreviated output selected.

Add new card to input instructions as follows:

Card TIME.1B is read only if ASBINT > 0 on card CARD14.1.

TIME. 1B ASBINT FORMAT(F14.6)

Columns	Variable	Description
1-14	ASBINT	Enter the print interval for abbreviated output (sec).

5.0 SAMPLE PROBLEM

The INGEN input generator was used to create COBRA-NC input for an analysis of a high energy steam line break (HELB) at a typical nuclear generator station. The steam line break that was modeled and the resulting INGEN input and output are described below.

5.1 STEAM LINE BREAK MODEL

The HELB scenario modeled involves the rupture of a high pressure pipe carrying saturated steam. The postulated pipe rupture occurs in the high pressure injection (HPI) pump room (Room 053) which has the following initial conditions:

Initial Pressure	14.7 psia
Initial Temperature	90°F
Initial Relative Humidity	50%

The steam escaping from the pipe has a temperature of 590°F and a pressure of 925 psia. The mass flow rate and enthalpy content of the escaping steam were defined to be as shown in Table 4.

The dimensional data for the rooms connected to the HPI pump room, including a description of the junctions between rooms is typical. A noding diagram for this model is shown in Figure 1.

This model consists of 18 computational cells with 12 lateral and 6 vertical junctions. The cell volumes are given in Table 5 and the junction flow areas are given in Table 6.

INGEN Input

A copy of the INGEN input for this model is shown in Figure 2. Note that the line numbers to the left of the input data are not part of this input. They will be used here to reference specific lines of input. Lines 1 through 4 are the Title Card, Operation Parameter Card, Restart Data Card, and Containment Initialization Card, respectively. These cards identify the input deck and provide some initialization data.

Lines 5 through 26 are the Geometry Input Group. Line 5 specifies that there are 3 floors; Lines 6, 19 and 25 specify the number and height of the cells on each floor. The remaining lines specify the volume of each cell and define the junctions between cells.

Line 27 is the Wall Conduction Input. In this case a blank card was used to select the INGEN default wall parameters.

TABLE 4. Mass Flow Rate and Specific Enthalpy of Steam Flow into Pump Room

Time From Pipe Rupture (sec)	Mass Flow Rate (lbm/sec)	Enthalpy (Btu/lbm)
0.00 - 0.85	142.0	1249.4
0.85 - 5.0	71.0	1249.4
5.0 - 6.0	68.8	1249.4
6.0 - 7.5	67.8	1249.4
7.5 - 10.0	64.9	1249.4
10.0 - 12.5	62.8	1249.4
12.4 - 15.0	61.0	1249.4
15.0 - 17.5	58.0	1249.4
17.5 - 20.0	54.5	1249.4
20.0 - 22.5	49.5	1249.4
22.5 - 25.0	46.2	1249.4
25.0 - 27.5	39.3	1249.4
27.5 - 30.0	27.7	1249.4
30.0 - 32.5	15.2	1249.4
35.0 - +	0	1249.4

TABLE 5. Cell Volumes Used in COBREE Analysis

Cell	Volume (ft^3)
1	25,498
2	4,493
3	29,395
4	7,286
5	8,163
6	25,661
7	3,525
8	95,910
9	567
10	11,703
12	6,683
13	12,830
14	1,763
15	283
16	5,851
17	7,664
18	3,525
Total volume:	266,127

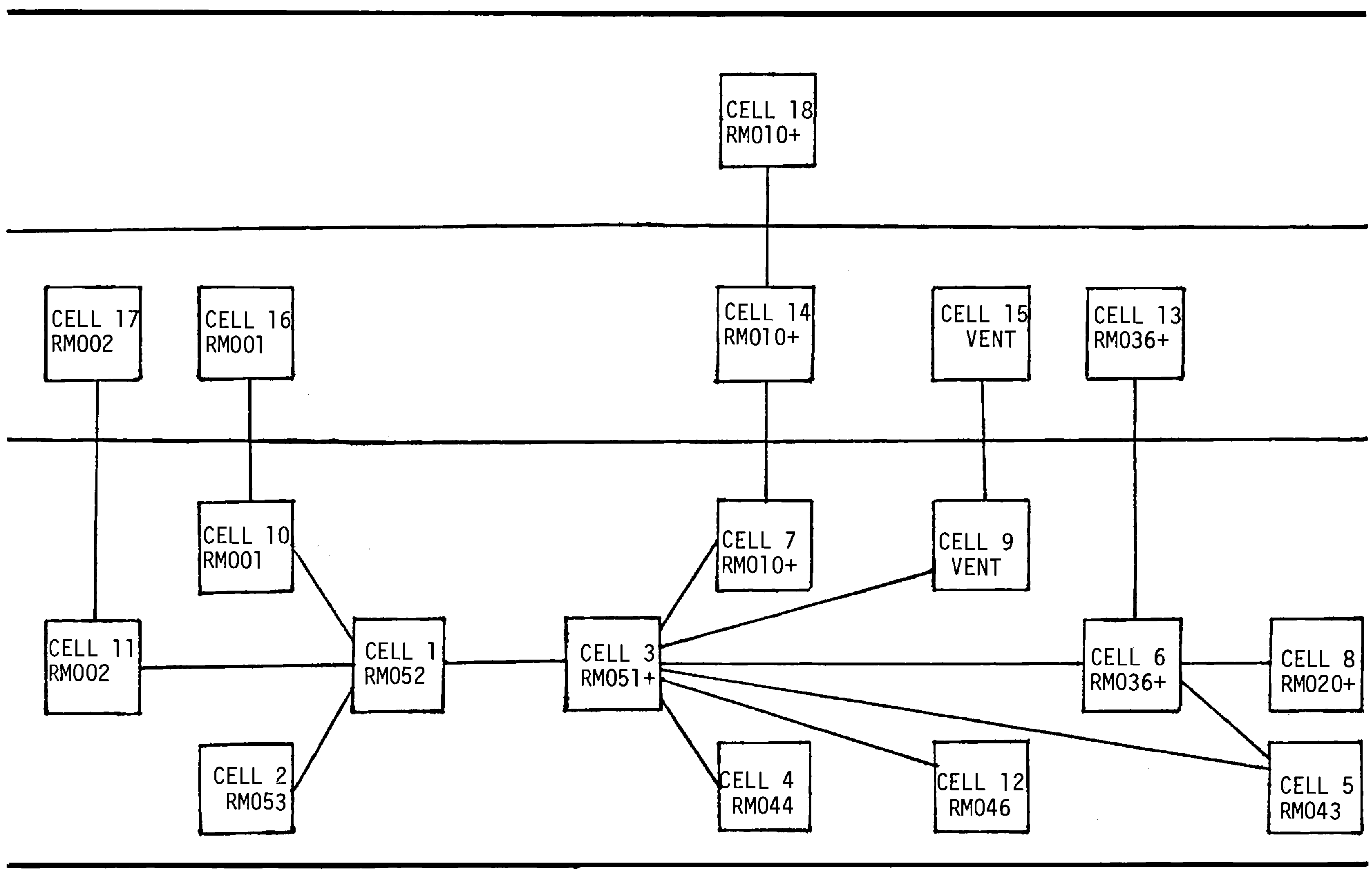

FIGURE 1. COBREE Noding Diagram

TABLE 6. Junction Flow Areas Used in COBREE Analysis

Connecting Cells	Flow Area (ft^2)
1-2	21.0
1-3	57.5
1-10	12.0
1-11	12.0
3-4	23.8
3-5	4.9
3-6	96.0
3-7	23.3
3-9	17.5
3-12	20.0
5-6	22.0
6-8	206.0
6-13	1425.0
7-14	195.0
9-15	31.0
10-16	650.0
11-17	850.0
14-18	195.0
15-atm	19.5

Lines 28 through 40 are the Boundary Specification Group. The steam line break boundary condition is described in lines 28 through 36. An atmospheric vent boundary is specified for cell 15 in lines 37 through 40.

Finally, line 41, which is blank, specifies INGEN default output selection.

INGEN Output

A copy of the output generated by INGEN for this analysis is given in Figure 3. Note that INGEN annotates the input file with comments to the right of the data at the beginning of the major input data groups. For a complete description of the COBRA-NC input data refer to Reference 1.

The input file generated by INGEN may now be submitted as input for COBRA-NC or modified to meet the requirements of the particular analysis being performed.

In this example we see the significant reduction in input requirements between INGEN and COBRA-NC. The 41 lines of input to INGEN is used to generate a 213 line input deck for COBRA-NC.

COBRA-NC Output

A copy of the output generated by COBRA-NC for this analysis is given in Appendix C.

```
1 helb model 3-21-85
         2                 1000.

     14.7        90.       0.5
         3
        12      18.0          1         1
    125498          2 21.0    3 57.5   10 12.0   11 12.0
    24493.
    329395          4 23.8    5  4.9    6 96.0    7 23.3    9 17.5   12 20.0
    47286.
    58163.          6 22.0
    625661          8206.0   -131425.
    73525.        -14 195.
    895910
    9 567.        -15 31.0
   1011703        -16 650.
   1115327        -17 850.
   126683.
         5      9.00          1         1
   1312830
   141763.        -18 195.
   15283.
   165851.
   177664.
         1      18.0          1         1
   183525.

         2          2      925.
        30          0
 0.0      142.0  0.85      142.00.851      71.0  5.0      71.0 5.01      68.8
 6.0       68.6  6.01      67.8   7.5      67.8 7.51      64.9 10.0      64.9
10.01      62.8  12.5      62.812.51       61.0 15.0      61.015.01      58.0
 17.5      58.017.51       54.5  20.0      54.520.01      49.5 22.5      49.5
22.51      46.2  25.0      46.225.01       39.3 27.5      39.327.51      27.7
 30.0      27.730.01       15.2  32.5      15.2 35.0       0.01500.
0.0
    1249.4
        15          1      14.7
         0          0
      14.7
     145.3

```

FIGURE 2. HELB INGEN input. (Line numbers to the left are for reference only)

```
                                     12        set units and linear conv.
          0   0.000000e+00                                   restart data
0.100000e-02              5          40               iteration control1
       1 helb model 3-21-85
   1    1                               0                    vessel 1.1
   278.00     278.00     27.80     278.00
   14.691   1101.108                          131.388  0.0000010  0.0237449
air     0.9762541
   2   18   18                                               vessel  2.1
   11417.150.5
   2249.663.20249.6
   31633.161.6
   4404.880.48
   5453.585.18
   61426.151 .0     1425.
   7195.855.98      195.0
   85328.292.0
   931.5022.45      31.00
  10650.2102.0      650.0
  11851.5116.7      850.0
  12371.377.07
  131426.151.01425.
  14195.955.98195.0195.0
  1531.4422.4331.0031.44
  16650.1102.0650.0
  17851.6116.7850.0
  18195.855.98195.0
   1                               -1     0
   2                               -2     0
   3                               -3     0
   4                               -4     0
   5                               -5     0
   6                               -6     0
   7                               -7     0
   8                               -8     0
   9                               -9     0
  10                              -10     0
  11                              -11     0
  12                              -12     0
  13                              -13     0
  14                              -14     0
  15                              -15     0
  16                              -16     0
  17                              -17     0
  18                              -18     0
```

FIGURE 3. HELB COBRA-NC input.

```
  3   12                                                      vessel 3.1
  1    1    21.1679.1652.5992.000
1.
  2    1    33.19415.172.6982.000
1.
  3    1  10.66676.9282.4882.000
1.
  4    1  11.66676.9282.4882.000
1.
  5    3    41.3229.7572.6162.000
1.
  6    3    5.27224.4271.9372.000
1.
  7    3    65.33319.602.7292.000
1.
  8    3    71.2949.6542.6132.000
1.
  9    3    9.97228.3672.5712.000
1.
 10    3  121.1118.9442.5922.000
1.
 11    5    61.2229.3812.6062.000
1.
 12    6    811.4428.712.7602.000
1.
                                                              blank 3.4
  4    3    1                                                 vessel 4.1
  1   12    1      18.00
  1    1                             1
  2    2                             2
  3    3                             3
  4    4                             4
  5    5                             5
  6   13                             6
  7   14                             7
  8    8                             8
  9   15                             9
 10   16                            10
 11   17                            11
 12   12                            12
  2    5    1       9.00
 13   13                             6
 14   18                             7
 15   15                             9
 16   16                            10
```

FIGURE 3. (contd)

```
 17   17                                 11
  3    1    1     18.00
 18   18                                 14
 18
  7    1                                                         vessel  7.1
2.6    2   15
  8  0  1  8  1   1                                              vessel  8.1
  280.00      2.00
  1    1              302.2        1.0
  2    2               90.9        1.0
  3    3              332.8        1.0
  4    4              125.5        1.0
  5    5              134.3        1.0
  6    6              218.8        1.0
  7    7               66.9        1.0
  8    8              884.0        1.0
  9    9               24.2        1.0
 10   10              138.1        1.0
 11   11              164.1        1.0
 12   12              118.3        1.0
 13   13              309.5        1.0
 14   14               56.2        1.0
 15   15               26.0        1.0
 16   16              174.2        1.0
 17   17              211.5        1.0
 18   18               66.9        1.0
  1   0   1   8   2                                              vessel  8.4
  1   2   3   4   5   6   7   8   9   1   0   1   1   1   2
 13   14   15   16   17   18
    0.0       90.0       45.0       90.0
  9  18                    0                                     vessel  9.1
  1 wall       302.      2.00    4        1
  5    10.008        5    10.042          5    1 0.65            5    1 1.30
  2 wall        91.      2.00    4        1
  5    10.008        5    10.042          5    1 0.65            5    1 1.30
  3 wall       333.      2.00    4        1
  5    10.008        5    10.042          5    1 0.65            5    1 1.30
  4 wall       125.      2.00    4        1
  5    10.008        5    10.042          5    1 0.65            5    1 1.30
  5 wall       134.      2.00    4        1
  5    10.008        5    10.042          5    1 0.65            5    1 1.30
  6 wall       219.      2.00    4        1
  5    10.008        5    10,042          5    1 0.65            5    1 1.30
  7 wall        67.      2.00    4        1
  5    10.008        5    10.042          5    1 0.65            5    1 1.30
```

FIGURE 3. (contd)

```
   8  wall          884.        2.00     4           1
   5     10.008             5     10.042             5     1 0.65           5     1 1.30
   9  wall           24.        2.00     4           1
   5     10.008             5     10.042             5     1 0.65           5     1 1.30
  10  wall          138.        2.00     4           1
   5     10.008             5     10.042             5     1 0.65           5     1 1.30
  11  wall          164.        2.00     4           1
   5     10.008             5     10.042             5     1 0.65           5     1 1.30
  12  wall          118.        2.00     4           1
   5     10.008             5     10.042             5     1 0.65           5     1 1.30
  13  wall          309,        2.00     4           1
   5     10.008             5     10.042             5     1 0.65           5     1 1.30
  14  wall           56.        2.00     4           1
   5     10.008             5     10.042             5     1 0.65           5     1 1.30
  15  wall           26.        2.00     4           1
   5     10.008             5     10.042             5     1 0.65           5     1 1.30
  16  wall          174.        2.00     4           1
   5     10.008             5     10.042             5     1 0.65           5     1 1.30
  17  wall          212.        2.00     4           1
   5     10.008             5     10.042             5     1 0.65           5     1 1.30
  18  wall           67.        2.00     4           1
   5     10.008             5     10.042             5     1 0.65           5     1 1.30
  10     1                                                                   vessel  10.1
   1     2      139.00
   50.000        0.220       0.867    1000.000       0.220        0.867
  13    24       0     1     0     0     0     0                             vessel  13.1
  30
        142.00.8500      142.00.8510      71.005.000      71.005.010       68.80
6.000       68.606.010     67.807.500      67.807.510      64.9010.00       64.90
10.01       62.8012.50     62.8012.51      61.0015.00      61.0015.01       58.00
17.50       58.0017.51     54.5020.00      54.5020.01      49.5022.50       49.50
22.51       46.2025.00     46.2025.01      39.3027.50      39.3027.51       27.70
30.00       27.7030.01     15.2032.50      15.2035.00       0.001500.        0.00
   2     1     2     1     0       1.000   1249.400    925.000
251.5.0001.9999.0001
                                                                             blank  13.4b
  15     3     1     0     0     14.700     145.300     14.700
152.3.9999.9999.0001
                                                                             blank  13.4b
   1     1     3
   3     1     3
   4     1     3
   5     1     3
   6     1     3
   7     1     3
```

FIGURE 3. (contd)

```
    8     1     3
    9     1     3
   10     1     3    11     1     3
   12     1     3
    1     2     3
    2     2     3
    3     2     3
    4     2     3
    5     2     3
    8     2     3
   12     2     3
   13     2     3
   16     2     3
   17     2     3
   18     2     3
   14     1     0                 0                 1                 vessel 14.1
                                                                       end set 1
                                                                    blank graf.1
    0    -1                                                               graf.2
      0.000100       0.001000       0.100000       1.000000     300.000000
1000000.0000001000000.000000     500.0000001000000.000000
      0.020000
      0.000100       0.050000       1.000000       1.000000     300.000000
1000000.0000001000000.000000     500.0000001000000.000000
      0.100000
      0.000100       0.010000      36.000000       1.000000     300.000000
1000000.0000001000000.000000     500.0000001000000.000000
      1.000000
      0.000100       0.200000      36.000000       1.000000     300.000000
1000000.0000001000000.000000     500.0000001000000.000000
     10.000000
     -1.000000
```

FIGURE 3. (contd)

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APPENDIX A

INGEN PROGRAM LISTING

APPENDIX A

INGEN PROGRAM LISTING

```
      program ingen(input,output,tape6=input,tty,tape9)
      common /forms/ ka(80)
      common scommon,
             title(17)  ,ck(12),nrpc(2,50),
             a(50),ncell(10),dx(10),ncstart(10),nclast(10),
     *       p(50),jc(6,50),ap(6,50),npts(9),irdint(9,50),
             ik(100), jk(100),gapn(100),length(100),fwall(100),
             wkr(100),abot(50),atop(50),kchana(50,6),kchanb(50,6),
     *       icy(50,10),cdl(50), izdum(50) ,jzdum(50) ,
     *       hperimi(100),rmuls(100),ir(50),dir(100) ,nwhtcf,
     *       abscis(50,9),ordint(50,9),lbot(50) ,ltop(50) ,
             ibound(9) ,isped(9) ,xvalue(9),asink(9) ,ssink(9) ,dxsink(9) ,
             hvalue(9),pvalue(9),npfn(9) ,nhfn(9),lcb(9) ,nbcs(50) ,
             xarg,zarg,nodes(50) ,nodesf(10) ,
             kcrit(2,50),icrit(2,50),
             nlll(50),
             ecommon
      real length
      dimension icommn(1)
      dimension jwarn(30)
      equivalence(icommn,scommon)
c
       data pi,feet,sqft,nconv/3.14159,1.,1.,12/
       data scvl,shvl,scll,shll/278.,278.,27.8,278./
      data humax,humin/280.,2.0/
cc****  zero common
      is=locf(ecommon) - locf(scommon)
c
      do 10 i=1,is
      icommn(i )=0
10    continue
c
      warning=0.
      nwarn=0
      do 20 j=1,5
      pvalue(j)=1.0
   20 hvalue(j)=1.0
      read (6,550)  title
      read (6,540)  nbound,mcrit,tottrn
      read (6,530)  idstep,timet
      read (6,560)  patm,tatm,rhumid
      if (patm.eq.0) patm=14.696
```

```
      if (tatm.eq.0.0) tatm=92.0
      if (rhumid.eq.0) rhumid=.5
cc*** default wall thickness to 2ft.
cc*** default steel material thickness to 1/2 inch.
      wt=2.*feet
      swt=.5/12.
      read (6,580)  nfloor,ncritc,ncritk
      nctot=0
      nntot=0
      do 40 l=1,nfloor
      read (6,533)   ncell(l),dx(l),nnode,iaorv
      if(nnode. le. 0) nnode=1
      nodesf(l)=nnode
      dx(l)=dx(l)*feet
      nc=ncell(l)
      do 30 ic=1,nc
      nctot=nctot+1
      if (ic.eq.1) ncstart(l)=nctot
      if (ic.eq.nc) nclast(l)=nctot
      read (6,570)  i,a(i),p(i),(jc(k,i),ap(k,i),k=1,6)
      icy(ic,l)=i
      lbot(i)=0
      nntot=nntot+nnode
      nodes(i )=nnode
      if(iaorv.gt.0)   a(i)=a(i)/dx(l)
      if(p(i).le.0.) p(i)=4.*sqrt(a(i))
      ltop(i)=0
   30 continue
   40 continue
      do 45 nncritc=1,ncritc
        read(6,660) icrit(1,nncritc),torb
        if(torb. eq. 0) then
          icrit(2,nncritc)=1
        else
          icrit(2, nncritc)=nodes(i crit(1,nncritc))+1
        end if
   45 continue
      do 47 nncritk=1,ncritk
        read(6,660)(kcri t(kk,nncritk),kk=1,2)
   47 continue
      nk=0
      l=1
      iwide=0
      ncdt=0
      ncd=0
      do 50 i=1,nctot
      lbot(i) =0
   50 ltop(i)=0
```

```
      do 90 i=1,nctot
      a(i)=a(i)*sqft
      p(i)=p(i)*feet
      if (i.gt.nclast(l)) l=l+1
      do 80 k=1,6
      j=iabs(jc(k,i))
      ap(k,i)=ap(k,i)*sqft
      if (j.eq.0) go to 90
cc*** room to room-define port loss coefficient
cc*** assumes circular port here
      f1=0.
      f2=0.
      if (jc(k,i).lt.0) go to 60
cc***  room to room - define port loss coefficient
cc                  r port here
       d0 = (4.*ap(k,i)/pi) ** .5
       xarg= wt/d0
      zarg=.5
      if (xarg.gt.l.3)    zarg=1.
      f1=2.204-.44*atan(9.556*(xarg- .6656))
      f2=2.826-.943*xarg
   60 continue
      if (j.gt.nclast(l)) go to 70
cc**  transverse port ****
      nk=nk+l
      gapn(nk)=ap(k,i)/dx(l)
      ik(nk)=i
      jk(nk)=j
      iwide=max0(iwide,iabs(j-i))
      length(nk)=amin1(0.125*(p(i)+p(j)),2.*sqrt(ap(k,i)))
      wkr(nk) =zarg*f1+(1.-zarg)*f2
cc*** assume all cells  are rooms for friction  calculatio@
      fwall(n k) =2.
      go to 80
   70 continue
cc***  come here if port connects different floors
      abot(j)=ap(k,i)
      lbot(j) =lbot(j)+1
      ltop(i)=ltop(i)+1
      lb=lbot(j)
      lt=ltop(i)
      kchanb(j,lb) =i
      atop(i)=ap(k,i)
      kchant(i  ,lt) =j
      ncdt=ncdt+1
      if (abs(f1).le.0.) go to 80
      ncd=ncd+1
      cdl(ncd) =zarg*f1+(1.-zarg)*f2
```

```
      izdum(ncd)=i
      jzdum(ncd)=nodes(i )+1
   80 continue
   90 continue
      do 110 i=1,nctot
      if (lbot(i).ne.0) go to 100
      lbot(i)=1
      kchanb(i ,1)=i
  100 if (ltop(i).ne.0) go to 110
      ltop(i)=1
      kchana(i ,1)=i
  110 continue
      read (6,580)  nmod
cc*** r=l set up concrete walls
cc*** k=2 set up  steel ( defaulted to zero surface area
      l=1
      do 140 i=1,nctot
      if(i  .gt.nclast(l)) l=l+1
      hperimi(i)  =2*a(i)  -abot(i)  -atop(i)
      do 120 k=1,6
      if (jc(k,i).eq.0) go to 130
      if (iabs(jc(k,i)).gt.nclast(l)) go to 120
      hperimi(i)=hperimi(i)-ap(k,i)
  120 continue
  130 continue
      hperimi(i)=hperimi(i)/dx(l)+p(i)
      n=i+nctot
      hperimi(n) =hperimi(i)
      rmuls(i)=1.
      if(hperimi(i).le.0) rmuls(i)=0.
      rmuls(n) =0.
      din(i)  =wt
      din(n) =swt
  140 continue
      if (nmod.le.0) go to 160
      do 150 k=1,nmod
      read (6,530)  n,hper,rmuls(n),dini
      if (hper.ne.0.) hperimi(n) =hper
      if (dini .ne.0.) din(n)=dini
      if(hper+dini.gt.0.and.rmuls(n).le.0) rmuls(n)=1.
  150 continue
  160 continue
      do 170 i=1,nctot
      nrpc(1,i)=0
  170 nrpc(2,i)=0
      itot=0
      nrtot=0
      do 180 i=1,nctot
```

```
      if (rmuls(i).eq.0) go to 180
      nrtot=nrtot+1
      nrpc(1,i)=nrtot
      itot=itot+1
      ir(nrtot)=i
180   continue
      nexcon = 0.
       do 190 i=1,nctot
      if(ltop(i).gt.1) nexcon = nexcon+ltop(i)-1
      if(lbot(i).gt.1) nexcon = nexcon+lbot(i)-1
      ip=nctot+i
      if (rmuls(ip).eq.0) go to 190
      nrtot=nrtot+1
      nrpc(2,i)=nrtot
      if (nrpc(1,i).eq.0) itot=itot+1
      ir(nrtot)=ip
190   continue
      nbc=2*(nctot-ncdt)+nbound
      nbc = nbc+ nexcon
      npt=0
      do 240 j=1,nbound
      read (6,590) ibound(j),ispec(j),xvalue(j),asink(j),ssink(j),dxsink
     1 (j)
      jbound=ibound(j)
      if(asink(j).le.0.) asink(j)=a(jbound)
      nbcs(jbound)=nbcs(jbound)+1
      lcb(j)=1
      if(abot(jbound).gt.0.or.nbcs(jbound).eq.2) lcb(j)=1+nodes(jbound)
      if(abot(jbound).le.0..or.atop(jbound).le.0.) go to 195
      warning=1.
      nwarn = nwarn+1
      jwarn(nwarn)=jbound
195   continue
      if (ispec(j).lt.4)  nbc=nbc-1
      if(abot(jbound).le.0.)  go to 198
      if(atop(jbound).le.O.)   atop(jbound) = asink(j)
      go to 199
198   abot(jbound) = asink(j)
199   continue
      if (ispec(j).ne.1) go to 200
      if (ssink(j).lt.0.) go to 200
      if (asink(j).le.0.0) go to 200
      d0=(4.*asink(j)/pi)**.5
       xarg= wt/d0
      zarg=.5
      if (xarg.gt.l.3)   zarg=1.
      f1=2.204-.44*atan(9.556*(xarg-.6656))
      f2=2.826-.943*xarg
```

```
      ncd=ncd+1
      cdl(ncd) =zarg*f1+(1.-zarg)*f2
      if (ssink(j).gt.0.) cdl(ncd)=ssink(j)
      izdum(ncd)=jbound
      jzdum(ncd)=lcb(j)
  200 continue
      asink(j)=asink(j)*sqft
      dxsink(j)=dxsink(j)*feet
      npfn(j) =0
      nhfn(j) =0
      read(6,580) npts1,npts2,nphtcf
      if (npts1.eq.0) go to 210
      pvalue(j)=1.
      npfn(j) =1
      npt=npt+1
      npts(npt)=npts1
      read (6,600)  (absci s(k,npt),ordint(k,npt),k=l,npts1)
      go to 220
  210 read (6,560)  pvalue(j)
  220 if (npts2.eq.0) go to 230
      nhfn(j) =npfn(j)+1
      hvalue(j) =l.
      npt=npt+1
      npts(npt) =npts2
      read (6,600)  (absci s(k,npt),ordint(k,npt),k=l,npts2)
      go to 240
  230 read (6,560)  hvalue(j)
  240 continue
      if (nphtcf.le.0) go to 250
      npt=npt+1
      npts(npt) =nphtcf
      read (6,600)  (abscis (k,npt),ordint(k,npt),k=1,nphtcf)
      nwhtcf=npt
  250 continue
cc***  start making output
cc***   default english units(12.0   for feet)
      write (9,610)  nconv
      write (9,620)  idstep,timet
      epso=.001
      itmax=5
      iitmax=40
      write (9,630)  epso,itmax,iitmax
      init=l
      if (idstep.ne.0) init=4
      write (9,640)  init,title
cc*** group 1
      ig=1
      write (9,650)  ig,ig,mcrit
```

```
      write(9,655) scvl,shvl,scll,shll
cc*** find psat of vapor in room
      ck(1) =-7.691234564
      ck(2) =-2.608023696e+1
      ck(3)=-1.681706546e+2
      ck(4) =6.423285504e+1
      ck(5) =-1.189646225e+2
      ck(6)=4.167117320
      ck(7) =2.097506760e+1
      ck(8)=1.e9
      ck(9)=6.
      theta=(tatm+459.67)/1.8/647.3
      sum=0.
      onemt=1.-theta
      onemt2=onemt*onemt
      pionemt=1.
      do 260 i=1,5
      pionemt=pionemt*onemt
      sum=sum+ck(i)*pionemt
  260 continue
      sum=sum/theta
      sum=sum/(1.+ck(6) *onemt+ck(7) *onemt2)
      sum=sum-onemt/(ck (8) *onemt2+ck(9) )
      beta=exp(sum)
      pg=beta*3208.11
      pv=amax1(.11,rhumid*pg)
cc*** default liquid volume fraction to .000001
      vfl=.000001
      vfls=vfl
      vfv=pv/patm
      vfa=1.-vfv-vfl
cc***  approximate vapor enthalpy by hsat at pg
      hs=hg(pg)
      do 265 m=1,1000
      ts=tv(pv,hs,fp)
      delh=(tatm - ts) / fp
      hs=hs + delh
      if(abs(delh/hs) .lt. 1.0e-6) go to 266
265   continue
266   continue
      ha=126.66+.24*(tatm-70.3)
      has=ha
c**  correct pressure so p at top of room is ref. pressure
      rhoa=144.0 * (patm - pv) / (tatm + 459.67) / 53.342
      rhov=1.0 / vog(pv, hs)
      rhom=rhoa + rhov
      delpres=rhom * dx(nfloor) / 144.0
      pcor=patm - delpres
```

```
      write(9,670) pcor,hs,ha,vfl,vfv
      write(9,680)  vfa
cc*** group 2
      ig=2
      write(9,690)  ig,nctot,itot
      do 270 i=1,nctot
      call blankit
      call form (a(i),1)
      call form(p(i)  ,6)
      call form (abot(i),11)
      call form(atop(i)  ,16)
  270 write(9,700)  i,(ka(k) ,k=1,20)
      do 280 i=1,nctot
      if (nrpc(1,i)+nrpc(2,i).eq.0.) go to 280
      n1=-nrpc(1,i)
      n2=-nrpc(2,i)
      write(9,710)  i,n1,n2
  280 continue
cc*** group 3
      if (nk.le.0) go to 300
      ig=3
      g1=1.
      write(9,720)  ig,nk
      do 290 k=1,nk
      call blankit
      call form(gapn(k)  ,1)
      call form(length(k) ,6)
      call form(wkr(k),11)
      call form(fwall(k) ,16)
      write(9,731) k,ik(k),jk(k),(ka(m),m=1,20)
      write(9,740)  gl
  290 continue
cc*** zero transverse momentum cards
      write(9,750)
cc*** group 4
cc***
  300 ig=4
      ig1=1
      write(9,760)  ig,nfloor,ig1
      htotal=0.
      do 330 l=1,nfloor
      htotal=htotal+dx(l)
      ig1=nodesf(l)
      dxo=dx(l)/nodesf(l)
      write(9,770)  l,ncell(l),ig1,dxo
      nc=ncell(l)
      do 320 ic=1,nc
      i=icy(ic,l)
```

```
      llb=lbot(i)
      llt=ltop(i)
      if (llt.eq.l)
     . write(9,780 )i,(kchana(i,ll),ll=1,llt),(kchanb(i,ll),ll=1,llb)
      if.(llt.eq.2)
     . write(9,790)i,(kchana(i,ll),ll=1,llt),(kchanb(i,ll),ll=1,llb)
      if (llt.eq.3)
     . write(9,800)i,(kchana(i,ll),ll=1,llt),(kchanb(i,ll),ll=1,llb)
      if (llt.eq.4)
     . write(9,810)i,(kchana(i,ll),ll=1,llt),(kchanb(i,ll),ll=1,llb)
      if (11t.eq.5)
     . write(9,820)i,(kchana(i,ll),ll=1,llt),(kchanb(i,ll),ll=1,llb)
      if (llt.eq.6)
     . write(9,830)i,(kchana(i,ll),ll=1,llt),(kchanb(i,ll),ll=1,llb)
      do 310 ll=1,llt
  310 iwide=max0(iwide,kchana(i,llt)-i,1)
  320 continue
  330 continue
      write (9,780)  nntot
cc*** group  7
cc***
      do 333 i=1,nc
  333 nlll(i)=0
      if (ncd.le.0) go to 350
      ig1=7
      jc1=1
      write (9,840)  igl,ncd
      do 340 j=1,ncd
       i=izdum(j)
       if(ltop(i).le.1) go to 339
       jzdum(j)=1
       nlll(i)=nlll(i)+1
       nll=nlll(i)
       izdum(j)=kchana(i,nll)
  339 continue
      write(9,850) cdl(j) ,jzdum(j),izdum(j)
  340 continue
  350 continue
cc*** group 8
cc***
      ig1=8
      jc1=1
      jc0=0
      write (9,860)  ig1,jc0,nrtot,jc1,jc1
      write (9,865)  humax,humin
      do 360 i=1,nrtot
      j=ir(i)
      write (9,870)  i,i,hperimi(j) ,rmuls(j)
```

```
  360 continue
cc*** card 8.4 and 8.5
      ig=1
      igt=0
      ig2=2
      write (9,880)  ig,igt,nrtot,ig2
      write (9,890)  (i,i=1,nrtot)
cc*** card  8.6
      gig=0.
      write (9,900)  gig,tatm,htotal,tatm
cc*** group9
cc***
      ig=9
      ig4=4
      write (9,910)  ig,nrtot,nwhtcf
      iwalls=1
      do 370 j=1,nrtot
      i=ir(j)
      iwall=1
      t1=amin1(.1,.1*din(i)*12.)/12.
      t2=amin1(.5,.2*din(i)*12.)/12.
      t3=(din(i)-t1-t2)/3.
      t4=din(i)  -t1-t2-t3
      if (i  r(j).gt .nctot) iwall=2
      if (iwall .eq.2) iwalls=2
      write (9,920)  j,hperimi(i),din(i),ig4,iwall
      ig5=5
      write (9,930)  ig5,iwall,t1,ig5,iwall,t2,ig5,iwall,t3,ig5,iwall,
     *  t4
  370 continue
cc*** group 10
cc***
cc*** default concrete for type 1  and steel for type 2
      ig=10
      ig2=2
      write (9,940)  ig,iwalls
      rc=139.
      rs=487.
      cpc=.22
      cps=.113
      tkc=.867
      tks=30.
      tp1=50.
      tpm=1000.
      ig=1
      write (9,950)  ig,ig2,rc
      write (9,960)  tpl,cpc,tkc,tpm,cpc,tkc
      if (iwalls.eq.1) go to 380
```

```
      ig=2
      write(9,950)  ig,ig2,rs
      write(9,960)  tp1,cps,tks,tpm,cps,tks
  380 continue
cc*** group 13
cc***
      ig=13
      nkbnd=0
      nfunct=npt
      ngbnd=0
      iconvb=0
      write(9,970)  ig,nbc,nkbnd,nfunct,ngbnd,iconvb,ncritc,ncritk
      if (nfunct.eq.0) go to 400
      write(9,660)  (npts(i)  ,i=1,npt)
      do 390 l=1,nfunct
      np=npts(l)
      do 387 k=1,np
      call blankit
      call form(abscis(k,l),1)
      do 385 j=1,5
385   irdint(j,k)=ka(j)
387   continue
      write(9,980) ((irdint(j,k),j=1,5),ordint(k,l),k=1,np)
  390 continue
  400 continue
      do 470 j=l,nbound
      jump=0
      jbound=ibound(j)
      if(ispec(j).eq.1) pvalue(j)=amax1(pvalue(j),xvalue(j))
      if(ispec(j).eq.1) xvalue(j)=pvalue(j)
      if (pvalue(j).eq.0..and.npfn(j).eq.0) pvalue(j)=xvalue(j)
      if(hvalue(j)+nhfn(j).ne.0.) go to 410
cc***  default  boundry  pressure and vol fract to that in c@
      hvalue(j)=hs
      g9=vfv
      g1=vfa
      ha=has
      vfl=vfls
      head=0.
      if(lcb(j).eq.1) head=rhom*htotal*1.25/144.
      jump=1
      xvalue(j)=patm+head
      pvalue(j)=patm+head
  410 continue
      if(lcb(j).gt.1.and.ispec(j).eq.1)lcb(j)=lcb(j)+1
      write(9,990)  ibound(j),lcb(j),ispec(j),npfn(j),nhfn(j),pvalue(j)
     $,hvalue(j),xvalue(j)
      if (jump.eq.1) go to 460
```

```
      h=hvalue(j)
      if (nhfn(j) .ne.0.) h=ordint(1,nhfn(j))
      hl=hf(xvalue(j))
      hv=hg(xvalue(j))
      x=(h-hl)/(hv-hl)
      if (x)  420,420,430
  420 t=tl(xvalue(j),h)
      alfa=.0001
      go to 450
  430 if (x.ge.1.) go to 440
      t=tl(xvalue(j),h)
      alfa=x/(x+vol(xvalue(j) ,h) /vog(xvalue(j) ,h) *(1. -x))
      alfa=amin1(alfa,,9999)
      alfa=amax1(alfa,.0001)
      go to 450
440   t=tv(xvalue(j) ,h, fp)
      alfa=.9999
450   ha=126.66 + 0.24 * (t  - 70.3)
      vfl=1.-alfa
cc*   default vol fraction of air upstream of break to .0001
      g9=.9999
      g1=.0001
  460 write (9,1020) ha,vfl,g9,g1
      write (9,1000)
  470 continue
      do 475 i=1,nbound
        if (ispec(j).eq.4) then
          write (9,1010)asink(j)
        else if (ispec(j).eq.5) then
          if(dxsink(j).eq.0.) dxsink (j)=a(jbound)**.5
          write (9,1010)  asink(j),ssink(j),dxsink(j)
        end if
  475 continue

      ig3=3
      do 500 k=1,2
      do 490 i=1,nctot
      kb=0
      kt=0
      do 480 j=1,nbound
      if (i.ne.ibound(j)) go to 480
      if (ispec(j).ge.4) go to 480
      if(lcb(j).ge.2) kt=1
      if (lcb(j).eq.1) kb=1
  480 continue
      if(kb.eq.0.and.k.eq.1.and.abot(i).le.0.) write (9,990) i,k,ig3
      if(k.eq.2.and.kt.eq.0.and.atop(i).le.0.) write(9,990)i,k,ig3
  490 continue
```

```
  500 continue
      if(ncri tc.eq.0) go to 504
      do 503 j=1,ncritc
        write(9,950) (icrit(ii,j),ii=1,2)
  503 continue
  504 continue
      if (ncritk.eq.0) go to 507
      do 506 j=1,ncritk
        write(9,950) (kcrit(ii,j),ii=1,2)
  506 continue
  507 continue
cc****  group  14
cc****
      ig=14
      read(6,580) n1,nout1,nout4,ncgraf,mfiche
      if (n1.eq.0) n1=1
      write(9,1030) ig,n1,nout1,nout4,1
      if (nout1.eq.0) go to 510
      read(6,1040) (izdum(i),i=1,nout1)
      write(9,1040) (izdum(i),i=1,nout1)
  510 if (nout4.eq.0) go to 520
      read(6,1040) (izdum(i),i=1,nout4)
      write(9,1040) (izdum(i),i=l,nout4)
  520 write(9,1050)
      write(9,1070)
      ig2=-1
       write(9,1080) ncgraf,ig2
cc   **** default time domain data
cc   *** start of run
      dtmin=.0001
      dtmax=.001
      tend=.1
      rtwfp = 1.
      tmax=300.
      write(9,1090) dtmin,dtmax,tend,rtwfp,tmax
      edint=1.e6
      if(mfiche.gt.0)   edint= 1.
      gfint=1.e6
      if(ncgraf .gt.0) gfint=1.
      dumpint=500.
      sedint=1.e6
      asbint=0.02
      write(9,1090) edint,gfint,dumpint,sedint
      write(9,1095) asbint
cc   *** intermediate zone
      dtmin=.0001
      dtmax=.05
      tend=1.
```

```
      rtwfp=1.
      tmax=300.
      write (9,1090)  dtmin,dtmax,tend,rtwfp,tmax
      edint=1.e6
      if(mfiche.gt.0)    edint= 1.
      gfint=1.e6
      if(ncgraf .gt.0) gfint=.1
      dumpint=500.
      asbint=0.1
      write (9,1090)  edint,gfint,dumpint,sedint
      write (9,1095)  asbint
cc   ****  duration of run
      dtmin=.0001
      dtmax=1.0
*
      tend=amin1(tottrn, 100.0)
      rtwfp = 1.
      tmax=300.
      write (9,1090)  dtmin,dtmax,tend,rtwfp,tmax
      edint=1.e6
      if(mfiche.gt.0)    edint= 1.
      gfint=1.e6
      if(ncgraf.gt.0)  gfint=1.
      dumpint=500.
      asbint=1.0
      write (9,1090)  edint,gfint,dumpint,sedint
      write (9,1095) asbint
      tend=tottrn
      asbint=10.0
      write (9,1090)  dtmin,dtmax,tend,rtwfp,tmax
      write (9,1090)  edint,gfint,dumpint,sedint
      write (9,1095) asbint
      dtmin=-1.
      write (9,1090)  dtmin
      if (warning.gt.0.) write (9,1100) (jwarn (i),i=1,nwarn)
  530 format (i10,3f10.3)
  533 format(i 10,f10.5,2i10)
  540 format (2i10,f10.3)
  550 format (17a4)
  560 format (8f10.2)
  570 format (i5,2f5.0,6(i5,f5.0))
  580 format (8i10)
  590 format (2i10,4f10.0)
  600 format (5(f5.0,f10.0))
  610 format (28x,i14,8x,26hset units and linear conv.)
  620 format (i 14,e14.6,40x,12hrestart data)
  630 format (e14.6,2i14,20x,18hiteration controll)
  640 format (5x,i5,17a4)
```

```
  655 format (4f10.2)
  650 format (2i5,30x,i5,24x,11hvessel  1.1)
  660 format (8i5)
  670 format (2f10.3,20x,1f10.3,2f10.7)
  680 format (8hair     ,f10.7)
  690 format (3i5,54x,llhvessel  2.1)
  700 format (i5,20a1)
  710 format (i5,30x,2i5)
  720 format (2i5,59x,llhvessel  3.1)
  730 format (3i5,2f5.0,2f5.2)
  731 format(3i5,20a1)
  740 format (f5.0)
  750 format (69x,11h blank 3.4 )
  760 format (3i5,54x,llhvessel  4.1)
  770 format (3i5,f10.2)
  780 format (2i5,25x,6i5)
  790 format (3i5,20x,6i5)
  800 format (4i5,15x,6i5)
  810 format (5i5,10x,6i5)
  820 format (6i5,5x,6i5)
  830 format (13i5)
  840 format (2i5,59x,llhvessel  7.1)
  850 format (f5.1,13i5)
  860 format (5i5,44x,llhvessel  8.1)
  865 format (2f10.2)
  870 format (2i5,10x,2f10.1)
  880 format (4i5,49x,llhvessel  8.4)
*/fix error in assigning wall desegnators
  890 format (12i5)
  900 format (4f10.1)
  910 format(2i5,15x,i5,39x,llhvessel  9.1)
  920 format (i5,5h wall,f10.0,f10.2,i5,i10)
  930 format (2(2i5,f5.3,5x),2(2i5,f5.2,5x))
  940 format (2i5,59x,llhvessel 10.1)
  950 format (2i5,f10.2)
  960 format (6f10.3)
  970 format (8i5,29x,llhvessel 13.1)
  980 format(5(5a1,f10.2))
  990 format (5i5,3f10.3)
 1000 format (69x,llhblank 13.4b)
 1010 format (8f5.1)
 1020 format (f5.1,3f5.4)
 1030 format (3i5,10x,i5,10x,i5,24x,11hvessel 14.1)
 1040 format (12i5)
 1050 format (71x,9hend set 1)
 1060 format (70x,10hblank 15.1)
 1070 format (68x,12hblank graf.1)
 1080 format (2i5,59x,10h    graf.2)
```

```
 1090 format (5f14.6)
 1095 format (f14.6)
 1100 format (40h **** too many boundaries in cells  ***   ,30i3)
      end


      function hg (p)
      dimension ag(3,12)
cc    constants for saturated vapor enthalpy equations
      data ag/ +.1105836875e+4, -.2234264997e+7, +.9059978254e+3,
     1         +.1436943768e+2, +.1231247634e+7, +.5561957539e+1,
     2         +.8018288621e+0, -.1978847871e+6, +.3434189609e+1,
     3         +.1617232913e-1, +.1859988044e+2, -.6406390628e+0,
     4         -.1501147505e-2,-.2765701318e+1, +.5918579484e-1,
     5                     0., +.1036033878e+4, -.2725378570e-2,
     6                     0., -.2143423131e+3, +.5006336938e-4,
     7                     0., +.1690507762e+2,              0.,
     8                     0., -.4864322134e+0,              0.,
     9         -.1237675562e-4,              0.,              0.,
     1         +.3004773304e-5,              0.,              0.,
     2         -.2062390734e-6,              0.,              0./
cc    p = psi
cc    hg=btu/lbm
      1=1
      ls=12
      x=alog(p)
      if (p.le.950.)  go to 10
      1=2
      ls=9
      if (p.le.2650.)  go to 10
      1=3
      ls=7
      x=(3208.2-p)**.41
   10 continue
      lsm=ls-1
      hg=ag(l,ls)
      do 20 n=1,lsm
   20 hg=hg*x+ag(l,ls-n)
      return
      end


      function hf (p)
      dimehsion af(3,9)
cc    constants for saturated liquid enthalpy (revised eq@
      data af/ +.6970887859e+2, +.8408618802e+6, +.9060030436e+3,
     1         +.3337529994e+2, +.3637413208e+6, -.1426813520e+2,
     2         +.2318240735e+1, -.4634506669e+6, +.1522233257e+1,
```

```
     3          +.1840599513e+0, +.1130306339e+6, -.6973992961e+0,
     4          -.5245502284e-2, -.4350217298e+3, +.1743091663e+0,
     5          +.2878007027e-2, -.3898988188e+4, -.2319717696e-1,
     6          +.1753652324e-2, +.6697399434e+3, +.1694019149e-2,
     7          -.4334859629e-3, -.4730726377e+2, -.6454771710e-4,
     8          +.3325699282e-4, +.1265125057e+1, +.1003003098e-5/
cc     p(psi),hf(btu/lbm)
       ls=9
       k=1
       x=alog(p)
       if (p.lt.950)  go to 10
       k=2
       if (p.lt.2550.) go to 10
       k=3
       x=(3208.2-p) **.41
   10  lsm=ls-1
       hf=af(k, ls)
       do 20 n=1,lsm
   20  hf=hf*x+af(k, ls-n)
       return
       end


       function tl (p,h)
       dimension a1(2,4), ac(5,5)
cc     constants for liquid temperature equation
       data al/ +.3276275552e+2, +.3360880214e-2, +.9763617000e+0,
     1          -.5595281760e-4, +.1857226027e-3, +.1618595991e-6,
     2          -.4682674330e-6, -.1180204381e-9/
cc     above critical pressure
       data ac/ +.6390801208e+3, -.4302857237e+0, +.1174524584e-3,
     1          -.1473977290e-7, +.7104327342e-12,-.3055217235e+1,
     2          +.2673303422e-2, -.6839200986e-6, +.8018858166e-10,
     3          -.3649500626e-14,+.8713231868e-2, -.5198380474e-5,
     4          +.1168011772e-8, -.1164901355e-12,+.4457387575e-17,
     5          -.6269403683e-5, +.3037825558e-8, -.4260074181e-12,
     6          +.4559400289e-17,+.1678398723e-20,-.9844700000e-17,
     7          +.3309704045e-12,-.2732081763e-15,+.5825511142e-19,
     8          -.37568004091e-23/
       if (p.gt.3208.2) go to 20
       tl=a1(1,4)+p*al(2,4)
       do 10 j=1,3
       k=4-j
   10  tl=tl*h+al(1,k)+p*al(2,k)
       return
   20  tl=poly5(ac,p,h)
       return
       end
```

```
      function tv(p,h,cpi)
      dimension a1(6),a2(6),b1(6),b2(6)
      dimension a11(4),a22(4),b11(4),b22(4)
      data a1/2.0110905e1,-1.250954e-2,2.8274992e-6,-9.8147341e-3,
     +        6.582489e-6,-1.4749938e-9/
      data a2/15.35885,-1.5655537e-2,5.2687849e-6,-1.1541553e-3,
     +        1.238456e-6,-4.1724604e-10/
      data b1/1.325023e-2,-1.0521514e-5,2.5007955e-9,5.7703098e-3,
     +        -2.9972073e-6,5.20373e-10/
      data b2/-2.5611614e-1,2.2270593e-4,-5.9928922e-8,2.796637e-2,
     +        -2.4665012e-5,6.772308e-9/
      data all/-1.0659659e4,4.981582,-7.7618225e-6,2.4391612e-10/
      data a22/-4.5298646e3,4.4185386e-1,-9.1654905e-6,2.7549766e-10/
      data b11/-2.8557816,-3.4620214,-3.6261637e-2,7.3529479e-4/
      data b22/126.5996,-21.81803,1.3424036,-4.9110372e-2/
      h2 = h*h
      h3 = h2*h
      plog = alog(p)
      tgaspl = all(1)+p*(a11(2)+p*(a11 (3)+p*a11(4)))
      tgasp2 = a22(1)+p*(a22(2) +p*(a22(3) +p*a22(4) ))
      cpgasl = bll(1)+plog*(bll (2)+plog*(b11(3)+plog*b11(4)))
      cpgas2 = b22(1)+plog*(b22(2) +plog*(b22(3) +plog*b22(4) ))
      patm = p/14.6959
      patm2 = patm*patm
      patm4 = patm2*patm2
      if (p.gt.1000..and.h.lt.1280.) go to 5
      t = tgasp1+a1(1)*h+a1(2)*h2+a1(3)*h3+p*(a1 (4) *h+a1(5)*h2+a1(6)*h3)
      cpi = cpgas1+b1(1)*h+b1(2)*h2+b1(3)*h3+plog*(b1(4)*h+b1(5)*h2+
     + b1(6)*h3)
      c = 1.0/cpi
      go to 10
 5    t = tgasp2+a2(1)*h+a2(2) *h2+a2(3) *h3+p*(a2(4) *h+a2(5) *h2+a2(6) *h3)
      cpi = cpgas2+b2(1)*h+b2(2) *h2+b2(3) *h3+plog*(b2(4) *h+b2(5) *h2+
     + b2(6)*h3)
      c = 1.0/cpi
   10 continue
c
c  start iteration loop
c
      do 20 n=1,10
      if(t.ge.-459.6) go to 13
      write(9,12) p,h
   12 format(/3x,"tgas failed -- negative temperature"/18x,
     . "pressure =",e15.6,"  enthalpy =",e15.6)
      call exit
   13 told = t
      tdc = (t-32.)/1.8
```

```
      tdk = tdc + 273.16
      tml = 1./tdk
      tm2 = tm1*tm1
      tm3 = tm1**3
      tm5 = tm1**5
      tm6 = tm1**6
      tm23 = tm1**23
      tm24 = tm23*tm1
      ex = 80870.*tm2
      bo = 1.89-2641.62*tm1*10.**ex
      bt = bo*tm1
      bt2 = bt*bt
      bt3 = bt2*bt
      bt4 = bt3 * bt
      bt12=bt4*bt4*bt4
      bt13=bt12*bt
      g1=82.546*tm1-1.6246*tm2*1.0e+5
      g2 = .21828-1.2697e5*tm2
      g3=3.635e-4*(1.1613e16*tm6)**4
      dg1dt=82.546-1.6246e5*2.*tm1
      dg2dt=-2.*1.2697e5*tm1
      dg3dt=-24.0*(1.1613e16*tm5)**4*tm3
      dbtdt=1.89-2.*2641.62*10.**ex*(1.0+ex*alog(10.))*tm1
      f1=2.*g1*bt*dbtdt+bt2*dg1dt
      f3=4.*bt3*g2*dbtdt+bt4*dg2dt
      f12 = -13.*bt12*g3*dbtdt-bt13*dg3dt
      fp1=1.472*tdk
      fp2=7.5566e-4/2.*tdk**2.
      fp3=47.8365*alog(tdk)
      fp=fp1+fp2+fp3+1803.68
      hp1=patm*dbtdt
      hp2=f1*patm2/2.
      hp3=f3*patm4/4.
      patm13=patm ** 13
      hp4 = f12*patm13/13.0
      hh = (hp1+hp2+hp3+hp4)*.101295+fp
      hh = 0.43*hh
      if (abs(hh-h) .lt. 0.5)  go to 30
c
c  adjust temperature
c
      t = told + (h-hh)/c
      t = 0.2*told+0.8*t
      if (abs(t-told) .lt.1.0) go to 30
20    continue
30    continue
       tv=amax1(35.,t)
      return
```

```
      function poly5 (a,p,h)
      dimension a(5,5)
      f=a(1,5)+p*(a(2,5)+p*(a(3,5)+p*(a(4,5)+p*a(5,5))))
      do 10 j=1,4
      k=5-j
   10 f=f*h+a(1,k)+p*(a(2,k)+p*(a(3,k)+p*(a(4,k)+p*a(5,k))))
      poly5=f
      return
      end

      function vol (p, h)
      dimension c(3,5)
cc    constants for liquid specific volume equation
      data c/  -.4117961750e+1, -.4816067020e-5, -.1820625039e-8,
     1         -.3811294543e-3, +.7744786733e-7, +.1440785930e-10,
     2         +.4308265942e-5, -.6988467605e-9, -.2082170753e-13,
     3         -.9160120130e-8, +.1916720525e-11,-.3603625114e-16,
     4         +.8017924673e-11,-.1760288590e-14,+.7407124321e-19/
      f=c(1,5)+p*(c(2,5)+c(3,5)*p)
      do 10 j=2,4
      k=5-j
   10 f=f*h+c(1,k)+p*(c(2,k)+c(3,k)*p)
      vol=exp(f)
      return
      end


      function vog (p,h)
      dimension c(4,3)
cc    constants for vapor specific volume equation
      data c/  -.1403086182e+4, +.3817195017e+0, -.6449501159e-4,
     1         +.7823817858e-8, +.1802594763e+1, -.5394444747e-3,
     2         +.8437637660e-7, -.1053834646e-10,-.2097979215e-3,
     3         +.1855203702e-6, -.2713755001e-10,+.3629590764e-14/
      f=c(1,3)/p+c(2,3)+p*(c(3,3)+c(4,3)*p)
      do 10 k=1,2
   10 f=f*h+c(1,k)/p+c(2,k)+p*(c(3,k)+c(4,k)*p)
      vog=f
      return
      end


      subroutine form (a,ns)
      common /forms/ ka(80)
      dimension num(15),j(5)
```

```
      data num /1h0,1h1,1h2,1h3,1h4,1h5,1h6,1h7,1h8,1h9,1h.,1he,1h-,1h*,
     1 lh /
      nset=ns-1
      b=a
      if (b.eq.0.)    return
      if (a.lt.0.0001)    go to 60
      if (a.gt.9999.)    go to 110
ccc   come here for non-exponential format.
      if (a.ge.1.) go to 10
      id=1
      go to 30
   10 id=2
      do 20 k=1,11
      b=b/10.
      if (b.lt.1.) go to 30
      id=id+1
   20 continue
   30 b=a*10.**(5-id)+.5
      do 40 i=1,4
      j(i)=ifix(b/10**(4-i))+1
      b=b-(j(i)-1)*10.**(4-i)
   40 continue
      do 50 l=1,4
      iadd=0
      if (l.ge.id) iadd=1
      i=j(l)
      ka(l+iadd+nset)=num(i)
   50 continue
      ka(i d+nset)=num(11)
      go to 140
ccc   come here for negative exponential format.
   60 nexp=ifix(alog10(a))-1
      front=a/10.**nexp
      if (front.lt.10.) go to 70
      nexp=nexp+1
      front=1.0
   70 continue
      if (nexp.ge.-9) go to 90
ccc   set field to *'s if >=1e-10
      do 80 l=1,5
   80 ka(l+nset)=num(14)
      go to 140
   90 iz=ifix(front+.5)
      if (iz.le.9)   go to 100
      iz=l
      nexp=nexp+1
  100 ka(1+nset)=num(iz+1)
      ka(2+nset)=num(11)
```

```
      ka(3+nset)=num(12)
      ka(4+nset)=num(13)
      ka(5+nset)=num(iabs(nexp)+1)
      go to 140
ccc   come here for positive exponential format.
  110 nexp=ifix(alog10(a))
      front=a/(1.*10.**nexp-1)
      iz2=ifix((front-ifix(front))*10.+.5)
      if (iz2.le.9)   go to 120
      iz2=0
      front=front+.5
  120 iz1=ifix(front+.5)
      if (iz1.le.9)   go to 130
      iz1=1
      nexp=nexp+1
  130 ka(1+nset)=num(iz1+1)
      ka(2+nset)=num(11)
      ka(3+nset)=num(iz2+1)
      ka(4+nset)=num(12)
      ka(5+nset)=num(nexp+1)
      if (nexp.le.9) go to 140
      ka(3+nset)=num(12)
      ka(4+nset)=num(nexp/10+1)
      ka(5+nset)=num(nexp-(nexp/10)*10+1)
  140 continue
      return
      entry blankit
      do 150 i=1,80
  150 ka(i)=num(15)
      return
       end
```

APPENDIX B

COBRA-NC MODIFICATION CARD LISTING

APPENDIX B

COBRA-NC MODIFICATION CARD LISTING

```
*id asb
*/
*/  start asb updates
*/ use feet and not inches  as geometry input
*i input.9
      common/unite/ enguni
*d upd13.723
      read (in, 10050) icobra,iapenk,inguni
      enguni=float(inguni)
      if(enguni.le.0.)   enguni=1.
*i setin.38
      common/unite/ enguni
*d setin.41
      data feets,sqfts,btu /12.,144.,3412./
*i setin.43
      feet=feets/enguni
      sqft=sqfts/enguni**2
*d setin.51
      read(i2,10000)ngroup,n1,n2,n3,n4,n5,n6,n7,n8
*d setin.53
      write(i3,10000)ngroup,n1,n2,n3,n4,n5,n6,n7,n8
*/ adds multplier on  wall heat transfer correlation
*/  whtcf and nwhtcf must be added to comdeck xtradat
*i prep3d.373
c
c      find time varying multplier on wall heat transfer coefficient.
      if(nwhtcf .gt.0) call curvel(whtcf,etime,nwhtcf)
*i setin.797
      nwhtcf=n5
      whtcf=1.
*/
*/ these changes add the critical flow model to xschem
*/  mcrit, ncritc, and ncritk must be added to comdeck xtradat
*i setin.63
      mcrit=n8
*/ add input of locations to check for critical flow
*/ add icrit and kcrit to common snkdat
*i setin.1417
      ncritc=n5
      ncritk=n6
*d setin.1503
```

```
      if(ngbnd.lt.1) go to 1377
*i setin.1526
 1377 if(ncritc.lt.1) go to 1395
      do 1380 l=1,ncritc
      read (12,10130) (icrit(n,l),n=1,2)
      icrit(3,l)=0.0
      msk=0
      do 1379 n=1,nibnd
      if(ispec(n) .ne.5) go to 1379
      msk=msk+l
      if(ibound(1,n).ne.icrit(1,l)) go to 1379
      if(ibound(2,n).ne.icrit(2,l)) go to 1379
      icrit(3,l)=msk
      go to 1380
 1379 continue
 1380 continue
      if(ncritc.le.mudim) go to 1395
      write(i3,20251) ncritc,mudim
20251 format(10x,"in card group 13, ncritc exceeds allowed dimensions"/
     1  10x,"ncritc="i5," mu=",i5//)
      istop=1
 1395 if(ncritk.lt.1) go to 1397
      do 1396 l=1,ncritk
 1396 read (12,10130) (kcrit(n,l),n=1,2)
      if(ncritk.le.mudim) go to 1397
      write(i3,20252) ncritk,mudim
20252 format(10x,"in card group 13, ncritk exceeds allowed dimensions"/
     1  10x,"ncritk="i5," mu=",i5//)
      istop=1
 1397 continue
*i prep3d.36
c
c     re initialize iaspec when critical flow model used
      if(mcrit.eq.0)   go to 3
      do 2 ic=1,nchanl
      i=idchar(ic)
      isec=lchar(i)
      jnodes=isects(isec,1)+2
      do 2 j=1,jnodes
      iaspec(i,j) =10
    2 continue
    3 continue
*i xschem.1258
c   check for critical flow calculation
c
      if(mcrit) 1824,1824,1801
 1801 msk=0
      if(ncritc) 1817,1817,1802
```

```fortran
 1802 do 1815 l=1,ncritc
      i=icrit(1,l)
      j=icrit(2,l)
      isp=iaspec(i,j)
      if((isp-10)*(isp-1)) 1809,1803,1809
 1803 sumf = fem(i,j) + fgm(i,j) + flm(i,j)
      jstar = j
      if(sumf) 1806,1815,1807
 1806 jstar=jp1
 1807 rll=rl(i,jstar)
      alrlst = aliq(i,jstar)*rll
      alrv=0.5*(al(i,j)*(rv(i,j)+rmgas(i,j))+al(i,jp1)*(rv(i,jp1)+rmgas
     1(i,jp1)))
      alrl=0.5*(aliq(i,j)*rl(i,j)+aliq(i,jp1)*rl(i,jp1))
      aerl=0.5*(ae(i,j)*rl(i,j)+ae(i,jp1)*rl(i,jpl))
      flc=flm(i,j)*alrlst/alrl
      aerlst=ae(i,jstar)*rll
      fec=fem(i,j)*aerlst/aerl
      rvapm=(rv(i,jstar)+rmgas(i,jstar))
      agrgst=al(i,jstar)*rvapm
      fgc=fgm(i,j)*agrgst/avrv
      sumf=fgc+fec+flc
      c1=alrlst+aerlst
      hvgas=rv(i,jstar)*hv(i,jstar)+rmgas(i,jstar)*hmgas(i,jstar)
      sumh=(c1*hl(i,jstar)+al(i,jstar)*hvgas)/(c1+agrgst)
      call gcritf(p(i,jstar)*ri144+pref,sumh,mcrit,gcrit,s,
             rvapm,rll)
      fcrit = gcrit*amom(i,j)
      if(fcrit .gt. sumf) go to 1815
      sumf =fcrit/(c1+s*agrgst)*sign(1.,sumf)
      fem(i,j) =  sumf*aerl
      fgm(i,j) =  sumf*avrv*s
      flm(i,j) =  sumf*alrl
      dfemdp(i,j) = 0.
      dfgmdp(i,j) = 0.
      dflmdp(i,j) = 0.
c   treat as forced flow boundry
        iaspec(i,j)=2
      go to 1815
 1809 if(isp-5) 1815,1810,1815
 1810 msk=icrit(3,l)
 1811 sumw = wesink(msk) + wgsink(msk)+wlsink(msk)
      if(sumw) 1812,1815,1813
 1812 pstar = p(i,j)*ri144 + pref
      c1 = rl(i,jp1)*(aliq(i,jp1)+ae(i,jpl))
      c2 = (rv(i,jpl) + rmgas(i,jp1))*al(i,jpl)
      rll=rl(i,jpl)
      rvv= rv(i,jp1)+rmgas(i,jp1)
```

```
      sumh = (c1*hl(i ,jpl) +(rv(i,jp1)*hv(i,jp1)+
     $rmgas(i,jp1)*hmgas(i,jp1))*asink(msk))/(c1+c2)
      go to 1814
 1813 cl = rlsink(msk)*(aliqs(msk) + aesink(msk))
      c2 = (rvsink(msk) + rmgsink(msk)) * alsink(msk)
      rll=rlsink(msk)
      rvv=rvsink(msk)+rmgsink(msk)
      sumh = (c1*hlsink(msk)+alsink(msk)*(rmgsink(msk)
     $*hgsink(msk)+rvsink(msk)*hvsink(msk)))/(c1+c2)
      pstar = psink(msk)*ri144 + pref
 1814 call gcritf(pstar, sumh,mcrit,gcrit,s,rvv,rll)
      fcrit = gcrit * asink(msk)*sign(1.,sumw)
      sumf = abs(sumw)
      if (fcrit  .gt. sumf) go to 1815
      sumf = fcrit/(c1+c2*s)*sign(l., sumw)
c      assume  alfal = alfae
      wesink(msk) =sumf*.5*c1
      wgsink(msk) =sumf*s*c2
      wlsink(msk) =sumf*.5*c1
      dwesink(msk) = 0.
      dwgsink(ms k)=0.
      dwlsink(msk)=0.
 1815 continue
c
c   check for gap critical flow
 1817 if(ncri tk)  1824,1824,1818
 1818 do 1823 l=1,ncritk
      k=kcrit(1,l)
      j=kcrit(2,l)
      ii=ik(k)
      jj=jk(k)
      sumw = wem(k,j) + wgm(k,j)+wlm(k,j)
      istar = ii
      if(sumw)  1821,1823,1822
 1821 istar=jj
 1822 rl1=rl(i star,j)
      alrls=aliq(istar,j)*rl1
      alrlisx=alrl/sdx
      aerls=aliq(istar,j)*rl1
      alerisx=alre/sdx
      alrvs=al(istar,j)*(rv(istar,j)+rmgas(istar,j))
      alrvisx=alrv/sdx
      wlc=wlm(k,j)*alrls/alrlisx
      wec=wem(k,j)*aerls/alreisx
      wgc=wgm(k,j)*alrvs/alrvisx
      rvapm=rv(istar,j)+rmgas(istar,j)
      sumf=wlc+wec+wgc
      c1=aerls+alrls
```

```
      hvgas=rv(istar,j)*hv(istar,j)+rmgas(istar,j)*hmgas(istar,j)
      sumh=(c1*hl(istar,j)+al(istar,j)*hvgas)/(c1+alrvs)
      call gcritf(p(i,j)*ri144+pref,sumh,mcrit,gcrit,s,rvamp,rll)
      wcrit = gcrit*sdx
      if(wcrit .gt. abs(sumf)) go to 1823
      sumw = wcrit/(c1+s*alrvs)*sign(l., sumf)
      wem(k,j) =  sumw*alreisx
      wgm(k,j) =  sumw*s*alrvisx
      wlm(k,j) =  sumw*alrlisx
      dwemdp(k,j) = 0.
      dwgmdp(k,j) = 0.
      dwlmdp(k,j) = 0.
 1823 continue
 1824 continue
*d xschem.2069
      if(dwgmdp(k,j).eq.0.) go to 3655
*i xschem.2083
      go to 3670
 3655 dumgx=1.
      dumvx=1.
      dumlx=1.
      dumex=1.
 3670 continue
*/ add critical flow tables to common
*i cobratf.25
       common /leakc / g01(735) ,ng,npi
       common /leakhe / pe01(368),nhhe,nphe
       common / leakh / pm(1062),nhh,nph
*i blkdat.448
      call datm
      call datz
      call dath
*/ the following make  changes to cobra-nc
*/ specifically  for asb by changing the way in which
*/ the output is formated.
*d cobratf.4
     $       tape10,tape59,fiche,tape4=fiche)
*i cobratf.11
*call  ocommn
      common /outasb/ asbint,iedit,asbedit
*i edit.7
      common /outasb/ asbint,iedit,asbedit
*i setin.38
      common /outasb/ asbint,iedit,asbedit
*i setin.1538
      asbint = float(n8)
*i trans.15
      common /outasb/ asbint,iedit,asbedit
```

```
*i timstp.17
      common /outasb/ asbint,iedit,asbedit
*i timstp.34
      if(asbint.gt.0) read (in,402) asbint
*i timstp.56
      if(asbint.le.0) go to 150
      write(iout,3201) asbint
      write(imout ,3201) asbint
      write(itty,3201) asbint
 3201 format(lx, " interval for  a.s.b. output is ",f10.5," seconds.")
  150 continue
*i timstp.67
      asbedit=timet+asbint
*d trans.179
      iedit=O
      if(timet.lt.(tedi t-eps))  go to 325
      iedit =iedit+1
  325 if(asbint.le.0) go to328
      if(timet.lt.(asbedit-eps)) go to 328
      iedit=iedit+2
  328 if(iedit.eq.0)   go to 330
*i trans.205
      iedit=l
      if(asbint.gt.0,)  iedit=2+iedit
      idon=1
*i blkdat.2
*call ocommn
*b blkdat.420
      data iprcnt/0/,idon/0/
*i edit.2
*call mcmx
*call spltdat
*call twophas
*call xtradat
*call propdat
*call ocommn
*call mfrac
*call gasvar
*b edit.10
      dimension ck(9)
      data ck/-7.691234564,  -2.608023696e+1,  -1.681706546e+2,
           6.423285504e+1,  -1.189646225e+2,  4.167117320,
     .     2.097506760e+1,  1.e9,  6./
*i edit.21
c   if asb output is required
c   i3 is set to 4 so that all the data from
c    subroutine result goes to lun 4.  i3 will be set
c   back to 6 before returning.
```

```
c
      if(asbint.gt.0.)   i3=4
      if(iedit.eq.2) go to 60
*i edit.24
   60 i3=6
      if(iedit.eq.1) go to 100
c     setup asb output
      asbedit=asbedit+asbint
c
c   store results in arrays until 50 entries
c   have been accumulated. if 50 entries have
c   been accumulated, call "prnter" to report
c   them.
c
      istop=iprcnt
      iprcnt=iprcnt + 1
      if(iprcnt.gt.50) call prnter(istop)
      if(iprcnt.gt.50)  iprcnt=1
      strtim(iprcnt)=etime
c
      if(nout1.le.0) go to  90
c
      iknt=0
c
      do  85 indx=1,nout1
      i=printc(indx)
      jnode=isects(lchan(i),1) + 1
      iknt=iknt + 1
c
c   store pressure
c
      storep(iknt,iprcnt)=p(i,jnode) / 144.0  + pref
c
c   store liquid fraction
c
      storal(iknt,iprcnt)=aliq(i,jnode )
c
c   store temperature
c
      rhomix=rmgas(i,jnode)+rv(i,jnode)
      vap=rv(i,jnode)/rhomix
      sum=vap/18.105
      do  65 nga=1,ngas
      frctnga=rgas(nga,i,jnode)/rhomix
      sum=sum+frctnga/mw(nga)
   65 continue
      ppvap=vap/18.105/sum
      pps=ppvap * (p(i,jnode) / 144.0  + pref)
```

```
      ppss=pps
      hvij=hv(i,jnode)
      ssat=tv(pps, hvij)
      theta=(ssat+459.67)/1.8/647.3
      sums=0.
      onemt=1.-theta
      onemt2=onemt*onemt
      pionemt=1.
      do  70 i=1,5
      pionemt=pionemt*onemt
      sums=sums+ck(i)*pionemt
   70 continue
      sums=sums/theta
      sums=sums/(1.+ck(6)*onemt+ck(7) *onemt2)
      sums=sums-onemt/(ck (8) *onemt2+ck(9) )
      beta=exp(sums)
      pssat=beta*2984.907486
 75   continue
c
 80   continue
c
      storet(i knt,iprcnt)=ssat
c
c   store relative humidity
c
      storrh(i knt,iprcnt)=ppss/pssat
c
c
 85   continue
      if(idon.eq.1) call prnter(istop+1)
c
 90   continue
*i error.5
*call ocommn
*i error.22
      idon=1
*i trans.2
*call ocommn
c
*af ,momntd2
*comdeck ocommn
c
c   this is common block is used to save containment
c   data for printing later. the dimensions are:
c
c    no. of rooms (max.  to be printed) x 50
c
      common/ocomn/ iprcnt,idon,storal(30 ,50),storep(30 ,50),
```

```
     1    storet(30,50),storrh(30,50),strtim(50)
*af ,cwvssl
*deck prnter
      subroutine prnter(istop)
c
*call xtradat
*call ocommn
c   this subroutine prints results
c   for the containment version of
c   cobra-tf
c
c   this is a much simpler routine than
c   "result".
c
c   only pressure, temperature, relative humidity,
c   and liquid fraction are reported. only one
c   node per "room" (channel) is reported as a function
c   of time.
c
c   first, pressure.
c
      ibeg=0
c
100   continue
c
      ibeg=ibeg + 1
      if(ibeg.gt.nout1) go to 175
      ifin=min0 (ibeg+9,nout1)
c
      write(i3,10001) (printc(i),i=ibeg,ifin)
10001 format(1h1,59x,"pressure (psia)"//2x,"time",
     1    10(4x,"room",i4)/2x,"(sec)"//)
c
      do 150 ii=1,istop
      write(i3,10002) strtim(ii),(storep(iknt,ii),iknt=ibeg,ifin)
10002 format(lx,f8.2,10(1x,lpe11.4))
150   continue
c
      ibeg=ifin
      go to 100
c
175   continue
c
      ibeg=0
c
200   continue
c
      ibeg=ibeg + 1
```

```
      if(i beg.gt.nout1) go to 275
      ifin=min0(ibeg + 9,nout1)
c
      write(i3,10003) (printc(i),i=ibeg,ifin)
10003 format(lhl, 53x,"temperature(degrees  f.)"//2x,
     1    "time",10(4x,"room",i4)/2x,"(sec)"//)
c
      do 250 ii=1,istop
      write(i3,10002) strtim(ii),(storet(iknt,ii),
     1    iknt=ibeg,ifin)
250   continue
c
      ibeg=ifin
      go to 200
c
275   continue
c
      ibeg=0
c
300   continue
c
      ibeg=ibeg + 1
      if(ibeg.gt.nout1) go to 375
      ifin=min0(ibeg + 9,nout1)
c
      write(i3,10004) (printc(i),i=ibeg,ifin)
10004 format(1h1,57x,"relative humidity"//2x,"time",
     1    10(4x,"room",i4)/2x,"(sec)"//)
c
      do 350 ii=1,istop
      write(i3,10002) strtim(ii),(storrh(iknt,ii),
     1    iknt=ibeg,ifin)
350   continue
c
      ibeg=ifin
      go to 300
c
375   continue
c
      ibeg=0
c
400   continue
c
      ibeg=ibeg + 1
      if(i beg.gt.nout1) go to 475
      ifin=min0(i beg + 9,noutl)
c
      write(i3,10005) (printc(i),i=ibeg,ifin)
```

```
10005 format(1h1,59x,"liquid fraction"//2x,"time",
     1    10(4x,"room",i4)/2x,"(sec)"//)
c
      do 450 ii=1,istop
      write(i3,10006) strtim(ii),(storal(iknt,ii),
     1    iknt=ibeg,ifin)
10006 format(1x,f8.2,3x,f7.5,9(5x,f7.5))
450   continue
c
      ibeg=ifin
      go to 400
c
475   continue
c
      return
      end
*af ,tods
*deck tvofph
      function tv(p,h)
c     p(psi),h(btu/lbm)
      dimension  av(5,5), ac(5,5)
c     constants for vapor temperature equation
      data av/ -.1179100862e+5, +.1256160907e+3, -.1083713369e+0,
     1          +.3278071846e-4, -.3425564927e-8, +.2829274345e+2,
     2          -.3333448495e+0, +.2928177730e-3, -.8970959364e-7,
     3          +.9527692453e-11,-.2678181564e-1,+.3326901268e-3,
     4          -.2972436458e-6, +.9246248312e-10,-.1001409043e-13,
     5          +.1218742752e-4, -.1477890326e-6, +.1342639113e-9,
     6          -.4249155515e-13,+.4703914404e-17,-.2092033147e-8,
     7          +.2463258371e-10,-.2275585718e-13,+.7338316751e-17,
     8          -.8315044742e-21/
c     above critical pressure
      data ac/ +.3795256853e+4, -.3910086240e+1, +.3410500159e-4,
     1          +.1527377542e-6, -.1437179752e-10,-.6347031007e+1,
     2          +.1222747819e-1, +.7010900113e-9, -.5356866315e-9,
     3          +.5006731336e-13,+.2867228326e-2, -.1404664699e-4,
     4          -.1030201866e-9,+.96823225984e-12,-.6365519546e-16,
     5          +.5953599813e-8, +.7505679464e-8, +.5731099333e-14,
     6          -.3668096142e-15,+.3473711350e-19,+.4798207438e-10,
     7          -.1608693653e-11,+.3720795449e-16,+.6946004624e-19,
     8          -.6842306083e-23/
      if(p.gt.3208.2)   go to 100
      tv=poly5(av,p,h)
      return
  100 tv=poly5(ac,p,h)
      return
      end
      function  poly5(a,p,h)
```

```
      dimension  a(5,5)
      f= a(1,5) +p*(a(2,5)+p*(a(3,5)+p*(a(4,5)+p*a(5,5))))
      do 10 j=1,4
      k=5-j
   10 f= f*h +a(1,k)+p*(a(2,k) +p*(a(3,k)+p*(a(4,k)+p*a(5,k))))
      poly5=f
      return
      end
*deck datm
      subroutine datm
c
      common / leakc / g01(35), g02(35), g03(35), g04(35), g05(35),
     1       g06(35), g07(35), g08(35), g09(35), g10(35), g11(35),
     2       g12(35), g13(35), g14(35), g15(35), g16(35), g17(35),
     3       g18(35), g19(35), g20(35), g21(35), ng, npi
c
c     critical flow tables
c
c     gxx(1)     = stagnation pressure  (psia)
c     gxx(even)  = maximum flow rate  (lbm/ft**2-sec)
c     gxx(odd)   = stagnation enthalpy  (btu/lb)
c
c     ng     = number of pairs of flow and enthalpy values per pressure
c     npi    = number of pressure values
c
      data  ng, npi / 17, 21 /
c
      data g01 /       1.0e0,  214.71e0,  69.733e0,   20.11e0, 173.340e0,
     1   10.95e0, 276.948e0,    7.54e0, 380.555e0,    5.76e0, 484.163e0,
     2    4.65e0, 587.771e0,    3.91e0, 691.378e0,    3.37e0, 794.986e0,
     3    2.96e0, 898.593e0,    2.64e0,1002.201e0,    2.38e0,1105.809e0,
     4    2.50e0,1112.678e0,    2.00e0,1238.828e0,    1.80e0,1369.999e0,
     5    1.60e0,1507.606e0,    1.40e0,1652.162e0,    1.30e0,1803.545e0/
      data g02 /       5.0e0,  527.49e0, 130.196e0,   90.72e0, 230.286e0,
     1   50.86e0, 330.376e0,   35.44e0, 430.465e0,   27.21e0, 530.555e0,
     2   22.09e0, 630.645e0,   18.60e0, 730.734e0,   16.06e0, 830.824e0,
     3   14.13e0, 930.913e0,   12.62e0,1031.003e0,   11.39e0,1131.093e0,
     4   11.70e0,1142.565e0,    9.80e0,1264.479e0,    8.60e0,1390.263e0,
     5    7.70e0,1521.800e0,    7.10e0,1659.584e0,    6.60e0,1803.492e0/
       data g03 /     10.0e0,  767.75e0, 161.261e0,  171.18e0, 259.470e0,
     1   97.76e0, 357.678e0,   68.64e0, 455.887e0,   52.93e0, 554.096e0,
     2   43.09e0, 652.305e0,   36.34e0,750.513e0,    31.42e0, 848.722e0,
     3   27.67e0, 946.931e0,   24.73e0,1045.140e0,   22.35e0,1143.348e0,
     4   22.90e0,1157.466e0,   19.30e0,1277.542e0,   17.10e0,1400.619e0,
     5   15.40e0,1529.045e0,   14.20e0,1663.351e0,   13.10e0,1803.425e0/
      data g04 /      14.7e0,  943.01e0, 180.179e0,  242.34e0, 277.210e0,
     1  140.17e0, 374.240e0,   98.93e0, 471.270e0,   76.51e0, 568.300e0,
     2   62.40e0, 665.331e0,   52.69e0, 762.361e0,   45.60e0, 859.391e0,
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     3   40.19e0, 956.421e0,   35.93e0,1053.452e0,   32.49e0,1150.482e0,
     4   33.10e0,1166.3770e0,  28.20e0,1258.449e0,   24.90e0,1406.903e0,
     5   22.60e0,1533.437e0,   20.80e0,1665.624e0,   19.30e0,1803.363e0/
      data g05 /    50.0e0, 1787.76e0, 250.212e0,  706.24e0, 342.600e0,
     1 432.14e0, 434.988e0,  312.25e0, 527.376e0,  244.68e0, 619.764e0,
     2 201.24e0, 712.153e0,  170.93e0, 804.541e0,  148.58e0, 896.929e0,
     3 131.40e0, 989.317e0,  117.79e0,1081.705e0,  106.74e0,1174.093e0,
     4 107.50e0,1196.581e0,   92.90e0,1312.998e0,   83.20e0,1428.913e0,
     5  76.00e0,1548.789e0,   70.40e0,1673.458e0,   65.80e0,1802.893e0/
      data g06 /   100.0e0, 2546.50e0, 298.538e0, 1252.95e0, 387.401e0,
     1 802.83e0, 476.264e0,  591.90e0, 565.127e0,  469.15e0, 653.989e0,
     2 388.73e0, 742.852e0,  331.92e0, 831.715e0,  289.63e0, 920.578e0,
     3 256.92e0,1009.440e0,  230.86e0,1098.303e0,  209.60e0,1187.166e0,
     4 209.20e0,1214.890e0,  182.30e0,1330.371e0,  164.50e0,1442.897e0,
     5 151.10e0,1558.489e0,  140.30e0,1678.248e0,  131.60e0,1802.229e0/
      data g07 /   200.0e0, 3608.16e0, 355.506e0, 2153.39e0, 439.789e0,
     1 1463.65e0, 524.071e0, 1108.91e0, 608.354e0,  893.05e0, 692.637e0,
     2 747.78e0, 776.920e0,  643.27e0, 861.202e0,  564.45e0, 945.485e0,
     3 502.88e0,1029.768e0,  453.44e0,1114.051e0,  412.87e0,1198.334e0,
     4 407.00e0,1234.101e0,  357.60e0,1349.174e0,  325.00e0,1458.103e0,
     5 300.00e0,1568.929e0,  279.90e0,1683.135e0,  263.30e0,1800.900e0/
      data g08 /   400.0e0, 5084.55e0, 424.167e0, 3560.62e0, 502.210e0,
     1 2601.91e0, 580.252e0, 2044.87e0, 658.294e0, 1683.97e0, 736.337e0,
     2 1413.45e0, 814.379e0, 1244.89e0, 892.421e0, 1101.42e0, 970.464e0,
     3 987.66e0,1048.506e0,  895.23e0,1126.548e0,  818.64e0,1204.591e0,
     4 792.40e0,1253.154e0,  701.20e0,1368.603e0,  641.80e0,1473.887e0,
     5 595.90e0,1579.509e0,  558.50e0,1687.509e0,  527.30e0,1798.245e0/
      data g09 /   600.0e0, 6192.24e0, 471.697e0, 4682.13e0, 544.893e0,
     1 3588.84e0, 618.089e0, 2897.01e0, 691.285e0, 2426.85e0, 764.481e0,
     2 2087.61e0, 837.677e0, 1831.53e0, 910.873e0, 1631.43e0, 984.069e0,
     3 1470.77e0,1057.265e0, 1338.95e0,1130.461e0, 1228.83e0,1203.657e0,
     4 1172.40e0,1262.896e0, 1040.80e0,1379.241e0,  956.20e0,1482.588e0,
     5 890.60e0,1585.098e0,  837.00e0,1689.262e0,  792.00e0,1795.591e0/
      data g10 /   800.0e0, 7103.30e0, 509.811e0, 5630.54e0, 578.769e0,
     1 4472.42e0, 647.726e0, 3689.49e0, 716.684e0, 3135.77e0, 785.641e0,
     2 2725.47e0, 854.599e0, 2409.78e0, 923.557e0, 2159.53e0, 992.514e0,
     3 1956.33e0,1061.472e0, 1788.08e0,1130.429e0, 1646.48e0,1199.387e0,
     4 1550.10e0,1268.822e0, 1378.50e0,1386.128e0, 1269.40e0,1488.245e0,
     5 1184.90e0,1588.533e0, 1115.70e0,1689.882e0, 1057.40e0,1792.940e0/
      data g11 /  1000.0e0, 7883.70e0, 542.551e0, 6458.25e0, 607.589e0,
     1 5277.33e0, 672.628e0, 4434.96e0, 737.666e0, 3818.11e0, 802.705e0,
     2 3349.91e0, 867.743e0, 2983.26e0, 932.782e0, 2688.66e0, 997.820e0,
     3 2446.89e0,1062.859e0, 2244.95e0,1127.898e0, 2073.79e0,1192.936e0,
     4 1928.00e0,1272.169e0, 1715.80e0,1390.601e0, 1582.30e0,1491.960e0,
     5 1479.30e0,1590.602e0, 1394.80e0,1689.784e0, 1323.60e0,1790.290e0/
      data g12 /  1200.0e0, 8566.61e0, 571.853e0, 7194.59e0, 633.149e0,
     1 6018.53e0, 694.445e0, 5141.21e0, 755.741e0, 4478.45e0, 817.037e0,
     2 3964.05e0, 878.333e0, 3554.43e0, 939.629e0, 3221.01e0,1000.925e0,
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     3 2944.51e0,1062.221e0, 2711.61e0,1123.517e0, 2512.78e0,1184.813e0,
     4 2306.00e0,1274.362e0, 2052.90e0,1393.811e0, 1895.20e0,1494.624e0,
     5 1773.90e0,1591.920e0, 1674.40e0,1689.289e0, 1590.60e0,1787.642e0/
      data g13 /   1400.0e0, 9171.02e0, 598.830e0, 7857.52e0, 656.477e0,
     1 6705.77e0, 714.125e0, 5813.30e0, 771.773e0, 5119.72e0, 829.420e0,
     2 4569.95e0, 887.068e0, 4125.04e0, 944.716e0, 3758.28e0,1002.364e0,
     3 3450.98e0,1060.011e0, 3189.90e0,1117.659e0, 2965.42e0,1175.307e0,
     4 2684.80e0,1275.682e0, 2390.20e0,1396.083e0, 2208.30e0,1496.504e0,
     5 2068.80e0,1592.681e0, 1954.50e0,1688.499e0, 1858.30e0,1784.994e0/
      data g14 /   1600.0e0, 9708.52e0, 624.202e0, 8458.62e0, 678.235e0,
     1 7345.72e0, 732.268e0, 6454.71e0, 786.300e0, 5743.98e0, 840.333e0,
     2 5169.19e0, 894.366e0, 4696.66e0, 948.399e0, 4302.13e0,1002.431e0,
     3 3968.12e0,1056.464e0, 3681.89e0,1110.497e0, 3433.97e0,1164.530e0,
     4 3067.10e0,1275.712e0, 2729.00e0,1397.285e0, 2522.30e0,1497.542e0,
     5 2364.50e0,1592.855e0, 2235.40e0,1687.403e0, 2126.80e0,1782.347e0/
      data g15 /   1800.0e0,10186.24e0, 648.490e0, 9005.71e0, 698.875e0,
     1 7943.45e0, 749.258e0, 7068.47e0, 799.642e0, 6353.40e0, 850.027e0,
     2 5763.77e0, 900.411e0, 5271.40e0, 950.795e0, 4855.02e0,1001.179e0,
     3 4498.77e0,1051.564e0, 4190.73e0,1101.948e0, 3921.87e0,1152.332e0,
     4 3448.60e0,1275.998e0, 3067.70e0,1398.372e0, 2836.40e0,1498.413e0,
     5 2660.50e0,1592.891e0, 2516.90e0,1686.228e0, 2396.00e0,1779.701e0/
      data g16 /   2000.0e0,10608.22e0, 672.111e0, 9504.17e0, 718.734e0,
     1 8503.14e0, 765.356e0, 7657.68e0, 811.979e0, 6950.77e0, 858.601e0,
     2 6356.68e0, 905.224e0, 5852.74e0, 951.846e0, 5420.97e0, 998.468e0,
     3 5047.45e0,1045.091e0, 4721.42e0,1091.713e0, 4434.55e0,1138.336e0,
     4 3833.80e0,1257.411e0, 3408.30e0,1398.751e0, 3151.70e0,1498.725e0,
     5 2957.50e0,1592.538e0, 2799.20e0,1684.851e0, 2666.10e0,1777.056e0/
      data g17 /   2200.0e0,10975.67e0, 695.462e0, 9956.80e0, 738.132e0,
     1 9027.41e0, 780.802e0, 8224.65e0, 823.471e0, 7538.67e0, 866.141e0,
     2 6951.18e0, 908.811e0, 6444.80e0, 951.481e0, 6004.98e0, 994.150e0,
     3 5620.04e0,1036.820e0, 5280.64e0,1079.490e0, 4979.37e0,1122.159e0,
     4 4220.10e0,1274.756e0, 3749.80e0,1398.911e0, 3467.80e0,1498.821e0,
     5 3255.10e0,1592.023e0, 3082.30e0,1683.386e0, 2937.10e0,1774.411e0/
      data g18 /   2400.0e0,11209.60e0, 718.953e0,10316.18e0, 757.431e0,
     1 9486.43e0, 795.909e0, 8750.33e0, 834.387e0, 8105.54e0, 872.866e0,
     2 7541.38e0, 911.344e0, 7046.15e0, 949.822e0, 6609.24e0, 988.300e0,
     3 6221.66e0,1026.779e0, 5875.90e0,1065.257e0, 5565.81e0,1103.735e0,
     4 4619.20e0,1271.798e0, 4096.70e0,1397.651e0, 3787.00e0,1497.913e0,
     5 3554.70e0,1590.843e0, 3366.60e0,1681.584e0, 3208.80e0,1771.765e0/
      data g19 /   2600.0e0,11428.29e0, 744.475e0,10644.57e0, 778.232e0,
     1 9914.50e0, 811.988e0, 9254.60e0, 845.745e0, 8664.25e0, 879.502e0,
     2 8137.27e0, 913.259e0, 7666.18e0, 947.016e0, 7243.77e0, 980.772e0,
     3 6863.58e0,1014.529e0, 6520.03e0,1048.286e0, 6208.34e0,1082.043e0,
     4 5012.40e0,1270.621e0, 4441.80e0,1397.239e0, 4105.40e0,1497.515e0,
     5 3854.20e0,1589.972e0, 3651.40e0,1679.930e0, 3481.50e0,1769.120e0/
      data g20 /   2800.0e0,11589.07e0, 770.686e0,10931.29e0, 799.200e0,
     110314.45e0, 827.715e0, 9746.45e0, 856.230e0, 9227.42e0, 884.745e0,
     2 8754.35e0, 913.260e0, 8323.15e0, 941.774e0, 7929.53e0, 970.289e0,
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     3 7569.46e0, 998.804e0, 7239.24e0,1027.319e0, 6935.60e0,1055.834e0,
     4 5411.00e0,1269.067e0, 4789.20e0,1396.501e0, 4425.40e0,1496.853e0,
     5 4154.90e0,1588.914e0, 3937.10e0,1678.177e0, 3755.00e0,1766.475e0/
      data g21 /   3000.0e0,11604.42e0, 801.845e0,11109.66e0, 823.687e0,
     110640.97e0, 845.529e0,10200.60e0, 867.371e0, 9788.61e0, 889.213e0,
     2 9403.93e0, 911.055e0, 9044.98e0, 932.898e0, 8709.95e0, 954.740e0,
     3 8397.01e0, 976.582e0, 8104.38e0, 998.424e0, 7830.38e0,1020.266e0,
     4 5816.40e0,1267.043e0, 5139.50e0,1395.404e0, 4747.10e0,1495.908e0,
     5 4456.80e0,1587.660e0, 4223.80e0,1676.323e0, 4029.40e0,1763.830e0/
c
      end
*deck date
      subroutine datz
c
      common / leakhe / pe01(23), pe02(23), pe03(23), pe04(23),
     1         pe05(23), pe06(23), pe07(23), pe08(23), pe09(23),
     2         pe10(23), pe11(23), pe12(23), pe13(23), pe14(23),
     3         pe15(23), pe16(23),nhhe,nphe
c
c     henry model critical flow tables extend to subcooled region
c
c     pe(   1,i) = stagnation pressure (psia)
c     pe(even,i) = maximum flow rate (lb/ft**2-sec)
c     pe( odd,i) = stagnation enthalpy (btu/lb)
c
c     nphe = number of pressure values
c     nhhe = number of pairs of enthalpy and flow values per pressure
c
      data nhhe,nphe / 11,16 /
c
      data pe01 /  10.0e0,    2293.0e0,  64.630e0,  2255.0e0,  74.271e0,
     1  2204.0e0,  83.914e0,  2140.0e0,  93.560e0,  2059.0e0, 103.210e0,
     2  1955.0e0, 112.866e0,  1820.0e0, 122.527e0,  1647.0e0, 132.195e0,
     3  1415.0e0, 141.871e0,  1108.0e0, 151.556e0,   768.0e0, 161.261e0/
c
      data pe02 /  14.7e0,    2788.0e0,  74.023e0,  2744.0e0,  84.605e0,
     1  2684.0e0,  95.190e0,  2609.0e0, 105.780e0,  2512.0e0, 116.377e0,
     2  2388.0e0, 126.981e0,  2227.0e0, 137.594e0,  2014.0e0, 148.217e0,
     3  1735.0e0, 158.852e0,  1369.0e0, 169.501e0,   943.0e0, 180.179e0/
c
      data pe03 /  50.0e0,    5174.0e0, 108.576e0,  5094.0e0, 122.624e0,
     1 4989.0e0,  136.686e0,  4853.0e0, 150.766e0,  4679.0e0, 164.868e0,
     2 4449.0e0,  178.996e0,  4156.0e0, 193.154e0,  3771.0e0, 207.349e0,
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     1 7059.0e0,  164.470e0,  6870.0e0, 180.909e0,  6624.0e0, 197.390e0,
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     125596.0e0,  326.069e0, 24745.0e0, 356.869e0, 23706.0e0, 388.160e0,
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      data pe15 /2200.0e0,   33369.0e0, 298.970e0, 32664.0e0, 332.498e0,
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      data pe16/2400.0e0,    34803.0e0, 305.833e0, 34045.0e0, 340.062e0,
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c
      end
*deck dath
      subroutine dath
c
      common /leakh/ pm(59,18),nhh,nph
c
c     henry model critical flow tables
c
c     pm(   1,i) = stagnation pressure (psia)
c     pm(even,i) = maximum flow rate (lb/ft**2-sec)
c     pm( odd,i) = stagnation enthalpy (btu/lb)
c
c     nph = number of pressure values
c     nhh = number of pairs of enthalpy and flow values per pressure
c
      data nhh,nph / 29,18 /
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     6 0.72840745e 02, 0.34470425e 02, 0.73876821e 02, 0.31384655e 02,
     7 0.74912897e 02, 0.29058887e 02, 0.75948974e 02, 0.27137574e 02,
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     9 0.79057202e 02, 0.23098901e 02, 0.80093278e 02, 0.16725915e 02/
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     6 0.13189709e 03, 0.91092395e 01, 0.14225785e 03, 0.85272263e 01,
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     4 0.10022011e 04, 0.25055368e 01, 0.11047726e 04/
      data pm( 1, 2),pm( 2, 2),pm( 3, 2),pm( 4, 2),pm( 5, 2),pm( 6, 2),
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     4 0.15021436e 03, 0.64259733e 02, 0.16022332e 03, 0.56157645e 02,
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     8 0.25946963e 03, 0.50774594e 02, 0.35767836e 03, 0.41893032e 02,
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     4 0.10534417e 04, 0.33806072e 02, 0.11495028e 04/
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     4 0.14000000e 04, 0.11153878e 05, 0.59882953e 03, 0.11114695e 05,
     5 0.59940601e 03, 0.11023777e 05, 0.59998248e 03, 0.10935160e 05,
     6 0.60055896e 03, 0.10824250e 05, 0.60113544e 03, 0.10740498e 05,
     7 0.60171192e 03, 0.10658759e 05, 0.60228839e 03, 0.10578952e 05,
     8 0.60286487e 03, 0.10501005e 05, 0.60344135e 03, 0.10402988e 05,
     9 0.60401782e 03, 0.10328995e 05, 0.60459430e 03, 0.96529195e 04,
      data pm(25,15),pm(26,15),pm(27,15),pm(28,15),pm(29,15),pm(30,15),
     1     pm(31,15),pm(32,15),pm(33,15),pm(34,15),pm(35,15),pm(36,15),
     2     pm(37,15),pm(38,15),pm(39,15),pm(40,15),pm(41,15),pm(42,15),
     3     pm(43,15),pm(44,15),pm(45,15),pm(46,15),pm(47,15),pm(48,15)/
     4 0.61035907e 03, 0.90851395e 04, 0.61612385e 03, 0.86244273e 04,
     5 0.62188862e 03, 0.82315907e 04, 0.62765339e 03, 0.78916747e 04,
     6 0.63341817e 03, 0.75939611e 04, 0.63918294e 03, 0.73305411e 04,
     7 0.64494771e 03, 0.72131545e 04, 0.65071249e 03, 0.70524429e 04,
     8 0.65647726e 03, 0.60582937e 04, 0.71412499e 03, 0.52735113e 04,
     9 0.77177272e 03, 0.46694008e 04, 0.82942045e 03, 0.42278200e 04/
      data pm(49,15),pm(50,15),pm(51,15),pm(52,15),pm(53,15),pm(54,15),
     1     pm(55,15),pm(56,15),pm(57,15),pm(58,15),pm(59,15)/
     2 0.88706818e 03, 0.38845710e 04, 0.94471591e 03, 0.36116173e 04,
     3 0.10023636e 04, 0.33915424e 04, 0.10600114e 04, 0.32023508e 04,
     4 0.11176591e 04, 0.30463219e 04, 0.11747303e 04/
      data pm( 1,16),pm( 2,16),pm( 3,16),pm( 4,16),pm( 5,16),pm( 6,16),
     1     pm( 7,16),pm( 8,16),pm( 9,16),pm(10,16),pm(11,16),pm(12,16),
     2     pm(13,16),pm(14,16),pm(15,16),pm(16,16),pm(17,16),pm(18,16),
     3     pm(19,16),pm(20,16),pm(21,16),pm(22,16),pm(23,16),pm(24,16)/
     4 0.18000000e 04, 0.12092534e 05, 0.64848967e 03, 0.12060637e 05,
     5 0.64899351e 03, 0.11997142e 05, 0.64949736e 03, 0.11934703e 05,
     6 0.65000120e 03, 0.11873291e 05, 0.65050504e 03, 0.11812880e 05,
     7 0.65100889e 03, 0.11753444e 05, 0.65151273e 03, 0.11694956e 05,
     8 0.65201657e 03, 0.11637392e 05, 0.65252041e 03, 0.11580728e 05,
     9 0.65302426e 03, 0.11524943e 05, 0.65352810e 03, 0.10990746e 05/
      data pm(25,16),pm(26,16),pm(27,16),pm(28,16),pm(29,16),pm(30,16),
     1     pm(31,16),pm(32,16),pm(33,16),pm(34,16),pm(35,16),pm(36,16),
     2     pm(37,16),pm(38,16),pm(39,16),pm(40,16),pm(41,16),pm(42,16),
     3     pm(43,16),pm(44,16),pm(45,16),pm(46,16),pm(47,16),pm(48,16)/
     4 0.65856652e 03, 0.10529341e 05, 0.66360495e 03, 0.10125821e 05,
     5 0.66864337e 03, 0.97692276e 04, 0.67368180e 03, 0.94513008e 04,
     6 0.67872022e 03, 0.92456831e 04, 0.68375865e 03, 0.91922360e 04,
     7 0.68879708e 03, 0.90603008e 04, 0.69383550e 03, 0.89992705e 04,
     8 0.69887393e 03, 0.79242901e 04, 0.74925818e 03, 0.69285961e 04,
     9 0.79964243e 03, 0.61446165e 04, 0.85002669e 03, 0.55627091e 04/
      data pm(49,16),pm(50,16),pm(51,16),pm(52,16),pm(53,16),pm(54,16),
     1     pm(55,16),pm(56,16),pm(57,16),pm(58,16),pm(59,16)/
     2 0.90041094e 03, 0.51168594e 04, 0.95079519e 03, 0.47668412e 04,
     3 0.10011794e 04, 0.44867060e 04, 0.10515637e 04, 0.42427561e 04,
     4 0.11019480e 04, 0.40393917e 04, 0.11518283e 04/
      data pm( 1,17),pm( 2,17),pm( 3,17),pm( 4,17),pm( 5,17),pm( 6,17),
     1     pm( 7,17),pm( 8,17),pm( 9,17),pm(10,17),pm(11,17),pm(12,17),
```

```
     2     pm(13,17),pm(14,17),pm(15,17),pm(16,17),pm(17,17),pm(18,17),
     3     pm(19,17),pm(20,17),pm(21,17),pm(22,17),pm(23,17),pm(24,17)/
     4 0.20000000e 04, 0.12548625e 05, 0.67211135e 03, 0.12527433e 05,
     5 0.67257758e 03, 0.12477584e 05, 0.67304380e 03, 0.12428359e 05,
     6 0.67351002e 03, 0.12354095e 05, 0.67397625e 03, 0.12306429e 05,
     7 0.67444247e 03, 0.12259343e 05, 0.67490870e 03, 0.12212826e 05,
     8 0.67537492e 03, 0.12166866e 05, 0.67584115e 03, 0.12097623e 05,
     9 0.67630737e 03, 0.12053056e 05, 0.67677360e 03, 0.11593333e 05/
      data pm(25,17),pm(26,17),pm(27,17),pm(28,17),pm(29,17),pm(30,17),
     1     pm(31,17),pm(32,17),pm(33,17),pm(34,17),pm(35,17),pm(36,17),
     2     pm(37,17),pm(38,17),pm(39,17),pm(40,17),pm(41,17),pm(42,17),
     3     pm(43,17),pm(44,17),pm(45,17),pm(46,17),pm(47,17),pm(48,17)/
     4 0.68143584e 03, 0.11157809e 05, 0.68609809e 03, 0.10765562e 05,
     5 0.69076033e 03, 0.10467344e 05, 0.69542258e 03, 0.10284563e 05,
     6 0.70008482e 03, 0.10275959e 05, 0.70474707e 03, 0.10180133e 05,
     7 0.70940931e 03, 0.10112706e 05, 0.71407156e 03, 0.10047270e 05,
     8 0.71873380e 03, 0.89878104e 04, 0.76535625e 03, 0.78172752e 04,
     9 0.81197870e 03, 0.69030697e 04, 0.85860115e 03, 0.62502254e 041
      data pm(49,17),pm(50,17),pm(51,17),pm(52,17),pm(53,17),pm(54,17),
     1     pm(55,17),pm(56,17),pm(57,17),pm(58,17),pm(59,17)/
     2 0.90522360e 03, 0.57611957e 04, 0.95184605e 03, 0.53897722e 04,
     3 0.99846850e 03, 0.50810573e 04, 0.10450909e 04, 0.48154370e 04,
     4 0.10917134e 04, 0.45892802e 04, 0.11378696e 04/
      data pm( 1,18),pm( 2,18),pm( 3,18),pm( 4,18),pm( 5,18),pm( 6,18),
     1     pm( 7,18),pm( 8,18),pm( 9,18),pm(10,18),pm(11,18),pm(12,18),
     2     pm(13,18),pm(14,18),pm(15,18),pm(16,18),pm(17,18),pm(18,18),
     3     pm(19,18),pm(20,18),pm(21,18),pm(22,18),pm(23,18),pm(24,18)/
     4 0.22000000e 04, 0.12813458e 05, 0.69546232e 03, 0.12797706e 05,
     5 0.69588902e 03, 0.12737513e 05, 0.69631572e 03, 0.12703856e 05,
     6 0.69674241e 03, 0.12670456e 05, 0.69716911e 03, 0.12612354e 05,
     7 0.69759581e 03, 0.12579734e 05, 0.69802250e 03, 0.12547358e 05,
     8 0.69844920e 03, 0.12515223e 05, 0.69887590e 03, 0.12459599e 05,
     9 0.69930260e 03, 0.12428195e 05, 0.69972929e 03, 0.12063798e 05/
      data pm(25,18),pm(26,18),pm(27,18),pm(28,18),pm(29,18),pm(30,18),
     1     pm(31,18),pm(32,18),pm(33,18),pm(34,18),pm(35,18),pm(36,18),
     2     pm(37,18),pm(38,18),pm(39,18),pm(40,18),pm(41,18),pm(42,18),
     3     pm(43,18),pm(44,18),pm(45,18),pm(46,18),pm(47,18),pm(48,18)/
     4 0.70399626e 03, 0.11751453e 05, 0.70826323e 03, 0.11464110e 05,
     5 0.71253020e 03, 0.11375772e 05, 0.71679717e 03, 0.11364155e 05,
     6 0.72106414e 03, 0.11429088e 05, 0.72533111e 03, 0.11397517e 05,
     7 0.72959808e 03, 0.11351836e 05, 0.73386505e 03, 0.11291398e 05,
     8 0.73813202e 03, 0.10144490e 05, 0.78080172e 03, 0.84951054e 04,
     9 0.82347142e 03, 0.74811964e 04, 0.86614112e 03, 0.68680311e 04/
      data pm(49,18),pm(50,18),pm(51,18),pm(52,18),pm(53,18),pm(54,18),
     1     pm(55,18),pm(56,18),pm(57,18),pm(58,18),pm(59,18)/
     2 0.90881083e 03, 0.64129876e 04, 0.95148053e 03, 0.60360975e 04,
     3 0.99415023e 03, 0.57181600e 04, 0.10368199e 04, 0.54250196e 04,
     4 0.10794896e 04, 0.51763832e 04, 0.11217326e 041
```

```
      end
c
*deck gcrit
      subroutine gcritf(p,h,m,g,s,rhov,rhol)
c
c       m=1     moody
c       m=2     henry fauske
c       m=3     subcoold henry
c
       common /leakc / g01(735) ,ng,npi
       common /leakhe / pe01(368),nhhe,nphe
       common / leakh / pm(1062),nhh,nph
      dimension tm(1),thfs(1),thf(1)
      equivalence (g01(1),tm(1)),(pe01(1),thfs(1)),(pm(1),thf(1))
      go to (10,20,30),m
   10 call dterp (p, h,g,tm,ng,npi)
      s=(rhol/rhov)**.33333334
      return
   20 call dterp(p,h,g,thfs,nhhe,nphe)
      s=1.
      return
   30 call dterp(p,h,g,thf,nhh,nph)
      s=1.
      return
      end
        subroutine dterp(p,h,g,table,ng,npi)
        dimension table (1)
        data lm1/10/
        lm1 = min0(npi-1,max0(lm1,1))
        inc = (2*ng + 1)
        l = lm1 + 1
        j = (lm1-1)*inc+1
        if(p.ge.table(j)) go to 25
        go to 55
25      do 50 i=1,npi
        j = j + inc
        if(p.gt.table(j)) go to 50
        f = (p  - table(j))/(table(j+inc) - table(j))
        l = j
        go to 70
50      lm1 = lm1 + 1
55      lm2 = lm1 - 1
        do 60 k=1,lm2
        j = j-inc
        if(p.lt.table(j)) go to 60
        lm1 = lm2 - k + 1
        l = j
        f = (p  - table(j)) /(table(j+inc)-table(j))
```

```
      go to 70
60    continue
70    11 = l + 2
      do 100 i =2,ng
      11 = 11 + 2
      if (h.ge.table(11)) go to 100
      lb = 11-2
     fm= (h-table(lb))/(table(11)-table(lb))
      gm=table(lb-1)+fm  *(table(11-1)-table(lb-1))
      go to 150
100   continue
150   if(h.ge.table(lb+inc)) go to 175
      go to 250
175   11 = lb + inc
      do 200 m=i,ng
      11 = 11+2
      if(h.ge.table(11)) go to 200
     fp=(h-table(11-2))/(table(11)-table(11-2))
      gp = table(11-3)+fp*(table(11-1)-table(11-3))
      go to 300
200       continue
250   11 = lb + inc
      do 252 m=1,i
      11=11 - 2
      if(h.lt.table(11)) go to 252
     fp= (h-table(11))/(table(11+2)-table(11))
      gp = table(11-1) +fp*(table(11+1)-table(11-1))
      go to 300
252   continue
300   g = gm + f *(gp-gm)
     return
     end
```

APPENDIX C

COBRA-NC SAMPLE ASB OUTPUT

```
                  xxxxxxxxxx                                 xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
                xx        xxxxx                              xx                         xxx
              xx            xxxxx                             xx                       xxxx
            xx               xxxxxx                            xx                     xxxx
          xx                   xxxxxxx                           xx               xxxxxx
         xx                    xxxxxxx                            xx             xxxxxx

   ccccc    oooo   bbbbbb   rrrrrr     aaaa            //          nnn    n    ccccc
  ccc   c  ooo  o  bbb   b  rrr   r   aaa  a          //           nnn    n   ccc    c
 ccc    c ooo    o bbb    b rrr    r aaa    a        //            nn n   n  ccc
 ccc      ooo    o bbb    b rrr    r aaa    a       //             nn n   n  ccc
 ccc      ooo    o bbbbbbb  rrrrrrr  aaaaaaaa      //              nn  n  n  ccc
 ccc      ooo    o bbbbbb   rrrrrr   aaaaaaaa     //               nn  n  n  ccc
 ccc      ooo    o bbb   b  rrr   r  aaa    a    //                nn   n n  ccc
 ccc    c ooo    o bbb    b rrr    r aaa    a   //                 nn   n n  ccc     c
  ccc   c  ooo  o  bbb    b rrr    r aaa    a  //                  nn    nn   ccc    c
   ccccc    oooo   bbbbbbb  rrr    r aaa    a //                   nn    nn    ccccc

          xx                    xxxxxxxx                              xx             xxxxxx
          xx                    xxxxxxxx                             xx               xxxxxx
          xx                    xxxxxxxx                             xx                xxxxx
          xx                    xxxxxxxx                            xx                  xxxxx
          xx                    xxxxxxxx                           xx                    xxxx

xxxxxxxxxxxxxxxdonxxxmarvxxxjoexxxtimxxxtomxxxrickxxxjudixxxgaryxxxchrisxxxannettexxxshawxxxpeggyxxxkeithxxxcathyx-
xxxxxxxxxxxxxxxx


                                          pppppp     nnn     n  |||
                                          ppp    p   nnn     n  |||
                                          ppp     p  nnnn    n  |||
                                          ppp     p  nnnnn   n  |||
                                          ppppppp    nnn nn  n  |||
                                          pppppp     nnn nn  n  |||
                                          ppp        nnn    nn  |||
                                          ppp        nnn    nn  |||
                                          ppp        nnn    nn  ||||||||
                                          ppp        nnn     n  ||||||||
```

C.1

```
bbbb  aa  ttt  ttt  eeee l    l    eeee          pppp  aa   cc   i   ffff  i    cc
b  b  a a  t    t   e    l    l    e             p  p  a a  c c  i   f     i   c  c
bbb  aaaa  t    t   eee  l    l    eee           pppp aaaa c     i   fff   i   c
b  b  a a  t    t   e    l    l    e             p    a a  c c  i   f     i   c  c
bbbb a  a  t    t   eeee llll llll eeee          p  a  a  c  c  i  f     i    cc

n  n  oo  rrr  ttt  h  h w w eeee ssss ttt     l    aa  bbbb  oo  rrr   aa  ttt   oo  rrrr y y
nnno  o r  r   t    h  hwwe    s     t       l   a  ab  bo  o r  r a a  t    o  o r  r y y
n nn o  o rrrr  t   hhhh w w eee  ssss  t      l   aaaa bbb  o  o rrrr aaaa  t   o  o rrrr  y
nnno  o r r     t   h  h www e       s  t     l   a ab  bo  o r r  a a  t    o  o r r    y
n  n  oo  r  r  t   h  h w w eeee ssss  t     llll a  abbbboo  r  r a  a  t    oo  r  r   y
```

p. o. box 999, richland, washington 99352

this is cycle 15 of cobranc - -09/19/85

in case of questions or problems, call

fluid and thermal engineering section of
pnl -- battelle pacific northwest laboratory
richland, washington

phone number -- (509) 375-2069

```
1********************************* input file listing *********************************
 123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890
                                        12         set units and linear conv.
           0  0.000000e+00                                           restart data
 0.100000e-02          5          40                          iteration controll
          1 model 3-21-85
    1    1                              0                          vessel   1.1
    278.00     278.00      27.80     278.00
    14.691   1101.108                    131.388  0.0000010  0.0237449
air      0.9762541
    2    18    18                                                  vessel   2.1
    11417.150.5
    2249.663.20249.6
    31633.161.6
    4404.880.48
    5453.585.18
    61426.151.0       1425.
    7195.855.98       195.0
    85328.292.0
    931.5022.45       31.00
   10650.2102.0       650.0
   11851.5116.7       850.0
   12371.377.07
   131426.151.01425.
   14195.955.98195.0195.0
   1531.4422.4331.0031.44
   16650.1102.0650.0
   17851.6116.7850.0
   18195.855.98195.0
    1                                  -1    0
    2                                  -2    0
    3                                  -3    0
 123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890
    4                                  -4    0
    5                                  -5    0
    6                                  -6    0
    7                                  -7    0
    8                                  -8    0
    9                                  -9    0
   10                                 -10    0
```

```
   11                                -11    0
   12                                -12    0
   13                                -13    0
   14                                -14    0
   15                                -15    0
   16                                -16    0
   17                                -17    0
   18                                -18    0
    3   12                                                               vessel   3.1
    1    1    21.1679.1652.5992.000
   1.
    2    1    33.19415.172.6982.000
   1.
    3    1   10.66676.9282.4882.000
   1.
    4    1   11.66676.9282.4882.000
   1.
    5    3    41.3229.7572.6162.000
   1.
    6    3    5.27224.4271.9372.000
   1.
    7    3    65.33319.602.7292.000
   1.
12345678901234567890123456789012345678901234567890123456789012345678901234567890
    8    3    71.2949.6542.6132.000
   1.
    9    3    9.97228.3672.5712.000
   1.
   10    3   121.1118.9442.5922.000
   1.
   11    5    61.2229.3812.6062.000
   1.
   12    6    811.4428.712.7602.000
   1.
                                                                           blank  3.4
    4    3    1                                                          vessel   4.1
    1   12    1     18.00
    1    1                             1
    2    2                             2
    3    3                             3
    4    4                             4
```

```
 78     5    5                             5
 79     6   13                             6
 80     7   14                             7
 81     8    8                             8
 82     9   15                             9
 83    10   16                            10
 84    11   17                            11
 85    12   12                            12
 86     2    5    1      9.00
 87    13   13                             6
 88    14   18                             7
 89    15   15                             9
 90    16   16                            10
   12345678901234567890123456789012345678901234567890123456789012345678901234567890
 91    17   17                            11
 92     3    1    1     18.00
 93    18   18                            14
 94    18
 95     7    1                                                                 vessel  7.1
 96   2.6    2   15
 97     8    0   18    1    1                                                  vessel  8.1
 98     280.00      2.00
 99     1    1              302.2        1.0
100     2    2               90.9        1.0
101     3    3              332.8        1.0
102     4    4              125.5        1.0
103     5    5              134.3        1.0
104     6    6              218.8        1.0
105     7    7               66.9        1.0
106     8    8              884.0        1.0
107     9    9               24.2        1.0
108    10   10              138.1        1.0
109    11   11              164.1        1.0
110    12   12              118.3        1.0
111    13   13              309.5        1.0
112    14   14               56.2        1.0
113    15   15               26.0        1.0
114    16   16              174.2        1.0
115    17   17              211.5        1.0
116    18   18               66.9        1.0
117     1    0   18    2                                                       vessel  8.4
```

```
     1     2     3     4     5     6     7     8     9  1  0  1  1  1  2
    13    14    15    16    17    18
          0.0        90.0        45.0        90.0
 12345678901234567890123456789012345678901234567890123456789012345678901234567890
     9    18                    0                                        vessel   9.1
     1 wall      302.        2.00    4          1
     5    10.008          5    10.042          5    1 0.65          5    1 1.30
     2 wall       91.        2.00    4          1
     5    10.008          5    10.042          5    1 0.65          5    1 1.30
     3 wall      333.        2.00    4          1
     5    10.008          5    10.042          5    1 0.65          5    1 1.30
     4 wall      125.        2.00    4          1
     5    10.008          5    10.042          5    1 0.65          5    1 1.30
     5 wall      134.        2.00    4          1
     5    10.008          5    10.042          5    1 0.65          5    1 1.30
     6 wall      219.        2.00    4          1
     5    10.008          5    10.042          5    1 0.65          5    1 1.30
     7 wall       67.        2.00    4          1
     5    10.008          5    10.042          5    1 0.65          5    1 1.30
     8 wall      884.        2.00    4          1
     5    10.008          5    10.042          5    1 0.65          5    1 1.30
     9 wall       24.        2.00    4          1
     5    10.008          5    10.042          5    1 0.65          5    1 1.30
    10 wall      138.        2.00    4          1
     5    10.008          5    10.042          5    1 0.65          5    1 1.30
    11 wall      164.        2.00    4          1
     5    10.008          5    10.042          5    1 0.65          5    1 1.30
    12 wall      118.        2.00    4          1
     5    10.008          5    10.042          5    1 0.65          5    1 1.30
    13 wall      309.        2.00    4          1
     5    10.008          5    10.042          5    1 0.65          5    1 1.30
    14 wall       56.        2.00    4          1
     5    10.008          5    10.042          5    1 0.65          5    1 1.30
    15 wall       26.        2.00    4          1
 12345678901234567890123456789012345678901234567890123456789012345678901234567890
     5    10.008          5    10.042          5    1 0.65          5    1 1.30
    16 wall      174.        2.00    4          1
     5    10.008          5    10.042          5    1 0.65          5    1 1.30
    17 wall      212.        2.00    4          1
     5    10.008          5    10.042          5    1 0.65          5    1 1.30
    18 wall       67.        2.00    4          1
```

```
    5    10.008         5    10.042         5    1 0.65         5    1 1.30
   10     1                                                          vessel  10.1
    1     2    139.00
    50.000     0.220     0.867  1000.000     0.220     0.867
   13    24     0     1     0     0     0     0                      vessel  13.1
   30
         142.00.8500    142.00.8510     71.005.000     71.005.010     68.80
6.000     68.606.010     67.807.500     67.807.510     64.9010.00     64.90
10.01     62.8012.50     62.8012.51     61.0015.00     61.0015.01     58.08
17.50     58.0017.51     54.5020.00     54.5020.01     49.5022.50     49.50
22.51     46.2025.00     46.2025.01     39.3027.50     39.3027.51     27.70
30.00     27.7030.01     15.2032.50     15.2035.00      0.001500.      0.00
    2     1     2     1     0     1.000  1249.400   925.000
251.5.0001.9999.0001
                                                                     blank 13.4b
   15     3     1     0     0    14.700   145.300    14.700
152.3.9999.9999.0001
                                                                     blank 13.4b
    1     1     3
    3     1     3
    4     1     3
    5     1     3
    6     1     3
    7     1     3
12345678901234567890123456789012345678901234567890123456789012345678901234567890
    8     1     3
    9     1     3
   10     1     3
   11     1     3
   12     1     3
    1     2     3
    2     2     3
    3     2     3
    4     2     3
    5     2     3
    8     2     3
   12     2     3
   13     2     3
   16     2     3
   17     2     3
   18     2     3
```

```
 197    14    1    0              0              1                      vessel 14.1
 198                                                                      end set 1
 199                                                                    blank graf.1
 200     0   -1                                                              graf.2
 201       0.000100      0.001000      0.100000      1.000000    300.000000
 202 1000000.0000001000000.000000    500.0000001000000.000000
 203       0.020000
 204       0.000100      0.050000      1.000000      1.000000    300.000000
 205 1000000.0000001000000.000000    500.0000001000000.000000
 206       0.100000
 207       0.000100      0.010000     36.000000      1.000000    300.000000
 208 1000000.0000001000000.000000    500.0000001000000.000000
 209       1.000000
 210       0.000100      0.200000     36.000000      1.000000    300.000000
     12345678901234567890123456789012345678901234567890123456789012345678901234567890
 211 1000000.0000001000000.000000    500.0000001000000.000000
 212      10.000000
 213      -1.000000
1

        cobra - nc      date   86/09/23     time   18:46:57
1                   main control parameters are:

                   restart time step  . . . . . . . . . . .    0
                   simulation start time  . . . . . . . . .     0.000
                   outer iteration convergence limit . . . 0.0010000
                   maximum number of inner iterations . .   40
                   maximum number of outer iterations  . .    5
                   appendix k h.t. option (1-on) --    --    0
   1    1    0    0    0    0    0    0    0
   2   18   18    0    0    0    0    0    0
   3   12    0    0    0    0    0    0    0
   4    3    1    0    0    0    0    0    0
   7    1    0    0    0    0    0    0    0
   8    0   18    1    1    0    0    0    0
   9   18    0    0    0    0    0    0    0
  10    1    0    0    0    0    0    0    0
  13   24    0    1    0    0    0    0    0
  14    1    0    0    0    0    0    0    1
   0    0    0    0    0    0    0    0    0
1                                                     input summary
```

rancho seco unit no 1 helb (5Ø-312) model 3-21-85

date 86/09/23 time 18:46:55

general information
****

Ø initial system operating pressure (psi) . . . 14.69100
initial system steam/water enthalpy 1101.10800
initial noncondensable gas enthalpy 131.38800
initial liquid volume fraction 0.00000
mass flux for initialization (lb/ft**2-sec) . . 0.00000
average linear heat rate (kw/ft) 0.00000
total axial length (inches). 540.00000
total no. of axial nodes 3

1

initial volume fractions of vapor and noncondensa gases

1

99.99990 percent of the total system volume is initially filled with vapor and/or noncondensable gases. the fraction

of this gas volume occupied by water vapor and each noncondensable gas is as follows:
steam 0.0237 air 0.97625
1

subchannel data

nominal wetted momentum momentum axial variation
tables
subchannel channel area perimeter area area continuity momentum
wetted
id. no. (in**2) (in.) (bottom) (top) area area
perimeter

1	204048.0000	1806.000	204048.0000	204048.0000	0	0	0
2	35942.4000	758.400	35942.4000	35942.4000	0	0	0
3	235152.0000	1939.200	235152.0000	235152.0000	0	0	0
4	58291.2000	965.760	58291.2000	58291.2000	0	0	0
5	65304.0000	1022.160	65304.0000	65304.0000	0	0	0
6	205344.0000	1812.000	205344.0000	205200.0000	0	0	0
7	28195.2000	671.760	28195.2000	28080.0000	0	0	0
8	767232.0000	3504.000	767232.0000	767232.0000	0	0	0
9	4536.0000	269.400	4536.0000	4464.0000	0	0	0
10	93628.8000	1224.000	93628.8000	93600.0000	0	0	0
11	122616.0000	1400.400	122616.0000	122400.0000	0	0	0
12	53467.2000	924.840	53467.2000	53467.2000	0	0	0
13	205344.0000	1812.000	205200.0000	205344.0000	0	0	0
14	28209.6000	671.760	28080.0000	28080.0000	0	0	0
15	4527.3600	269.160	4464.0000	4527.3600	0	0	0
16	93614.4000	1224.000	93600.0000	93614.4000	0	0	0
17	122630.4000	1400.400	122400.0000	122630.4000	0	0	0
18	28195.2000	671.760	28080.0000	28195.2000	0	0	0

0

axial loss coefficients
****

node
----

channel 1 2

**-
****
15 * 0.000 2.600
Ø data for lateral momentum convected by axial velocities at section boundries

channel node gap gap area node gap gap area node gap gap area node gap
gap area
no. no. below above no. below above no. below above no. below
above

Ø

**-
******

channel thermal connection input data
----

channel no.	fuel rod indices						heat slab indices						
1	Ø	Ø	Ø	Ø	Ø	Ø	-1	Ø	Ø	Ø	Ø	Ø	Ø

```
             2        Ø  Ø  Ø  Ø  Ø  Ø     -2  Ø  Ø  Ø  Ø  Ø  Ø
Ø
             3        Ø  Ø  Ø  Ø  Ø  Ø     -3  Ø  Ø  Ø  Ø  Ø  Ø
Ø
             4        B  B  B  B  B  B     -4  Ø  Ø  Ø  Ø  Ø  Ø
Ø
             5        B  B  B  B  B  B     -5  Ø  Ø  Ø  Ø  Ø  Ø
Ø
             6        B  B  B  B  B  B     -6  Ø  Ø  Ø  Ø  Ø  Ø
Ø
             7        B  B  B  B  B  B     -7  Ø  Ø  Ø  Ø  Ø  Ø
Ø
             8        B  B  B  B  B  B     -8  Ø  Ø  Ø  Ø  Ø  Ø
Ø
             9        Ø  Ø  Ø  Ø  Ø  Ø     -9  Ø  Ø  Ø  Ø  Ø  Ø
Ø
            1Ø        B  B  B  B  B  B    -1Ø  Ø  Ø  Ø  Ø  Ø  Ø
Ø
            11        B  B  B  B  B  B    -11  Ø  Ø  Ø  Ø  Ø  Ø
Ø
            12        B  B  B  B  B  B    -12  Ø  Ø  Ø  Ø  Ø  Ø
Ø
            13        Ø  Ø  Ø  Ø  Ø  Ø    -13  Ø  Ø  Ø  Ø  Ø  Ø
Ø
            14        B  B  B  B  B  B    -14  Ø  Ø  Ø  Ø  Ø  Ø
Ø
            15        B  B  B  B  B  B    -15  Ø  Ø  Ø  Ø  Ø  Ø
Ø
            16        B  B  B  B  B  B    -16  Ø  Ø  Ø  Ø  Ø  Ø
Ø
            17        B  B  B  B  B  B    -17  Ø  Ø  Ø  Ø  Ø  Ø
Ø
            18        B  B  B  B  B  B    -18  Ø  Ø  Ø  Ø  Ø  Ø
Ø

*************************************************************************************************************************-
***********
```

0

gap data

gap no.	ik	jk	gap width	centroid distance	loss coeff.	frict. flag	gap below	gap above	sign modifier	gaps which face this gap: ii side			jj side			variation table
1	1	2	14.004	109.980	2.599	2.00	0	0	1.000	0	0	0	0	0	0	0
2	1	3	38.328	182.040	2.698	2.00	0	0	1.000	0	0	0	0	0	0	0
3	1	10	8.000	83.136	2.488	2.00	0	0	1.000	0	0	0	0	0	0	0
4	1	11	8.000	83.136	2.488	2.00	0	0	1.000	0	0	0	0	0	0	0
5	3	4	15.864	117.084	2.616	2.00	0	0	1.000	0	0	0	0	0	0	0
6	3	5	3.266	53.124	1.937	2.00	0	0	1.000	0	0	0	0	0	0	0
7	3	6	63.996	235.200	2.729	2.00	0	0	1.000	0	0	0	0	0	0	0
8	3	7	15.528	115.848	2.613	2.00	0	0	1.000	0	0	0	0	0	0	0
9	3	9	11.666	100.404	2.571	2.00	0	0	1.000	0	0	0	0	0	0	0
10	3	12	13.332	107.328	2.592	2.00	0	0	1.000	0	0	0	0	0	0	0
11	5	6	14.664	112.572	2.606	2.00	0	0	1.000	0	0	0	0	0	0	0

```
   12     6    8 137.280  344.520   2.760  2.00     0     0    1.000       0     0     0        0     0     0
    0
1
```

channel splitting data - axial level o

number of channels	no. of nodes
12	1

channel	channels above						channels below					
1	1	0	0	0	0	0	1	0	0	0	0	0
2	2	0	0	0	0	0	2	0	0	0	0	0
3	3	0	0	0	0	0	3	0	0	0	0	0
4	4	0	0	0	0	0	4	0	0	0	0	0
5	5	0	0	0	0	0	5	0	0	0	0	0
6	13	0	0	0	0	0	6	0	0	0	0	0
7	14	0	0	0	0	0	7	0	0	0	0	0
8	8	0	0	0	0	0	8	0	0	0	0	0
9	15	0	0	0	0	0	9	0	0	0	0	0
10	16	0	0	0	0	0	10	0	0	0	0	0
11	17	0	0	0	0	0	11	0	0	0	0	0
12	12	0	0	0	0	0	12	0	0	0	0	0

channel splitting data - axial level 2 of 3

number of channels	no. of nodes
5	1

channel	channels above						channels below					
13	13	0	0	0	0	0	6	0	0	0	0	0

14	18	0	0	0	0	0	7	0	0	0	0	0
15	15	0	0	0	0	0	9	0	0	0	0	0
16	16	0	0	0	0	0	10	0	0	0	0	0
17	17	0	0	0	0	0	11	0	0	0	0	0

1

channel splitting data - axial level 3 of 3

number of channels	no. of nodes
1	1

channel	channels above						channels below						
18	18	0	0	0	0	0	1	4	0	0	0	0	0

simultaneous solution group information

no. of groups	last cell number in each group
1	18

1

**-
****

fuel rod and heat slab model input

no. of fuel rods = **0**
no. of heat slabs = **18**

***-
****

heat slab model input

heat slab index	channel connection - heated perimeter inside	outside	geometry type	conductor type	slab multiplier
1	1 - 3626.40	0 - 0.00	wall	1	1.000
2	2 - 1090.80	0 - 0.00	wall	2	1.000
3	3 - 3993.60	0 - 0.00	wall	3	1.000
4	4 - 1506.00	0 - 0.00	wall	4	1.000
5	5 - 1611.60	0 - 0.00	wall	5	1.000
6	6 - 2625.60	0 - 0.00	wall	6	1.000
7	7 - 802.80	0 - 0.00	wall	7	1.000
8	8 -10608.00	0 - 0.00	wall	8	1.000
9	9 - 290.40	0 - 0.00	wall	9	1.000
10	10 - 1657.20	0 - 0.00	wall	10	1.000
11	11 - 1969.20	0 - 0.00	wall	11	1.000
12	12 - 1419.60	0 - 0.00	wall	12	1.000
13	13 - 3714.00	0 - 0.00	wall	13	1.000
14	14 - 674.40	0 - 0.00	wall	14	1.000
15	15 - 312.00	0 - 0.00	wall	15	1.000
16	16 - 2090.40	0 - 0.00	wall	16	1.000
17	17 - 2538.00	0 - 0.00	wall	17	1.000
18	18 - 802.80	0 - 0.00	wall	18	1.000

----

conductor geometry description

no. of geometry types = 18

type 1 - wall ftat plate conductor geometry

wall perimeter 3624.000 (in.)
wall thickness 24.0000 (in.)
no. of nodes (total) 20
material index (inside) 1
material index(outside) 0

radial noding information

node no.	material index	radial location	node boundaries (inside)	node boundaries (outside)	power fraction
1	1	0.0000	0.0000	0.0107	0.00000
2	1	0.0213	0.0107	0.0320	0.00000
3	1	0.0427	0.0320	0.0533	0.00000
4	1	0.0640	0.0533	0.0747	0.00000
5	1	0.0853	0.0747	0.0960	0.00000
6	1	0.1464	0.0960	0.1968	0.00000
7	1	0.2472	0.1968	0.2976	0.00000
8	1	0.3480	0.2976	0.3984	0.00000
9	1	0.4488	0.3984	0.4992	0.00000
10	1	0.5496	0.4992	0.6000	0.00000
11	1	1.3800	0.6000	2.1600	0.00000
12	1	2.9400	2.1600	3.7200	0.00000
13	1	4.5000	3.7200	5.2800	0.00000
14	1	6.0600	5.2800	6.8400	0.00000
15	1	7.6200	6.8400	8.4000	0.00000
16	1	10.1333	8.4000	11.8667	0.00000
17	1	13.6000	11.8667	15.3333	0.00000
18	1	17.0667	15.3333	18.8000	0.00000
19	1	20.5333	18.8000	22.2667	0.00000

20	1	24.0000	22.2667	24.0000	0.00000

type 2 - wall flat plate conductor geometry

----

wall perimeter 1092.000 (in.)
wall thickness 24.0000 (in.)
no. of nodes (total) 20
material index (inside) 1
material index(outside) 0

radial noding information

node no.	material index	radial location	node boundaries (inside)	(outside)	power fraction
1	1	0.0000	0.0000	0.0107	0.00000
2	1	0.0213	0.0107	0.0320	0.00000
3	1	0.0427	0.0320	0.0533	0.00000
4	1	0.0640	0.0533	0.0747	0.00000
5	1	0.0853	0.0747	0.0960	0.00000
6	1	0.1464	0.0960	0.1968	0.00000
7	1	0.2472	0.1968	0.2976	0.00000
8	1	0.3480	0.2976	0.3984	0.00000
9	1	0.4488	0.3984	0.4992	0.00000
10	1	0.5496	0.4992	0.6000	0.00000
11	1	1.3800	0.6000	2.1600	0.00000
12	1	2.9400	2.1600	3.7200	0.00000
13	1	4.5000	3.7200	5.2800	0.00000
14	1	6.0600	5.2800	6.8400	0.00000
15	1	7.6200	6.8400	8.4000	0.00000
16	1	10.1333	8.4000	11.8667	0.00000
17	1	13.6000	11.8667	15.3333	0.00000
18	1	17.0667	15.3333	18.8000	0.00000
19	1	20.5333	18.8000	22.2667	0.00000
20	1	24.0000	22.2667	24.0000	0.00000

type 3 - wall flat plate conductor geometry

----

wall perimeter	3996.000 (in.)
wall thickness	24.0000 (in.)
no. of nodes (total)	20
material index (inside)	1
material index(outside)	0

radial noding information

node no.	material index	radial location	node boundaries (inside)	node boundaries (outside)	power fraction
1	1	0.0000	0.0000	0.0107	0.00000
2	1	0.0213	0.0107	0.0320	0.00000
3	1	0.0427	0.0320	0.0533	0.00000
4	1	0.0640	0.0533	0.0747	0.00000
5	1	0.0853	0.0747	0.0960	0.00000
6	1	0.1464	0.0960	0.1968	0.00000
7	1	0.2472	0.1968	0.2976	0.00000
8	1	0.3480	0.2976	0.3984	0.00000
9	1	0.4488	8.3984	0.4992	0.00000
10	1	0.5496	0.4992	0.6000	0.00000
11	1	1.3800	0.6000	2.1600	0.00000
12	1	2.9400	2.1600	3.7200	0.00000
13	1	4.5000	3.7200	5.2800	0.00000
14	1	6.0600	5.2800	6.8400	0.00000
15	1	7.6200	6.8400	8.4000	0.00000
16	1	10.1333	8.4000	11.8667	0.00000
17	1	13.6000	11.8667	15.3333	0.00000
18	1	17.0667	15.3333	18.8000	0.00000
19	1	20.5333	18.8000	22.2667	0.00000
20	1	24.0000	22.2667	24.0000	0.00000

type 4 - wall flat plate conductor geometry

---

wall perimeter	1500.000 (in.)
wall thickness	24.0000 (in.)
no. of nodes (total)	20
material index (inside)	1

material index(outside) 0

radial noding information

node no.	material index	radial location	node boundaries (inside)	node boundaries (outside)	power fraction
1	1	0.0000	0.0000	0.0107	0.00000
2	1	0.0213	0.0107	0.0320	0.00000
3	1	0.0427	0.0320	0.0533	0.00000
4	1	0.0640	0.0533	0.0747	0.00000
5	1	0.0853	0.0747	0.0960	0.00000
6	1	0.1464	0.0960	0.1968	0.00000
7	1	0.2472	8.1968	0.2976	0.00000
8	1	0.3480	0.2976	0.3984	0.00000
9	1	0.4488	0.3984	0.4992	0.00000
10	1	0.5496	0.4992	0.6000	0.00000
11	1	1.3800	0.6800	2.1600	0.00000
12	1	2.9400	2.1600	3.7200	0.00000
13	1	4.5000	3.7200	5.2800	0.00000
14	1	6.0600	5.2800	6.8408	0.00000
15	1	7.6200	6.8400	8.4000	0.00000
16	1	10.1333	8.4000	11.8667	0.00000
17	1	13.6000	11.8667	15.3333	0.00000
18	1	17.0667	15.3333	18.8000	0.00000
19	1	20.5333	18.8000	22.2667	0.00000
20	1	24.0000	22.2667	24.0000	0.00000

type 5 - wall flat plate conductor geometry

....

wall perimeter 1608.000 (in.)
wall thickness 24.0000 (in.)
no. of nodes (total) 20
material index (inside) 1
material index(outside) 0

radial noding information

node	material	radial	node boundaries	power

no.	index	location	(inside)	(outside)	fraction
1	1	0.0000	0.0000	0.0107	0.00000
2	1	0.0213	0.0107	0.0320	0.00000
3	1	0.0427	0.0320	0.0533	0.00000
4	1	0.0640	0.0533	0.0747	0.00000
5	1	0.0853	0.0747	0.0960	0.00000
6	1	0.1464	0.0960	0.1968	0.00000
7	1	0.2472	0.1968	0.2976	0.00000
8	1	0.3480	0.2976	0.3984	0.00000
9	1	0.4488	0.3984	0.4992	0.00000
10	1	0.5496	0.4992	0.6000	0.00000
11	1	1.3800	0.6000	2.1600	0.00000
12	1	2.9400	2.1600	3.7200	0.00000
13	1	4.5000	3.7200	5.2800	0.00000
14	1	6.0600	5.2800	6.8400	0.00000
15	1	7.6200	6.8400	8.4000	0.00000
16	1	10.1333	8.4000	11.8667	0.00000
17	1	13.6000	11.8667	15.3333	0.00000
18	1	17.0667	15.3333	18.8000	8.00000
19	1	20.5333	18.8000	22.2667	8.00000
20	1	24.0000	22.2667	24.0000	0.00000

type 6 - wall flat plate conductor geometry

---

wall perimeter 2628.000 (in.)
wall thickness 24.0000 (in.)
no. of nodes (total) 20
material index (inside) 1
material index(outside) 0

radial noding information

node no.	material index	radial location	node boundaries (inside)	(outside)	power fraction
1	1	0.0000	0.0000	0.0107	0.00000
2	1	0.0213	0.0107	0.0320	0.00000
3	1	0.0427	0.0320	0.0533	0.00000

4	1	0.0640	0.0533	0.0747	0.00000
5	1	0.0853	0.0747	0.0960	0.00000
6	1	0.1464	0.0960	0.1968	0.00000
7	1	0.2472	0.1968	0.2976	0.00000
8	1	0.3480	0.2976	0.3984	0.00000
9	1	0.4488	0.3984	0.4992	0.00000
10	1	0.5496	0.4992	0.6000	0.00000
11	1	1.3800	0.6000	2.1600	0.00000
12	1	2.9400	2.1600	3.7200	0.00000
13	1	4.5000	3.7200	5.2800	0.00000
14	1	6.0600	5.2800	6.8400	0.00000
15	1	7.6200	6.8400	8.4000	0.00000
16	1	10.1333	8.4000	11.8667	0.00000
17	1	13.6000	11.8667	15.3333	0.00000
18	1	17.0667	15.3333	18.8000	0.00000
19	1	20.5333	18.8000	22.2667	0.00000
20	1	24.0000	22.2667	24.0000	0.00000

type 7 - wall flat plate conductor geometry

....

wall perimeter 804.000 (in.)
wall thickness 24.0000 (in.)
no. of nodes (total) 20
material index (inside) 1
material index(outside) 0

radial noding information

node no.	material index	radial location	node boundaries (inside)	(outside)	power fraction
1	1	0.0000	0.0000	0.0107	0.00000
2	1	0.0213	0.0107	0.0320	0.00000
3	1	0.0427	0.0320	0.0533	0.00000
4	1	0.0640	0.0533	0.0747	0.00000
5	1	0.0853	0.0747	0.0960	0.00000
6	1	0.1464	0.0960	0.1968	0.00000
7	1	0.2472	0.1968	0.2976	0.00000
8	1	0.3480	0.2976	0.3984	0.00000

9	1	0.4488	0.3984	0.4992	0.00000
10	1	0.5496	0.4992	0.6000	0.00000
11	1	1.3800	0.6000	2.1600	0.00000
12	1	2.9400	2.1600	3.7200	0.00000
13	1	4.5000	3.7200	5.2800	0.00000
14	1	6.0600	5.2800	6.8400	0.00000
15	1	7.6200	6.8400	8.4000	0.00000
16	1	10.1333	8.4000	11.8667	0.00000
17	1	13.6000	11.8667	15.3333	0.00000
18	1	17.0667	15.3333	18.8000	0.00000
19	1	20.5333	18.8000	22.2667	0.00000
20	1	24.0000	22.2667	24.0000	0.00000

type 8 - wall flat plate conductor geometry

....

wall perimeter 10608.000 (in.)
wall thickness 24.0000 (in.)
no. of nodes (total) 20
material index (inside) 1
material index(outside) 0

radial noding information

node no.	material index	radial location	node boundaries (inside)	(outside)	power fraction
1	1	0.0000	0.0000	0.0107	0.00000
2	1	0.0213	0.0107	0.0320	0.00000
3	1	0.0427	0.0320	0.0533	0.00000
4	1	0.0640	0.0533	0.0747	0.00000
5	1	0.0853	0.0747	0.0960	0.00000
6	1	0.1464	0.0960	0.1968	0.00000
7	1	0.2472	0.1968	0.2976	0.00000
8	1	0.3480	0.2976	0.3984	0.00000
9	1	0.4488	0.3984	0.4992	0.00000
10	1	0.5496	0.4992	0.6000	0.00000
11	1	1.3800	0.6000	2.1600	0.00000
12	1	2.9400	2.1600	3.7200	0.00000
13	1	4.5000	3.7200	5.2800	0.00000

14	1	6.0600	5.2800	6.8400	0.00000
15	1	7.6200	6.8400	8.4000	0.00000
16	1	10.1333	8.4000	11.8667	0.00000
17	1	13.6000	11.8667	15.3333	0.00000
18	1	17.0667	15.3333	18.8000	0.00000
19	1	20.5333	18.8000	22.2667	0.00000
20	1	24.0000	22.2667	24.0000	0.00000

type 9 - wall flat plate conductor geometry

wall perimeter 288.000 (in.)
wall thickness 24.0000 (in.)
no. of nodes (total) 20
aaterial index (inside) 1
material index(outside) 0

radial noding information

node no.	mazerial index	radial location	node boundaries (inside)	(outside)	power fraction
1	1	0.0000	0.0000	0.0107	0.00000
2	1	0.0213	0.0107	0.0320	0.00000
3	1	0.0427	0.0320	0.0533	0.00000
4	1	0.0640	0.0533	0.0747	0.00000
5	1	0.0853	0.0747	0.0960	0.00000
6	1	0.1464	0.0960	0.1968	0.00000
7	1	0.2472	0.1968	0.2976	8.00000
8	1	0.3480	0.2976	0.3984	0.00000
9	1	0.4488	0.3984	0.4992	0.00000
10	1	0.5496	0.4992	0.6000	0.00000
11	1	1.3800	0.6000	2.1600	0.00000
12	1	2.9400	2.1600	3.7200	0.00000
13	1	4.5000	3.7200	5.2800	0.00000
14	1	6.0600	5.2800	6.8400	0.00000
15	1	7.6200	6.8400	8.4000	0.00000
16	1	10.1333	8.4000	11.8667	0.00000
17	1	13.6000	11.8667	15.3333	0.00000
18	1	17.0667	15.3333	18.8000	0.00000

19	1	20.5333	18.8000	22.2667	0.00000
20	1	24.0000	22.2667	24.0000	0.00000

type 10 - wall flat plate conductor geometry

....

wall perimeter 1656.000 (in.)
wall thickness 24.0000 (in.)
no. of nodes (total) 20
material index (inside) 1
material index(outside) 0

radial noding information

node no.	material index	radial location	node boundaries (inside)	node boundaries (outside)	power fraction
1	1	0.0000	0.0000	0.0107	0.00000
2	1	0.0213	0.0107	0.0320	0.00000
3	1	0.0427	0.0320	0.0533	0.00000
4	1	0.0640	0.0533	0.0747	0.00000
5	1	0.0853	0.0747	0.0960	0.00000
6	1	0.1464	0.0960	0.1968	0.00000
7	1	0.2472	0.1968	0.2976	0.00000
8	1	0.3480	0.2976	0.3984	0.00000
9	1	0.4488	0.3984	0.4992	0.00000
10	1	0.5496	0.4992	0.6000	0.00000
11	1	1.3800	0.6000	2.1600	0.00000
12	1	2.9400	2.1600	3.7200	0.00000
13	1	4.5000	3.7200	5.2800	0.00000
14	1	6.0600	5.2800	6.8400	0.00000
15	1	7.6200	6.8400	8.4000	0.00000
16	1	10.1333	8.4000	11.8667	0.00000
17	1	13.6000	11.8667	15.3333	0.00000
18	1	17.0667	15.3333	18.8000	0.00000
19	1	20.5333	18.8000	22.2667	0.00000
20	1	24.0000	22.2667	24.0000	0.00000

type 11 - wall   slab plate conductor geometry

....

wall perimeter   1968.000 (in.)
wall thickness   24.0000 (in.)
no. of nodes (total)   20
material index (inside)   1
material index(outside)   0

radial noding information

node no.	material index	radial location	node boundaries (inside)	node boundaries (outside)	power fraction
1	1	0.0000	0.0000	0.0107	0.00000
2	1	0.0213	0.0107	0.0320	0.00000
3	1	0.0427	0.0320	0.0533	0.00000
4	1	0.0640	0.0533	0.0747	0.00000
5	1	0.0853	0.0747	0.0960	0.00000
6	1	0.1464	0.0960	0.1968	0.00000
7	1	0.2472	0.1968	0.2976	0.00000
8	1	0.3480	0.2976	0.3984	0.00000
9	1	0.4488	0.3984	0.4992	0.00000
10	1	0.5496	0.4992	0.6000	0.00000
11	1	1.3800	0.6000	2.1600	0.00000
12	1	2.9400	2.1600	3.7200	0.00000
13	1	4.5000	3.7200	6.2800	0.00000
14	1	6.0600	5.2800	6.8400	0.00000
15	1	7.6200	6.8400	8.4000	0.00000
16	1	10.1333	8.4000	11.8667	0.00000
17	1	13.6000	11.8667	15.3333	0.00000
18	1	17.0667	15.3333	18.8000	0.00000
19	1	20.5333	18.8000	22.2667	0.00000
20	1	24.0000	22.2667	24.0000	0.00000

type 12 - wall   flat plate conductor geometry

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wall perimeter   1416.000 (in.)
wall thickness   24.0000 (in.)

no. of nodes (total) 20
material index (inside) 1
material index (outside) Ø

radial noding information

node no.	material index	radial location	node boundaries (inside)	node boundaries (outside)	power fraction
1	1	Ø.ØØØØ	0.0000	0.0107	0.00000
2	1	Ø.Ø213	0.0107	0.0320	0.00000
3	1	Ø.Ø427	0.0320	0.0533	0.00000
4	1	Ø.Ø64Ø	0.0533	0.0747	0.00000
5	1	Ø.Ø853	0.0747	0.0960	0.00000
6	1	Ø.1464	0.0960	0.1968	0.00000
7	1	Ø.2472	0.1968	0.2976	0.00000
8	1	Ø.348Ø	0.2976	0.3984	0.00000
9	1	Ø.4488	0.3984	0.4992	0.00000
1Ø	1	Ø.5496	0.4992	0.6000	0.00000
11	1	1.38ØØ	0.6000	2.1600	0.00000
12	1	2.94ØØ	2.1600	3.7200	0.00000
13	1	4.5ØØØ	3.7200	5.2800	0.00000
14	1	6.Ø6ØØ	5.2800	6.8400	0.00000
15	1	7.62ØØ	6.8400	8.4000	0.00000
16	1	1Ø.1333	8.4000	11.8667	0.00000
17	1	13.6ØØØ	11.8667	15.3333	0.00000
18	1	17.Ø667	15.3333	18.8000	0.00000
19	1	2Ø.5333	18.8000	22.2667	0.00000
20	1	24.ØØØØ	22.2667	24.0000	0.00000

type 13 - wall flat plate conductor geometry

wall perimeter 3708.000 (in.)
wall thickness 24.0000 (in.)
no. of nodes (total) 2Ø
material index (inside) 1
material index(outside) Ø

radial noding information

node no.	material index	radial location	node boundaries (inside)	node boundaries (outside)	power fraction
1	1	8.8808	8,0000	Ø.Ø107	Ø.ØØØØØ
2	1	Ø.Ø213	Ø.Ø107	Ø.Ø32Ø	Ø.ØØØØØ
3	1	0.Ø427	Ø·Ø32Ø	Ø.Ø533	Ø.ØØØØØ
4	1	Ø.Ø64Ø	8.Ø533	Ø.Ø747	Ø.ØØØØØ
5	1	Ø.Ø853	Ø.Ø747	8,Ø968	Ø.ØØØØØ
6	1	Ø.1464	0.8960	8,1968	Ø.ØØØØØ
7	1	Ø.2472	8,1968	Ø.2976	Ø.ØØØØØ
8	1	Ø.348Ø	Ø.2976	Ø.3984	Ø.ØØØØØ
9	1	Ø.4488	Ø·3984	Ø.4992	Ø.ØØØØØ
1Ø	1	Ø.5496	Ø.4992	8,6888	Ø.ØØØØØ
11	1	1.38ØØ	8,6008	2.16ØØ	Ø.ØØØØØ
12	1	2.94ØØ	2.1688	3.72ØØ	Ø.ØØØØØ
13	1	4.5ØØØ	3.72ØØ	5.28ØØ	Ø.ØØØØØ
14	1	6,8688	5.28ØØ	6.84ØØ	Ø.ØØØØØ
15	1	7.62ØØ	6.84ØØ	8.4ØØØ	Ø.ØØØØØ
16	1	1Ø.1333	8.4ØØØ	11.8667	Ø.ØØØØØ
17	1	13.6ØØØ	11.8667	15.3333	Ø.ØØØØØ
18	1	17.Ø667	15.3333	18.8ØØØ	Ø.ØØØØØ
19	1	2Ø.5333	18.8ØØØ	22.2667	Ø.ØØØØØ
2Ø	1	Zd.0008	22.2667	zt.ØØØØ	Ø.ØØØØØ

type 14 - wall   flat plate conductor geometry

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wall perimeter	672.ØØØ (in.)
wall thickness	24.ØØØØ (in.)
no. of nodes **(total)**	2Ø
material index (inside)	I
material index(outside)	Ø

radial noding information

node no.	material index	radial location	node boundaries (insideỊ	o u ~ ~ide)	power fraction
1	1	0.0000	0,0000	Ø.Ø107	0.00000

2	1	0.0213	0.0107	0.0320	0.00000
3	1	0.0427	0.0320	0.0533	0.00000
4	1	0.0640	0.0533	0.0747	0.00000
5	1	0.0853	0.0747	0.0960	0.00000
6	1	0.1464	0.0960	0.1968	0.00000
7	1	0.2472	0.1968	0.2976	0.00000
8	1	0.3480	0.2976	0.3984	0.00000
9	1	0.4488	0.3984	0.4992	0.00000
10	1	0.5496	0.4992	0.6000	0.00000
11	1	1.3800	0.6000	2.1600	0.00000
12	1	2.9400	2.1600	3.7200	0.00000
13	1	4.5000	3.7200	5.2800	0.00000
14	1	6.0600	5.2800	6.8400	0.00000
15	1	7.6200	6.8400	8.4000	0.00000
16	1	10.1333	8.4000	11.8667	0.00000
17	1	13.6000	11.8667	15.3333	0.00000
18	1	17.0667	15.3333	18.8000	0.00000
19	1	20.5333	18.8000	22.2667	0.00000
20	1	24.0000	22.2667	24.0000	0.00000

type 15 - wall   flat plate conductor geometry

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wall perimeter   312.000 (in.)
wall thickness   24.0000 (in.)
no. of nodes (total)   20
material index (inside)   1
material index(outside)   0

radial noding information

node no.	material index	radial location	node boundaries (inside)	node boundaries (outside)	power fraction
1	1	0.0000	0.0000	0.0107	0.00000
2	1	0.0213	0.0107	0.0320	0.00000
3	1	0.0427	0.0320	0.0533	0.00000
4	1	0.0640	0.0533	0.0747	0.00000
5	1	0.0853	0.0747	0.0960	0.00000
6	1	0.1464	0.0960	0.1968	0.00000

7	1	0.2472	0.1968	0.2976	0.00000
8	1	0.3480	0.2976	0.3984	0.00000
9	1	0.4488	0.3984	0.4992	0.00000
10	1	0.5496	0.4992	0.6000	0.00000
11	1	1.3800	0.6000	2.1600	0.00000
12	1	2.9400	2.1600	3.7200	0.00000
13	1	4.5000	3.7200	5.2800	0.00000
14	1	6.0600	5.2800	6.8400	0.00000
15	1	7.6200	6.8400	8.4000	0.00000
16	1	10.1333	8.4000	11.8667	0.00000
17	1	13.6000	11.8667	15.3333	0.00000
18	1	17.0667	15.3333	18.8000	0.00000
19	1	20.5333	18.8000	22.2667	0.00000
20	1	24.0000	22.2667	24.0000	0.00000

type 16 - wall flat plate conductor geometry

....

wall perimeter 2088.000 (in.)
wall thickness 24.0000 (in.)
no. of nodes (total) 20
material index (inside) 1
material index(outside) 0

radial noding information

node no.	material index	radial location	node boundaries (inside)	(outside)	power fraction
1	1	0.0000	0.0000	0.0107	0.00000
2	1	0.0213	0.0107	0.0320	0.00000
3	1	0.0427	0.0320	0.0533	0.00000
4	1	0.0640	0.0533	0.0747	0.00000
5	1	0.0853	0.0747	0.0960	0.00000
6	1	0.1464	0.0960	0.1968	0.00000
7	1	0.2472	0.1968	0.2976	0.00000
8	1	0.3480	0.2976	0.3984	0.00000
9	1	0.4488	0.3984	0.4992	0.00000
10	1	0.5496	0.4992	0.6000	0.00000
11	1	1.3800	0.6000	2.1600	0.00000

12	1	2.9400	2.1600	3.7200	0.00000
13	1	4.5000	3.7200	5.2800	0.00000
14	1	6.0600	5.2800	6.8400	0.00000
15	1	7.6200	6.8400	8.4000	0.00000
16	1	10.1333	8.4000	11.8667	0.00000
17	1	13.6000	11.8667	15.3333	0.00000
18	1	17.0667	15.3333	18.8000	0.00000
19	1	20.5333	18.8000	22.2667	0.00000
20	1	24.0000	22.2667	24.0000	0.00000

type 17 - wall flat plate conductor geometry

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wall perimeter 2544.000 (in.)
wall thickness 24.0000 (in.)
no. of nodes (total) 20
material index (inside) 1
naterial index(outside) 0

radial noding infornation

node no.	naterial index	radial location	node boundaries (inside)	(outside)	power fraction
1	1	0.0000	0.0000	0.0107	0.00000
2	1	0.0213	0.0107	0.0320	0.00000
3	1	0.0427	0.0320	0.0533	0.00000
4	1	0.0640	0.0533	0.0747	0.00000
5	1	0.0853	0.0747	0.0960	0.00000
6	1	0.1464	0.0960	0.1968	0.00000
7	1	0.2472	0.1968	0.2976	0.00000
8	1	0.3480	0.2976	0.3984	0.00000
9	1	0.4488	0.3984	0.4992	0.00000
10	1	0.5496	0.4992	0.6000	0.00000
11	1	1.3800	0.6000	2.1600	0.00000
12	1	2.9400	2.1600	3.7200	0.00000
13	1	4.5000	3.7200	5.2800	0.00000
14	1	6.0600	5.2800	6.8400	0.00000
15	1	7.6200	6.8400	8.4000	0.00000
16	1	10.1333	8.4000	11.8667	0.00000

17	1	13.6000	11.8667	15.3333	0.00000
18	1	17.0667	15.3333	18.8000	0.00000
19	1	20.5333	18.8000	22.2667	0.00000
20	1	24.0000	22.2667	24.0000	0.00000

type 18 - uall   flat plate conductor geometry

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wall perimeter 804.000 (in.)
wall thickness 24.0000 (in.)
no. of nodes (total) 20
material index (inside) 1
material index(outside) 0

radial noding information

node no.	material index	radial location	node boundaries (ins~ e)	node boundaries (outs~ e)	power fraction
1	1	0.0000	0.0088	0.0107	0.00000
2	1	0.0213	0.0107	0.0320	0.00000
3	1	0.0427	0.0320	0.0638	0.00000
4	1	0.0640	0.0533	0.0747	0.00000
5	1	0.0853	0.0747	0.0960	0.00000
6	1	0.1464	0.0960	0.1968	0.00000
7	1	0.2472	0.1968	0.2976	0.00000
8	1	0.3480	0.2976	0.3984	0.00000
9	1	0.4488	0.3984	0.4992	0.00000
10	1	0.5496	0.4992	0.6008	0.00000
11	1	1.3800	8.6008	2.1600	0.00000
12	1	2.9400	2.1600	3.7200	0.00000
13	1	4.6000	3.7200	5.2800	0.00000
14	1	6.0600	5.2800	6.8400	0.00000
15	1	7.6200	6.8400	8.4000	0.00000
16	1	10.1333	8.4000	11.8667	0.00000
17	1	13.6000	11.8667	15.3333	0.00000
18	1	17.0667	15.3333	18.8000	0.00000
19	1	20.5333	18.8000	22.2667	0.00000
20	1	24.0000	22.2667	24.0000	0.00000

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material property tables
....

material type - 1 cold state density = 139.000 (lbm/ft3)

temperature (f)	specific heat (btu/lbm-f)	conductivity (btu/hr-ft-f)
50.0	0.22000	0.867
1000.0	0.22000	0.867

1 forcing function tables

0 table 1

time coord	forcing factor	time coord.	forcing factor	time coord.	forcing factor	time coord.	forcing factor	time coord.	forcing factor
0.000	142.000	6.010	67.800	12.510	61.000	20.010	49.500	27.510	27.700
0.850	142.000	7.500	67.800	15.000	61.000	22.500	49.500	30.000	27.700
0.851	71.000	7.510	64.900	15.010	58.000	22.510	46.200	30.010	15.200
5.000	71.000	10.000	64.900	17.500	58.000	25.000	46.200	32.500	15.200
5.010	68.800	10.010	62.800	17.510	54.500	25.010	39.300	35.000	0.000

6.000	68.600	12.500	62.800	20.000	54.500	27.500	39.300	1500.000
0.000								

1

axial and/or injection boundary conditions

boundary type	property specification
1= pressure and enthalpy (axial)	pressure
2= flow and ehthalpy (axial)	mass flow
3= zero axial flow	zero
4= injected flow and enthalpy	injected flow
5= pressure sink and enthalpy	sink pressure

channel index	axial node	boundary type (see above)	specified property (see above)	enthalpy
2	1	2	1.00	1249.40
15	3	1	14.70	145.30
1	1	3	0.00	0.00
3	1	3	0.00	0.00
4	1	3	0.00	0.00
5	1	3	0.00	0.00
6	1	3	0.00	0.00
7	1	3	0.00	0.00
8	1	3	0.00	0.00
9	1	3	0.00	0.00
10	1	3	0.00	0.00
11	1	3	0.00	0.00
12	1	3	0.00	0.00
1	2	3	0.00	0.00
2	2	3	0.00	0.00
3	2	3	0.00	0.00
4	2	3	0.00	0.00
5	2	3	0.00	0.00
8	2	3	0.00	0.00
12	2	3	0.00	0.00

13	2	3	0.00	0.00
16	2	3	0.00	0.00
17	2	3	0.00	0.00
18	2	3	0.00	0.00

0

zero crossflow boundary conditions

gap index   axial node

18   channels will be printed

1 2 3 4 5 6 7 8 9 10
11 12 13 14 15 16 17 18

0   0   rods will be printed

0   0   gaps will be printed

1 trac major edit

time = 0.000e+00 seconds   delt = 0.000e+00 seconds   time steps + 0   oitno= 0

average outer iteration count over ther last 0 time steps was 0.00e+00
the last minimum number of outer iterations was 0 at step 8
the last maximum number of outer iterations was 0 at step 0
last minimum number of inner iterations was 0 at step 0
current convergence limits and limitation counts

delamx	delemx	delrmx	delvmx	delpmx
0.000e+00	0.000e+00	0.000e+00	0.000e+00	0.000e+00
0	0	0	0	0

cptime = 5.640e-01

```
*************************************************************************
*                          nɐu time domain reached                      *
*   minimum   maximum    time      long      short   graphics     dump  *
*    time      time     domain     edit      edit      edit             *
*    step      step       ɐnd    interval  interval  interval  interval *
*                                                                       *
* 1.000e-04 1.000e-03 1.000e-01 1.000e+06 1.000e+06 1.000e+06 5.000e+02 *
*************************************************************************


 interval for  a.s.b. oubpub is    0.02000 seconds.
time step ratio      =  1.000e+00

1 trac major edit
1 trac major edit
1 trac major edit
1 trac major edit
1 trac major edit


*************************************************************************
*                          nɐu time domain reached                      *
*   minimum   maximum    time      long      short   graphics     dump  *
*    time      time     domain     edit      edit      edit             *
*    step      step       ɐnd    interval  interval  interval  interval *
*                                                                       *
* 1.000e-04 5.000e-02 1.000e+00 1.000e+06 1.000e+06 1.000e+06 5.000e+02 *
*************************************************************************


 interval for  a.s.b. oubpub is    0.10000 seconds.
time sbɐp ratio      =  1.000e+00

1 trac major edit
1 trac major edit
1 trac major edit
1 trac major edit
1 trac major edit
1 trac major edit
1 trac major edit
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1 trac major edit
1 trac major edit


*****************************************************************************
*                        new tine domain reached                            *
*  minimum   maximum    time      long      short   graphics    dump        *
*    time      time    domain     edit      edit      edit                  *
*    step      step     end     interval  interval  interval  interval     *
*                                                                           *
* 1.000e-04 1.000e-02 3.600e+01 1.000e+06 1.000e+06 1.000e+06 5.000e+02 *
*****************************************************************************


  interval for  a.s.b. output is    1.00000 seconds.
 timestepratio      =  1.000e+00

1 trac major edit
1 trac major edit
1 trac najor edit
1 trac major edit
1 trac najor edit
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1 trac major edit
1 trac major edit
1 trac najor edit
1 trac major edit
1 trac najor edit
1 trac major edit
1 trac major edit
1 trac major edit
1 trac major edit
1 trac major edit
1 trac major edit
0saved a restart dump at 3662 36.007
1 trac major edit

time = 3.601e+01 seconds delt = 1.000e-02 seconds time steps + 3662 oitno= 1

average outer iteration count over ther last 3662 time steps was 1.00e+00
the last minimum number of outer iterations was 1 at step 3661
the last maximum nunber of outer iterations was 1 at step 3661
last minimum number of inner iterations was 0 at step 3505
current convergence limits and limitation counts

delamx	delemx	delrmx	delvmx	delpmx
1.000e+08	1.000e+08	1.000e+08	1.990e+00	1.000e+08
0	0	0	0	0

cptime = 3.556e+01

1 pressure (psia)

time (sec)	room 1	room 2	room 3	room 4	room 5	room 6	room 7	room 8	room 9	room 10
0.00	1.4713e+01	1.4713e+01	1.4713e+01	1.4713e+01	1.4713e+01	1.4713e+01	1.4713e+01	1.4713e+01	1.4713e+01	1.4713e+01
0.02	1.4718e+01	1.5204e+01	1.4713e+01	1.4713e+01	1.4713e+01	1.4713e+01	1.4713e+01	1.4713e+01	1.4719e+01	1.4713e+01
0.04	1.4744e+01	1.5547e+01	1.4714e+01	1.4713e+01	1.4713e+01	1.4713e+01	1.4713e+01	1.4713e+01	1.4759e+01	1.4714e+01

10.03	1.8482e+01	1.8547e+01	1.8476e+01	1.8475e+01	1.8474e+01	1.8465e+01	1.8475e+01	1.8465e+01	2.3113e+01	1.8480e+01
11.03	1.8674e+01	1.8740e+01	1.8668e+01	1.8667e+01	1.8661e+01	1.8656e+01	1.8667e+01	1.8656e+01	2.3189e+01	1.8672e+01
12.03	1.8860e+01	1.8927e+01	1.8854e+01	1.8853e+01	1.8845e+01	1.8841e+01	1.8853e+01	1.8841e+01	2.3261e+01	1.8858e+01
13.03	1.9035e+01	1.9097e+01	1.9029e+01	1.9028e+01	1.9020e+01	1.9018e+01	1.9028e+01	1.9018e+01	2.3328e+01	1.9033e+01
14.03	1.9202e+01	1.9264e+01	1.9197e+01	1.9197e+01	1.9186e+01	1.9186e+01	1.9196e+01	1.9186e+01	2.3393e+01	1.9201e+01
15.03	1.9362e+01	1.9415e+01	1.9357e+01	1.9357e+01	1.9344e+01	1.9344e+01	1.9356e+01	1.9344e+01	2.3455e+01	1.9361e+01
16.03	1.9506e+01	1.9562e+01	1.9501e+01	1.9500e+01	1.9488e+01	1.9488e+01	1.9500e+01	1.9488e+01	2.3510e+01	1.9505e+01
17.03	1.9643e+01	1.9699e+01	1.9638e+01	1.9638e+01	1.9626e+01	1.9626e+01	1.9637e+01	1.9626e+01	2.3563e+01	1.9642e+01
18.03	1.9768e+01	1.9817e+01	1.9763e+01	1.9762e+01	1.9754e+01	1.9754e+01	1.9762e+01	1.9754e+01	2.3610e+01	1.9766e+01
19.03	1.9884e+01	1.9933e+01	1.9880e+01	1.9879e+01	1.9870e+01	1.9870e+01	1.9879e+01	1.9870e+01	2.3655e+01	1.9883e+01
20.03	1.9994e+01	2.0028e+01	1.9990e+01	1.9990e+01	1.9981e+01	1.9981e+01	1.9990e+01	1.9981e+01	2.3697e+01	1.9994e+01
21.03	2.0087e+01	2.0127e+01	2.0083e+01	2.0083e+01	2.0077e+01	2.0077e+01	2.0083e+01	2.0077e+01	2.3732e+01	2.0086e+01
22.03	2.0177e+01	2.0217e+01	2.0173e+01	2.0173e+01	2.0168e+01	2.0167e+01	2.0173e+01	2.0167e+01	2.3766e+01	2.0177e+01
23.03	2.0259e+01	2.0294e+01	2.0255e+01	2.0255e+01	2.0251e+01	2.0251e+01	2.0255e+01	2.0250e+01	2.3797e+01	2.0258e+01
24.03	2.0335e+01	2.0369e+01	2.0331e+01	2.0331e+01	2.0327e+01	2.0327e+01	2.0331e+01	2.0327e+01	2.3826e+01	2.0334e+01
25.03	2.0406e+01	2.0422e+01	2.0404e+01	2.0404e+01	2.0400e+01	2.0400e+01	2.0404e+01	2.0400e+01	2.3853e+01	2.0407e+01
26.03	2.0461e+01	2.0487e+01	2.0459e+01	2.0459e+01	2.0457e+01	2.0457e+01	2.0459e+01	2.0457e+01	2.3873e+01	2.0461e+01
27.03	2.0543e+01	2.0566e+01	2.0506e+01	2.0512e+01	2.0507e+01	2.0507e+01	2.0506e+01	2.0508e+01	2.3889e+01	2.0541e+01
28.03	2.0653e+01	2.0665e+01	2.0538e+01	2.0531e+01	2.0537e+01	2.0537e+01	2.0539e+01	2.0537e+01	2.3900e+01	2.0651e+01
29.03	2.0686e+01	2.0698e+01	2.0575e+01	2.0580e+01	2.0573e+01	2.0573e+01	2.0573e+01	2.0573e+01	2.3915e+01	2.0685e+01

30.03	2.0724e+01	2.0702e+01	2.0625e+01	2.0625e+01	2.0601e+01	2.0601e+01	2.0627e+01	2.0601e+01	2.3936e+01	2.0726e+01
31.03	2.0673e+01	2.0677e+01	2.0639e+01	2.0650e+01	2.0639e+01	2.0640e+01	2.0655e+01	2.0640e+01	2.3936e+01	2.0674e+01
32.03	2.0679e+01	2.0682e+01	2.0675e+01	2.0656e+01	2.0671e+01	2.0671e+01	2.0649e+01	2.0671e+01	2.3954e+01	2.0678e+01
33.03	2.0715e+01	2.0716e+01	2.0712e+01	2.0733e+01	2.0701e+01	2.0701e+01	2.0729e+01	2.0701e+01	2.3967e+01	2.0715e+01
34.03	2.0715e+01	2.0715e+01	2.0737e+01	2.0737e+01	2.0735e+01	2.0735e+01	2.0748e+01	2.0735e+01	2.3973e+01	2.0715e+01
35.03	2.0682e+01	2.0681e+01	2.0736e+01	2.0736e+01	2.0760e+01	2.0760e+01	2.0728e+01	2.0761e+01	2.3971e+01	2.0682e+01
36.00	2.0640e+01	2.0640e+01	2.0714e+01	2.0720e+01	2.0744e+01	2.0745e+01	2.0723e+01	2.0745e+01	2.3959e+01	2.0640e+01

1 pressure (psia)

time	room 11	room 12	room 13	room 14	room 15	room 16	room 17	room 18	room
0.00	1.4713e+01	1.4713e+01	1.4707e+01	1.4707e+01	1.4707e+01	1.4707e+01	1.4707e+01	1.4700e+01	
0.02	1.4713e+01	1.4713e+01	1.4707e+01	1.4707e+01	1.4742e+01	1.4707e+01	1.4707e+01	1.4700e+01	
0.04	1.4714e+01	1.4713e+01	1.4707e+01	1.4707e+01	1.4769e+01	1.4707e+01	1.4707e+01	1.4700e+01	
0.06	1.4716e+01	1.4714e+01	1.4707e+01	1.4707e+01	1.4742e+01	1.4709e+01	1.4708e+01	1.4700e+01	
0.08	1.4720e+01	1.4715e+01	1.4707e+01	1.4708e+01	1.4695e+01	1.4714e+01	1.4713e+01	1.4700e+01	
0.10	1.4729e+01	1.4719e+01	1.4708e+01	1.4710e+01	1.4665e+01	1.4726e+01	1.4721e+01	1.4702e+01	
0.20	1.4818e+01	1.4812e+01	1.4748e+01	1.4793e+01	1.4932e+01	1.4839e+01	1.4812e+01	1.4786e+01	
0.28	1.4885e+01	1.4875e+01	1.4789e+01	1.4873e+01	1.4971e+01	1.4914e+01	1.4879e+01	1.4868e+01	
0.40	1.4955e+01	1.4875e+01	1.4836e+01	1.4876e+01	1.4949e+01	1.4976e+01	1.4949e+01	1.4869e+01	
0.46	1.4988e+01	1.4893e+01	1.4871e+01	1.4880e+01	1.5118e+01	1.5001e+01	1.4981e+01	1.4873e+01	
0.59	1.5040e+01	1.4949e+01	1.4939e+01	1.4939e+01	1.6471e+01	1.5042e+01	1.5033e+01	1.4931e+01	
0.69	1.5075e+01	1.5002e+01	1.4986e+01	1.4996e+01	1.7641e+01	1.5075e+01	1.5068e+01	1.4989e+01	
0.79	1.5113e+01	1.5056e+01	1.5031e+01	1.5050e+01	1.8092e+01	1.5113e+01	1.5106e+01	1.5043e+01	
0.89	1.5151e+01	1.5110e+01	1.5078e+01	1.5102e+01	1.7582e+01	1.5153e+01	1.5144e+01	1.5096e+01	
0.99	1.5171e+01	1.5154e+01	1.5123e+01	1.5147e+01	1.6469e+01	1.5169e+01	1.5165e+01	1.5141e+01	
2.03	1.5352e+01	1.5825e+01	1.5563e+01	1.5721e+01	1.4681e+01	1.5338e+01	1.5343e+01	1.5709e+01	
3.03	1.6389e+01	1.6434e+01	1.6370e+01	1.6412e+01	1.7473e+01	1.6416e+01	1.6382e+01	1.6405e+01	
4.03	1.6836e+01	1.6844e+01	1.6824e+01	1.6837e+01	1.7322e+01	1.6835e+01	1.6828e+01	1.6829e+01	
5.03	1.7173e+01	1.7159e+01	1.7151e+01	1.7164e+01	1.7488e+01	1.7167e+01	1.7166e+01	1.7158e+01	
6.03	1.7534e+01	1.7618e+01	1.7506e+01	1.7533e+01	1.7626e+01	1.7530e+01	1.7526e+01	1.7525e+01	
7.03	1.7816e+01	1.7822e+01	1.7804e+01	1.7809e+01	1.7771e+01	1.7812e+01	1.7809e+01	1.7801e+01	
8.03	1.8062e+01	1.8061e+01	1.8045e+01	1.8053e+01	1.7850e+01	1.8057e+01	1.8055e+01	1.8045e+01	
9.03	1.8278e+01	1.8275e+01	1.8258e+01	1.8268e+01	1.7920e+01	1.8272e+01	1.8270e+01	1.8260e+01	
10.03	1.8478e+01	1.8474e+01	1.8457e+01	1.8467e+01	1.7983e+01	1.8472e+01	1.8470e+01	1.8459e+01	

11.03	1.8670e+01	1.8667e+01	1.8648e+01	1.8659e+01	1.8044e+01	1.8664e+01	1.8662e+01	1.8651e+01
12.03	1.8857e+01	1.8853e+01	1.8833e+01	1.8845e+01	1.8102e+01	1.8850e+01	1.8849e+01	1.8837e+01
13.03	1.9032e+01	1.9026e+01	1.9010e+01	1.9020e+01	1.8157e+01	1.9025e+01	1.9024e+01	1.9012e+01
14.03	1.9200e+01	1.9195e+01	1.9178e+01	1.9188e+01	1.8210e+01	1.9193e+01	1.9192e+01	1.9180e+01
15.03	1.9360e+01	1.9356e+01	1.9337e+01	1.9348e+01	1.8260e+01	1.9353e+01	1.9352e+01	1.9340e+01
16.03	1.9504e+01	1.9500e+01	1.9481e+01	1.9492e+01	1.8305e+01	1.9496e+01	1.9496e+01	1.9484e+01
17.03	1.9641e+01	1.9637e+01	1.9618e+01	1.9629e+01	1.8348e+01	1.9634e+01	1.9633e+01	1.9621e+01
18.03	1.9766e+01	1.9762e+01	1.9746e+01	1.9754e+01	1.8387e+01	1.9758e+01	1.9758e+01	1.9746e+01
19.03	1.9883e+01	1.9879e+01	1.9863e+01	1.9871e+01	1.8424e+01	1.9875e+01	1.9875e+01	1.9863e+01
20.03	1.9993e+01	1.9990e+01	1.9973e+01	1.9982e+01	1.8458e+01	1.9986e+01	1.9985e+01	1.9973e+01
21.03	2.0086e+01	2.0083e+01	2.0069e+01	2.0075e+01	1.8487e+01	2.0078e+01	2.0078e+01	2.0067e+01
22.03	2.0176e+01	2.0173e+01	2.0159e+01	2.0165e+01	1.8515e+01	2.0168e+01	2.0168e+01	2.0156e+01
23.03	2.0258e+01	2.0255e+01	2.0243e+01	2.0247e+01	1.8541e+01	2.0250e+01	2.0250e+01	2.0238e+01
24.03	2.0334e+01	2.0331e+01	2.0319e+01	2.0323e+01	1.8565e+01	2.0326e+01	2.0326e+01	2.0314e+01
25.03	2.0407e+01	2.0404e+01	2.0392e+01	2.0396e+01	1.8587e+01	2.0399e+01	2.0399e+01	2.0387e+01
26.03	2.0461e+01	2.0459e+01	2.0449e+01	2.0451e+01	1.8604e+01	2.0452e+01	2.0452e+01	2.0443e+01
27.03	2.0540e+01	2.0506e+01	2.0499e+01	2.0498e+01	1.8618e+01	2.0533e+01	2.0531e+01	2.0489e+01
28.03	2.0651e+01	2.0537e+01	2.0529e+01	2.0531e+01	1.8628e+01	2.0642e+01	2.0643e+01	2.0522e+01
29.03	2.0686e+01	2.0573e+01	2.0565e+01	2.0565e+01	1.8640e+01	2.0677e+01	2.0677e+01	2.0557e+01
30.03	2.0726e+01	2.0630e+01	2.0593e+01	2.0618e+01	1.8655e+01	2.0718e+01	2.0718e+01	2.0610e+01
31.03	2.0674e+01	2.0648e+01	2.0632e+01	2.0647e+01	1.8659e+01	2.0665e+01	2.0665e+01	2.0638e+01
32.03	2.0678e+01	2.0655e+01	2.0663e+01	2.0641e+01	1.8670e+01	2.0670e+01	2.0670e+01	2.0633e+01
33.03	2.0715e+01	2.0733e+01	2.0693e+01	2.0721e+01	1.8681e+01	2.0707e+01	2.0707e+01	2.0713e+01
34.03	2.0715e+01	2.0736e+01	2.0727e+01	2.0739e+01	1.8689e+01	2.0707e+01	2.0707e+01	2.0731e+01
35.03	2.0682e+01	2.0737e+01	2.0752e+01	2.0719e+01	1.8688e+01	2.0674e+01	2.0674e+01	2.0711e+01
36.00	2.0640e+01	2.0720e+01	2.0737e+01	2.0715e+01	1.8680e+01	2.0632e+01	2.0632e+01	2.0707e+01

1 temperature (degrees f.)

time (sec)	room 1	room 2	room 3	room 4	room 5	room 6	room 7	room 8	room 9	room 10
0.00	8.6556e+01	8.6556e+01	8.6556e+01	8.6556e+01	8.6556e+01	8.6556e+01	8.6556e+01	8.6556e+01	8.6556e+01	8.6556e+01
0.02	8.6613e+01	9.8033e+01	8.6556e+01	8.6556e+01	8.6556e+01	8.6556e+01	8.6556e+01	8.6556e+01	8.6621e+01	8.6556e+01
0.04	8.6927e+01	1.0731e+02	8.6567e+01	8.6556e+01	8.6556e+01	8.6556e+01	8.6556e+01	8.6556e+01	8.7073e+01	8.6562e+01
0.06	8.7514e+01	1.1476e+02	8.6617e+01	8.6559e+01	8.6557e+01	8.6557e+01	8.6561e+01	8.6556e+01	8.6995e+01	8.6589e+01

0.08	8.8201e+01	1.2105e+02	8.6719e+01	8.6573e+01	8.6563e+01	8.6563e+01	8.6580e+01	8.6556e+01	8.6390e+01	8.6658e+01
0.10	8.8818e+01	1.2679e+02	8.6860e+01	8.6615e+01	8.6581e+01	8.6579e+01	8.6623e+01	8.6556e+01	8.6357e+01	8.6788e+01
0.20	9.0299e+01	1.5456e+02	8.7747e+01	8.7680e+01	8.7060e+01	8.7030e+01	8.7542e+01	8.6638e+01	8.8513e+01	8.8066e+01
0.28	9.1697e+01	1.7569e+02	8.8159e+01	8.8391e+01	8.7579e+01	8.7488e+01	8.8400e+01	8.7050e+01	8.9412e+01	8.8916e+01
0.40	9.4552e+01	2.0339e+02	8.8615e+01	8.8374e+01	8.7974e+01	8.8042e+01	8.8464e+01	8.8009e+01	9.2850e+01	8.9628e+01
0.46	9.6259e+01	2.1779e+02	8.8852e+01	8.8573e+01	8.8315e+01	8.8439e+01	8.8524e+01	8.8505e+01	9.3408e+01	8.9922e+01
0.59	9.9839e+01	2.4324e+02	8.9633e+01	8.9210e+01	8.9145e+01	8.9200e+01	8.9174e+01	8.9250e+01	9.0620e+01	9.0403e+01
0.69	1.0280e+02	2.6027e+02	9.0369e+01	8.9800e+01	8.9707e+01	8.9732e+01	8.9808e+01	8.9704e+01	9.4984e+01	9.0787e+01
0.79	1.0598e+02	2.7598e+02	9.1138e+01	9.0402e+01	9.0224e+01	9.0244e+01	9.0412e+01	9.0156e+01	1.0340e+02	9.1252e+01
0.89	1.0883e+02	2.8234e+02	9.1980e+01	9.1001e+01	9.0740e+01	9.0772e+01	9.1004e+01	9.0644e+01	1.2718e+02	9.1738e+01
0.99	1.1038e+02	2.8684e+02	9.2779e+01	9.1489e+01	9.1236e+01	9.1290e+01	9.1502e+01	9.1170e+01	1.5563e+02	9.1923e+01
2.03	1.3066e+02	3.4556e+02	1.1168e+02	9.9139e+01	9.5397e+01	9.6351e+01	9.8131e+01	9.3260e+01	1.7662e+02	9.4195e+01
3.03	1.5409e+02	3.8510e+02	1.5324e+02	1.0689e+02	1.0565e+02	1.1277e+02	1.0934e+02	1.0480e+02	1.7706e+02	1.0846e+02
4.03	1.7408e+02	4.0423e+02	1.6232e+02	1.1192e+02	1.1164e+02	1.2301e+02	1.1575e+02	1.0963e+02	1.7720e+02	1.1409e+02
5.03	1.9270e+02	4.1491e+02	1.6634e+02	1.1586e+02	1.0538e+02	1.2898e+02	1.2059e+02	1.1319e+02	1.7729e+02	1.1871e+02
6.03	2.1053e+02	4.2161e+02	1.6881e+02	1.2027e+02	1.3569e+02	1.2696e+02	1.2598e+02	1.1690e+02	1.7715e+02	1.2393e+02
7.03	2.2654e+02	4.2508e+02	1.7039e+02	1.2335e+02	1.4419e+02	1.3218e+02	1.2984e+02	1.1980e+02	1.7839e+02	1.2807e+02
8.03	2.4103e+02	4.2685e+02	1.7153e+02	1.2511e+02	1.4973e+02	1.3583e+02	1.3310e+02	1.2218e+02	1.7900e+02	1.3176e+02
9.03	2.5420e+02	4.2779e+02	1.7239e+02	1.2660e+02	1.5328e+02	1.3913e+02	1.3590e+02	1.2429e+02	1.7954e+02	1.3506e+02
10.03	2.6645e+02	4.2821e+02	1.7312e+02	1.2784e+02	1.5592e+02	1.4210e+02	1.3834e+02	1.2624e+02	1.8002e+02	1.3818e+02

11.03	2.7754e+02	4.2850e+02	1.7392e+02	1.2892e+02	1.5789e+02	1.4494e+02	1.4027e+02	1.2810e+02	1.8048e+02	1.4122e+02
12.03	2.8789e+02	4.2863e+02	1.7476e+02	1.2990e+02	1.5936e+02	1.4761e+02	1.4183e+02	1.2989e+02	1.8091e+02	1.4421e+02
13.03	2.9736e+02	4.2859e+02	1.7561e+02	1.3079e+02	1.6044e+02	1.5006e+02	1.4307e+02	1.3158e+02	1.8132e+02	1.4705e+02
14.03	3.0604e+02	4.2852e+02	1.7644e+02	1.3169e+02	1.6120e+02	1.5231e+02	1.4410e+02	1.3317e+02	1.8170e+02	1.4980e+02
15.03	3.1411e+02	4.2831e+02	1.7726e+02	1.3261e+02	1.6168e+02	1.5436e+02	1.4486e+02	1.3466e+02	1.8207e+02	1.5244e+02
16.03	3.2119e+02	4.2815e+02	1.7799e+02	1.3327e+02	1.6202e+02	1.5613e+02	1.4553e+02	1.3600e+02	1.8239e+02	1.5481e+02
17.03	3.2777e+02	4.2796e+02	1.7867e+02	1.3393e+02	1.6229e+02	1.5773e+02	1.4627e+02	1.3726e+02	1.8270e+02	1.5709e+02
18.03	3.3367e+02	4.2765e+02	1.7925e+02	1.3455e+02	1.6253e+02	1.5913e+02	1.4700e+02	1.3842e+02	1.8297e+02	1.5917e+02
19.03	3.3898e+02	4.2741e+02	1.7975e+02	1.3518e+02	1.6273e+02	1.6035e+02	1.4775e+02	1.3947e+02	1.8323e+02	1.6112e+02
20.03	3.4392e+02	4.2702e+02	1.8019e+02	1.3581e+02	1.6293e+02	1.6145e+02	1.4851e+02	1.4045e+02	1.8347e+02	1.6297e+02
21.03	3.4801e+02	4.2676e+02	1.8047e+02	1.3634e+02	1.6307e+02	1.6235e+02	1.4915e+02	1.4128e+02	1.8367e+02	1.6451e+02
22.03	3.5185e+02	4.2649e+02	1.8071e+02	1.3688e+02	1.6322e+02	1.6317e+02	1.4980e+02	1.4205e+02	1.8387e+02	1.6602e+02
23.03	3.5529e+02	4.2614e+02	1.8087e+02	1.3739e+02	1.6364e+02	1.6389e+02	1.5040e+02	1.4275e+02	1.8404e+02	1.6737e+02
24.03	3.5837e+02	4.2585e+02	1.8096e+02	1.3788e+02	1.6382e+02	1.6453e+02	1.5097e+02	1.4337e+02	1.8421e+02	1.6864e+02
25.03	3.6126e+02	4.2539e+02	1.8102e+02	1.3836e+02	1.6394e+02	1.6513e+02	1.5152e+02	1.4396e+02	1.8436e+02	1.6985e+02
26.03	3.6340e+02	4.2507e+02	1.8090e+02	1.3870e+02	1.6400e+02	1.6557e+02	1.5191e+02	1.4440e+02	1.8447e+02	1.7072e+02
27.03	3.6569e+02	4.2496e+02	1.8070e+02	1.3906e+02	1.6402e+02	1.6595e+02	1.5221e+02	1.4477e+02	1.8456e+02	1.7207e+02
28.03	3.6779e+02	4.2489e+02	1.8031e+02	1.3912e+02	1.6398e+02	1.6616e+02	1.5238e+02	1.4492e+02	1.8463e+02	1.7395e+02
29.03	3.6877e+02	4.2415e+02	1.8002e+02	1.3949e+02	1.6398e+02	1.6644e+02	1.5260e+02	1.4514e+02	1.8471e+02	1.7449e+02
30.03	3.6974e+02	4.2322e+02	1.7972e+02	1.3982e+02	1.6356e+02	1.6665e+02	1.5302e+02	1.4527e+02	1.8482e+02	1.7513e+02

31.03	3.6866e+02	4.2180e+02	1.7936e+02	1.3996e+02	1.6381e+02	1.6701e+02	1.5319e+02	1.4550e+02	1.8483e+02	1.7445e+02
32.03	3.6860e+02	4.2080e+02	1.7907e+02	1.3993e+02	1.6391e+02	1.6729e+02	1.5308e+02	1.4565e+02	1.8493e+02	1.7446e+02
33.03	3.6880e+02	4.2013e+02	1.7907e+02	1.4058e+02	1.6397e+02	1.6757e+02	1.5381e+02	1.4579e+02	1.8500e+02	1.7504e+02
34.03	3.6826e+02	4.1891e+02	1.7897e+02	1.4053e+02	1.6406e+02	1.6791e+02	1.5390e+02	1.4597e+02	1.8503e+02	1.7496e+02
35.03	3.6628e+02	4.1704e+02	1.7878e+02	1.4044e+02	1.6403e+02	1.6815e+02	1.5367e+02	1.4606e+02	1.8502e+02	1.7444e+02
36.00	3.6234e+02	4.1462e+02	1.7835e+02	1.4022e+02	1.6368e+02	1.6799e+02	1.5357e+02	1.4578e+02	1.8496e+02	1.7384e+02

1 temperature (degrees f.)

time	room 11	room 12	room 13	room 14	room 15	room 16	room 17	room 18	room
0.00	8.6556e+01	8.6556e+01	8.6556e+01	8.6556e+01	8.6556e+01	8.6556e+01	8.6556e+01	8.6556e+01	
0.02	8.6556e+01	8.6556e+01	8.6556e+01	8.6556e+01	8.6936e+01	8.6556e+01	8.6556e+01	8.6556e+01	
0.04	8.6560e+01	8.6556e+01	8.6556e+01	8.6556e+01	8.7195e+01	8.6558e+01	8.6558e+01	8.6556e+01	
0.06	8.6581e+01	8.6559e+01	8.6557e+01	8.6558e+01	8.6866e+01	8.6578e+01	8.6573e+01	8.6556e+01	
0.08	8.6635e+01	8.6573e+01	8.6561e+01	8.6568e+01	8.6329e+01	8.6643e+01	8.6623e+01	8.6561e+01	
0.10	8.6735e+01	8.6614e+01	8.6576e+01	8.6599e+01	8.5989e+01	8.6771e+01	8.6721e+01	8.6583e+01	
0.20	8.7760e+01	8.7669e+01	8.7026e+01	8.7530e+01	9.4485e+01	8.8049e+01	8.7744e+01	8.7524e+01	
0.28	8.8527e+01	8.8381e+01	8.7481e+01	8.8430e+01	1.1703e+02	8.8885e+01	8.8497e+01	8.8453e+01	
0.40	8.9330e+01	8.8381e+01	8.8019e+01	8.8460e+01	1.3658e+02	8.9579e+01	8.9279e+01	8.8460e+01	
0.46	8.9706e+01	8.8574e+01	8.8411e+01	8.8510e+01	1.4735e+02	8.9862e+01	8.9641e+01	8.8501e+01	
0.59	9.0314e+01	8.9206e+01	8.9166e+01	8.9164e+01	1.6120e+02	9.0319e+01	9.0219e+01	8.9160e+01	
0.69	9.0731e+01	8.9797e+01	8.9692e+01	8.9800e+01	1.6730e+02	9.0678e+01	9.0609e+01	8.9799e+01	
0.79	9.1182e+01	9.0399e+01	9.0196e+01	9.0401e+01	1.6973e+02	9.1106e+01	9.1024e+01	9.0401e+01	
0.89	9.1648e+01	9.0998e+01	9.0713e+01	9.0987e+01	1.7100e+02	9.1549e+01	9.1448e+01	9.0986e+01	
0.99	9.1897e+01	9.1487e+01	9.1216e+01	9.1485e+01	1.7225e+02	9.1717e+01	9.1673e+01	9.1486e+01	
2.03	9.4241e+01	9.8874e+01	9.6027e+01	9.7750e+01	1.7692e+02	9.3565e+01	9.3619e+01	9.7675e+01	
3.03	1.0803e+02	1.0690e+02	1.0471e+02	1.0535e+02	1.7721e+02	1.0511e+02	1.0476e+02	1.0499e+02	
4.03	1.1403e+02	1.1190e+02	1.0956e+02	1.0993e+02	1.7846e+02	1.0942e+02	1.0937e+02	1.0927e+02	
5.03	1.1874e+02	1.1567e+02	1.1301e+02	1.1344e+02	1.7950e+02	1.1277e+02	1.1278e+02	1.1250e+02	
6.03	1.2393e+02	1.2022e+02	1.1667e+02	1.1741e+02	1.8035e+02	1.1638e+02	1.1637e+02	1.1605e+02	
7.03	1.2810e+02	1.2139e+02	1.1967e+02	1.2035e+02	1.8122e+02	1.1914e+02	1.1914e+02	1.1864e+02	
8.03	1.3181e+02	1.2275e+02	1.2206e+02	1.2290e+02	1.8169e+02	1.2149e+02	1.2151e+02	1.2087e+02	
9.03	1.3512e+02	1.2381e+02	1.2415e+02	1.2513e+02	1.8210e+02	1.2353e+02	1.2356e+02	1.2281e+02	
10.03	1.3825e+02	1.2478e+02	1.2608e+02	1.2717e+02	1.8247e+02	1.2540e+02	1.2545e+02	1.2456e+02	
11.03	1.4130e+02	1.2577e+02	1.2791e+02	1.2911e+02	1.8282e+02	1.2718e+02	1.2723e+02	1.2622e+02	
12.03	1.4431e+02	1.2679e+02	1.2968e+02	1.3097e+02	1.8316e+02	1.2889e+02	1.2896e+02	1.2782e+02	

13.03	1.4716e+02	1.2780e+02	1.3134e+02	1.3269e+02	1.8348e+02	1.3048e+02	1.3056e+02	1.2929e+02
14.03	1.4992e+02	1.2881e+02	1.3291e+02	1.3430e+02	1.8378e+02	1.3199e+02	1.3209e+02	1.3067e+02
15.03	1.5257e+02	1.2977e+02	1.3437e+02	1.3581e+02	1.8407e+02	1.3342e+02	1.3353e+02	1.3198e+02
16.03	1.5495e+02	1.3062e+02	1.3568e+02	1.3712e+02	1.8432e+02	1.3468e+02	1.3480e+02	1.3312e+02
17.03	1.5724e+02	1.3148e+02	1.3691e+02	1.3835e+02	1.8456e+02	1.3587e+02	1.3600e+02	1.3418e+02
18.03	1.5933e+02	1.3228e+02	1.3805e+02	1.3944e+02	1.8478e+02	1.3693e+02	1.3707e+02	1.3513e+02
19.03	1.6129e+02	1.3305e+02	1.3907e+02	1.4044e+02	1.8499e+02	1.3792e+02	1.3807e+02	1.3599e+02
20.03	1.6315e+02	1.3381e+02	1.4002e+02	1.4136e+02	1.8518e+02	1.3883e+02	1.3900e+02	1.3679e+02
21.03	1.6470e+02	1.3444e+02	1.4082e+02	1.4211e+02	1.8534e+02	1.3957e+02	1.3975e+02	1.3743e+02
22.03	1.6622e+02	1.3506e+02	1.4156e+02	1.4282e+02	1.8549e+02	1.4029e+02	1.4048e+02	1.3803e+02
23.03	1.6758e+02	1.3564e+02	1.4224e+02	1.4344e+02	1.8563e+02	1.4091e+02	1.4112e+02	1.3856e+02
24.03	1.6885e+02	1.3618e+02	1.4284e+02	1.4401e+02	1.8576e+02	1.4149e+02	1.4170e+02	1.3904e+02
25.03	1.7007e+02	1.3670e+02	1.4340e+02	1.4454e+02	1.8589e+02	1.4203e+02	1.4225e+02	1.3948e+02
26.03	1.7095e+02	1.3708e+02	1.4382e+02	1.4490e+02	1.8598e+02	1.4238e+02	1.4262e+02	1.3976e+02
27.03	1.7228e+02	1.3738e+02	1.4416e+02	1.4517e+02	1.8606e+02	1.4299e+02	1.4323e+02	1.3996e+02
28.03	1.7420e+02	1.3758e+02	1.4431e+02	1.4531e+02	1.8611e+02	1.4389e+02	1.4416e+02	1.4004e+02
29.03	1.7473e+02	1.3784e+02	1.4451e+02	1.4547e+02	1.8617e+02	1.4405e+02	1.4433e+02	1.4013e+02
30.03	1.7537e+02	1.3830e+02	1.4464e+02	1.4581e+02	1.8626e+02	1.4428e+02	1.4456e+02	1.4039e+02
31.03	1.7470e+02	1.3839e+02	1.4487e+02	1.4590e+02	1.8628e+02	1.4365e+02	1.4394e+02	1.4043e+02
32.03	1.7471e+02	1.3839e+02	1.4504e+02	1.4567e+02	1.8634e+02	1.4352e+02	1.4383e+02	1.4017e+02
33.03	1.7529e+02	1.3907e+02	1.4518e+02	1.4627e+02	1.8640e+02	1.4371e+02	1.4403e+02	1.4067e+02
34.03	1.7523e+02	1.3901e+02	1.4537e+02	1.4627e+02	1.8644e+02	1.4354e+02	1.4387e+02	1.4062e+02
35.03	1.7472e+02	1.3895e+02	1.4547e+02	1.4590e+02	1.8644e+02	1.4308e+02	1.4342e+02	1.4023e+02
36.00	1.7414e+02	1.3874e+02	1.4520e+02	1.4569e+02	1.8640e+02	1.4255e+02	1.4290e+02	1.3999e+02

1 relative humidity

time (sec)	room 1	room 2	room 3	room 4	room 5	room 6	room 7	room 8	room 9	room 10
0.00	5.7746e-01	5.7746e-01	5.7746e-01	5.7746e-01	5.7746e-01	5.7746e-01	5.7746e-01	5.7746e-01	5.7746e-01	5.7746e-01
0.02	5.7665e-01	6.7485e-01	5.7745e-01	5.7746e-01	5.7746e-01	5.7746e-01	5.7746e-01	5.7746e-01	5.7649e-01	5.7745e-01
0.04	5.7262e-01	7.0945e-01	5.7730e-01	5.7745e-01	5.7745e-01	5.7745e-01	5.7745e-01	5.7746e-01	5.7013e-01	5.7737e-01
0.06	5.6588e-01	7.2969e-01	5.7655e-01	5.7741e-01	5.7744e-01	5.7743e-01	5.7738e-01	5.7746e-01	5.7226e-01	5.7697e-01
0.08	5.5926e-01	7.4072e-01	5.7504e-01	5.7720e-01	5.7735e-01	5.7735e-01	5.7710e-01	5.7745e-01	5.8257e-01	5.7594e-01

0.10	5.5500e-01	7.4173e-01	5.7295e-01	5.7658e-01	5.7709e-01	5.7711e-01	5.7645e-01	5.7745e-01	5.8442e-01	5.7402e-01
0.20	5.7490e-01	6.4373e-01	5.6032e-01	5.6099e-01	5.7000e-01	5.7044e-01	5.6298e-01	5.7623e-01	5.7477e-01	5.5566e-01
0.28	6.0731e-01	5.3096e-01	5.5534e-01	5.5087e-01	5.6244e-01	5.6375e-01	5.5075e-01	5.7015e-01	6.4822e-01	5.4410e-01
0.40	6.5445e-01	3.9547e-01	5.5163e-01	5.5112e-01	5.5678e-01	5.5580e-01	5.4985e-01	5.5628e-01	7.3850e-01	5.3496e-01
0.46	6.8263e-01	3.3755e-01	5.5076e-01	5.4832e-01	5.5195e-01	5.5022e-01	5.4901e-01	5.4926e-01	7.7737e-01	5.3139e-01
0.59	7.3349e-01	2.5589e-01	5.4642e-01	5.3951e-01	5.4040e-01	5.3976e-01	5.4004e-01	5.3892e-01	1.1657e+00	5.2589e-01
0.69	7.6396e-01	2.1356e-01	5.4269e-01	5.3152e-01	5.3276e-01	5.3266e-01	5.3150e-01	5.3274e-01	1.1520e+00	5.2183e-01
0.79	7.8735e-01	1.8182e-01	5.4014e-01	5.2352e-01	5.2585e-01	5.2600e-01	5.2356e-01	5.2667e-01	1.1258e+00	5.1726e-01
0.89	8.0495e-01	1.7124e-01	5.3981e-01	5.1573e-01	5.1908e-01	5.1933e-01	5.1597e-01	5.2020e-01	1.0425e+00	5.1287e-01
0.99	8.2100e-01	1.6376e-01	5.4846e-01	5.0951e-01	5.1272e-01	5.1304e-01	5.0975e-01	5.1334e-01	1.0335e+00	5.1132e-01
2.03	7.5447e-01	9.4048e-02	1.1133e+00	4.4336e-01	4.6893e-01	4.7407e-01	4.7796e-01	4.8719e-01	1.0609e+00	4.9997e-01
3.03	5.9870e-01	6.9741e-02	1.0672e+00	4.6342e-01	4.5076e-01	6.8568e-01	5.7849e-01	3.7614e-01	1.0600e+00	4.3638e-01
4.03	4.9097e-01	6.1910e-02	1.0637e+00	4.6336e-01	4.3735e-01	7.7983e-01	6.0955e-01	3.4725e-01	1.0601e+00	4.2035e-01
5.03	4.0612e-01	5.8682e-02	1.0626e+00	4.6474e-01	1.0006e+00	8.5968e-01	6.2917e-01	3.3151e-01	1.0600e+00	4.1104e-01
6.03	3.3697e-01	5.7260e-02	1.0620e+00	4.6729e-01	1.0793e+00	1.0889e+00	6.4329e-01	3.2000e-01	1.0600e+00	4.0254e-01
7.03	2.8678e-01	5.7048e-02	1.0617e+00	4.7343e-01	1.0722e+00	1.0828e+00	6.4912e-01	3.1278e-01	1.0599e+00	3.9674e-01
8.03	2.4890e-01	5.7363e-02	1.0615e+00	5.6138e-01	1.0686e+00	1.0790e+00	6.5032e-01	3.0792e-01	1.0599e+00	3.9212e-01
9.03	2.1955e-01	5.7882e-02	1.0613e+00	5.9237e-01	1.0667e+00	1.0760e+00	6.4968e-01	3.0433e-01	1.0598e+00	3.8826e-01
10.03	1.9623e-01	5.8518e-02	1.0612e+00	6.1977e-01	1.0655e+00	1.0736e+00	6.5355e-01	3.0155e-01	1.0598e+00	3.8466e-01
11.03	1.7778e-01	5.9129e-02	1.0611e+00	6.4777e-01	1.0647e+00	1.0714e+00	6.7976e-01	2.9934e-01	1.0598e+00	3.8103e-01

12.03	1.6259e-01	5.9736e-02	1.0609e+00	6.7490e-01	1.0641e+00	1.0684e+00	7.0928e-01	2.9759e-01	1.0598e+00	3.7723e-01
13.03	1.5022e-01	6.0308e-02	1.0608e+00	7.0020e-01	1.0637e+00	1.0652e+00	7.3859e-01	2.9623e-01	1.0598e+00	3.7343e-01
14.03	1.3999e-01	6.0885e-02	1.0607e+00	7.3418e-01	1.0634e+00	1.0631e+00	7.6074e-01	2.9523e-01	1.0598e+00	3.6956e-01
15.03	1.3138e-01	6.1496e-02	1.0607e+00	7.5445e-01	1.0632e+00	1.0596e+00	7.8793e-01	2.9451e-01	1.0598e+00	3.6568e-01
16.03	1.2447e-01	6.2068e-02	1.0606e+00	7.6860e-01	1.0631e+00	1.0567e+00	8.1453e-01	2.9406e-01	1.0598e+00	3.6215e-01
17.03	1.1855e-01	6.2633e-02	1.0605e+00	7.8203e-01	1.0630e+00	1.0537e+00	8.3475e-01	2.9376e-01	1.0598e+00	3.5864e-01
18.03	1.1364e-01	6.3218e-02	1.0605e+00	7.9364e-01	1.0629e+00	1.0515e+00	8.5069e-01	2.9360e-01	1.0598e+00	3.5542e-01
19.03	1.0951e-01	6.3755e-02	1.0605e+00	8.0242e-01	1.0628e+00	1.0497e+00	8.6320e-01	2.9358e-01	1.0597e+00	3.5236e-01
20.03	1.0592e-01	6.4325e-02	1.0604e+00	8.0916e-01	1.0627e+00	1.0477e+00	8.7291e-01	2.9363e-01	1.0597e+00	3.4944e-01
21.03	1.0313e-01	6.4825e-02	1.0604e+00	8.1508e-01	1.0627e+00	1.0470e+00	8.8126e-01	2.9382e-01	1.0597e+00	3.4709e-01
22.03	1.0065e-01	6.5306e-02	1.0604e+00	8.1980e-01	1.0626e+00	1.0458e+00	8.8806e-01	2.9407e-01	1.0597e+00	3 4475e-01
23.03	9.8555e-02	6.5797e-02	1.0604e+00	8.2380e-01	1.0546e+00	1.0448e+00	8.9399e-01	2.9438e-01	1.0597e+00	3.4271e-01
24.03	9.6778e-02	6.6248e-02	1.0603e+00	8.2718e-01	1.0524e+00	1.0440e+00	8.9921e-01	2.9476e-01	1.0597e+00	3.4082e-01
25.03	9.5204e-02	6.6747e-02	1.0603e+00	8.2998e-01	1.0516e+00	1.0429e+00	9.0381e-01	2.9519e-01	1.0597e+00	3.3902e-01
26.03	9.4130e-02	6.7195e-02	1.0603e+00	8.3347e-01	1.0512e+00	1.0432e+00	9.0925e-01	2.9576e-01	1.0597e+00	3.3790e-01
27.03	9.2978e-02	6.7536e-02	1.0603e+00	8.3600e-01	1.0511e+00	1.0438e+00	9.1525e-01	2.9643e-01	1.0597e+00	3.3577e-01
28.03	9.1926e-02	6.7914e-02	1.0603e+00	8.3990e-01	1.0511e+00	1.0461e+00	9.2211e-01	2.9733e-01	1.0597e+00	3.3252e-01
29.03	9.1619e-02	6.8562e-02	1.0603e+00	8.3933e-01	1.0505e+00	1.0468e+00	9.2796e-01	2.9823e-01	1.0598e+00	3.3203e-01
30.03	9.1334e-02	6.9267e-02	1.0603e+00	8.4077e-01	1.0616e+00	1.0482e+00	9.3209e-01	2.9929e-01	1.0598e+00	3.3131e-01
31.03	9.2338e-02	7.0246e-02	1.0603e+00	8.4350e-01	1.0546e+00	1.0486e+00	9.3982e-01	3.0031e-01	1.0598e+00	3.3469e-01

32.03	9.2653e-02	7.1024e-02	1.0603e+00	8.4686e-01	1.0511e+00	1.0507e+00	9.4848e-01	3.0145e-01	1.0598e+00	3.3535e-01
33.03	9.2793e-02	7.1665e-02	1.0603e+00	8.4343e-01	1.0487e+00	1.0522e+00	9.4759e-01	3.0265e-01	1.0598e+00	3.3475e-01
34.03	9.3420e-02	7.2608e-02	1.0603e+00	8.4918e-01	1.0461e+00	1.0524e+00	9.5619e-01	3.0387e-01	1.0598e+00	3.3558e-01
35.03	9.5134e-02	7.3943e-02	1.0603e+00	8.5325e-01	1.0455e+00	1.0539e+00	9.6656e-01	3.0518e-01	1.0598e+00	3.3795e-01
36.00	9.8948e-02	7.5562e-02	1.0603e+00	8.5762e-01	1.0511e+00	1.0608e+00	9.7260e-01	3.0352e-01	1.0598e+00	3.4079e-01

1 relative humidity

time	room 11	room 12	room 13	room 14	room 15	room 16	room 17	room 18	room
0.00	5.7746e-01	5.7746e-01	5.7746e-01	5.7746e-01	5.7746e-01	5.7746e-01	5.7746e-01	5.7746e-01	
0.02	5.7745e-01	5.7746e-01	5.7746e-01	5.7746e-01	6.0964e-01	5.7746e-01	5.7746e-01	5.7746e-01	
0.04	5.7739e-01	5.7745e-01	5.7746e-01	5.7745e-01	7.2911e-01	5.7742e-01	5.7743e-01	5.7746e-01	
0.06	5.7708e-01	5.7741e-01	5.7745e-01	5.7743e-01	8.3785e-01	5.7712e-01	5.7720e-01	5.7745e-01	
0.08	5.7629e-01	5.7720e-01	5.7738e-01	5.7728e-01	8.9599e-01	5.7616e-01	5.7646e-01	5.7738e-01	
0.10	5.7480e-01	5.7658e-01	5.7716e-01	5.7681e-01	9.2532e-01	5.7427e-01	5.7500e-01	5.7706e-01	
0.20	5.6001e-01	5.6114e-01	5.7050e-01	5.6316e-01	1.3052e+00	5.5572e-01	5.6008e-01	5.6325e-01	
0.28	5.4946e-01	5.5102e-01	5.6387e-01	5.5031e-01	1.1570e+00	5.4396e-01	5.4938e-01	5.5000e-01	
0.40	5.3903e-01	5.5102e-01	5.5615e-01	5.4989e-01	1.1213e+00	5.3445e-01	5.3854e-01	5.4991e-01	
0.46	5.3442e-01	5.4831e-01	5.5059e-01	5.4920e-01	1.0526e+00	5.3062e-01	5.3360e-01	5.4933e-01	
0.59	5.2743e-01	5.3956e-01	5.4008e-01	5.4012e-01	1.0324e+00	5.2451e-01	5.2584e-01	5.4018e-01	
0.69	5.2300e-01	5.3155e-01	5.3290e-01	5.3145e-01	1.0397e+00	5.1977e-01	5.2068e-01	5.3146e-01	
0.79	5.1855e-01	5.2356e-01	5.2613e-01	5.2341e-01	1.0603e+00	5.1419e-01	5.1526e-01	5.2341e-01	
0.89	5.1432e-01	5.1577e-01	5.1930e-01	5.1571e-01	1.0654e+00	5.0850e-01	5.0980e-01	5.1574e-01	
0.99	5.1223e-01	5.0954e-01	5.1275e-01	5.0929e-01	1.0648e+00	5.0637e-01	5.0692e-01	5.0928e-01	
2.03	4.9914e-01	4.4537e-01	4.5502e-01	4.3740e-01	1.0621e+00	4.8367e-01	4.8301e-01	4.3679e-01	
3.03	4.3793e-01	4.6232e-01	3.7654e-01	3.8483e-01	1.0612e+00	3.6784e-01	3.7067e-01	3.6634e-01	
4.03	4.2061e-01	4.6249e-01	3.4754e-01	3.6154e-01	1.0612e+00	3.3471e-01	3.3506e-01	3.3202e-01	
5.03	4.1104e-01	4.6406e-01	3.3231e-01	3.4870e-01	1.0611e+00	3.1208e-01	3.1198e-01	3.0900e-01	
6.03	4.0249e-01	5.8370e-01	3.2115e-01	3.3856e-01	1.0610e+00	2.9029e-01	2.9028e-01	2.8617e-01	
7.03	3.9654e-01	6.6329e-01	3.1422e-01	3.3353e-01	1.0610e+00	2.7546e-01	2.7534e-01	2.7109e-01	
8.03	3.9176e-01	6.9928e-01	3.0946e-01	3.2981e-01	1.0609e+00	2.6387e-01	2.6365e-01	2.5905e-01	
9.03	3.8777e-01	7.3176e-01	3.0606e-01	3.2734e-01	1.0609e+00	2.5464e-01	2.5435e-01	2.4931e-01	
10.03	3.8406e-01	7.6170e-01	3.0345e-01	3.2564e-01	1.0609e+00	2.4678e-01	2.4642e-01	2.4103e-01	
11.03	3.8031e-01	7.8775e-01	3.0143e-01	3.2477e-01	1.0609e+00	2.3980e-01	2.3939e-01	2.3357e-01	
12.03	3.7641e-01	8.1006e-01	2.9988e-01	3.2491e-01	1.0609e+00	2.3351e-01	2.3304e-01	2.2684e-01	
13.03	3.7252e-01	8.2625e-01	2.9874e-01	3.2586e-01	1.0609e+00	2.2806e-01	2.2753e-01	2.2095e-01	
14.03	3.6856e-01	8.2929e-01	2.9796e-01	3.2737e-01	1.0609e+00	2.2320e-01	2.2260e-01	2.1570e-01	

15.03	3.6462e-01	8.3804e-01	2.9746e-01	3.2918e-01	1.0609e+00	2.1888e-01	2.1824e-01	2.1099e-01
16.03	3.6100e-01	8.4659e-01	2.9725e-01	3.3133e-01	1.0609e+00	2.1534e-01	2.1464e-01	2.0710e-01
17.03	3.5742e-01	8.5238e-01	2.9718e-01	3.3369e-01	1.0608e+00	2.1217e-01	2.1141e-01	2.0364e-01
18.03	3.5414e-01	8.5637e-01	2.9726e-01	3.3613e-01	1.0608e+00	2.0952e-01	2.0870e-01	2.0072e-01
19.03	3.5102e-01	8.5894e-01	2.9747e-01	3.3861e-01	1.0608e+00	2.0721e-01	2.0634e-01	1.9819e-01
20.03	3.4803e-01	8.6041e-01	2.9776e-01	3.4109e-01	1.0608e+00	2.0519e-01	2.0426e-01	1.9596e-01
21.03	3.4562e-01	8.6195e-01	2.9820e-01	3.4348e-01	1.0608e+00	2.0372e-01	2.0273e-01	1.9431e-01
22.03	3.4322e-01	8.6264e-01	2.9868e-01	3.4585e-01	1.0608e+00	2.0236e-01	2.0131e-01	1.9283e-01
23.03	3.4112e-01	8.6306e-01	2.9922e-01	3.4817e-01	1.0608e+00	2.0129e-01	2.0018e-01	1.9163e-01
24.03	3.3917e-01	8.6322e-01	2.9981e-01	3.5044e-01	1.0608e+00	2.0039e-01	1.9921e-01	1.9062e-01
25.03	3.3731e-01	8.6312e-01	3.0043e-01	3.5269e-01	1.0608e+00	1.9959e-01	1.9836e-01	1.8974e-01
26.03	3.3614e-01	8.6405e-01	3.0118e-01	3.5483e-01	1.0608e+00	1.9929e-01	1.9799e-01	1.8936e-01
27.03	3.3401e-01	8.6570e-01	3.0198e-01	3.5691e-01	1.0608e+00	1.9837e-01	1.9705e-01	1.8923e-01
28.03	3.3061e-01	8.6746e-01	3.0297e-01	3.5892e-01	1.0608e+00	1.9689e-01	1.9542e-01	1.8946e-01
29.03	3.3009e-01	8.6747e-01	3.0391e-01	3.6095e-01	1.0608e+00	1.9709e-01	1.9557e-01	1.8967e-01
30.03	3.2931e-01	8.6664e-01	3.0492e-01	3.6309e-01	1.0608e+00	1.9716e-01	1.9558e-01	1.8938e-01
31.03	3.3258e-01	8.7013e-01	3.0581e-01	3.6509e-01	1.0608e+00	1.9987e-01	1.9818e-01	1.8976e-01
32.03	3.3318e-01	8.7289e-01	3.0678e-01	3.6721e-01	1.0608e+00	2.0078e-01	1.9902e-01	1.9106e-01
33.03	3.3253e-01	8.6885e-01	3.0776e-01	3.6957e-01	1.0608e+00	2.0093e-01	1.9910e-01	1.9009e-01
34.03	3.3328e-01	8.7463e-01	3.0869e-01	3.7149e-01	1.0608e+00	2.0194e-01	2.0004e-01	1.9074e-01
35.03	3.3558e-01	8.7821e-01	3.0970e-01	3.7370e-01	1.0608e+00	2.0401e-01	2.0202e-01	1.9245e-01
36.00	3.3834e-01	8.8271e-01	3.1168e-01	3.7550e-01	1.0608e+00	2.0638e-01	2.0430e-01	1.9366e-01

1 liquid fraction

time (sec)	room 1	room 2	room 3	roon 4	room 5	room 6	roon 7	room 8	room 9	room 10
0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.02	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.04	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
0.06	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00001	0.00000
0.08	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00002	0.00000
0.10	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00005	0.00000

0.20	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00022	0.00000
0.28	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00038	0.00000
0.40	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00072	0.00000
0.46	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00097	0.00000
0.59	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00230	0.00000
0.69	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00548	0.00000
0.79	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.01418	0.00000
0.89	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.03357	0.00000
0.99	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.06611	0.00000
2.03	0.00000	0.00001	0.00147	0.00000	0.00000	0.00000	0.00000	0.00000	0.59349	0.00000
3.03	0.00000	0.00003	0.00268	0.00000	0.00000	0.00000	0.00000	0.00000	0.88197	0.00000
4.03	0.00000	0.00005	0.00348	0.00000	0.00000	0.00001	0.00000	0.00000	0.93968	0.00000
5.03	0.00000	0.00007	0.00496	0.00000	0.00003	0.00003	0.00000	0.00000	0.97392	0.00000
6.03	0.00000	0.00008	0.00703	0.00000	0.00041	0.00009	0.00000	0.00000	0.99109	0.00000
7.03	0.00001	0.00010	0.00962	0.00001	0.00105	0.00019	0.00000	0.00000	0.99562	0.00000
8.03	0.00001	0.00011	0.01269	0.00004	0.00187	0.00034	0.00001	0.00000	0.99773	0.00000
9.03	0.00001	0.00013	0.01620	0.00009	0.00303	0.00054	0.00002	0.00000	0.99874	0.00000
10.03	0.00001	0.00014	0.02011	0.00014	0.00437	0.00078	0.00005	0.00000	0.99924	0.00000
11.03	0.00001	0.00015	0.02435	0.00021	0.00583	0.00104	0.00012	0.00000	0.99954	0.00000
12.03	0.00002	0.00016	0.02887	0.00028	0.00738	0.00130	0.00023	0.00000	0.99972	0.00000

13.03	0.00002	0.00017	0.03364	0.00037	0.00896	0.00159	0.00038	0.00000	0.99983	0.00000
14.03	0.00002	0.00018	0.03862	0.00048	0.01035	0.00193	0.00061	0.00000	0.99989	0.00000
15.03	0.00003	0.00019	0.04380	0.00062	0.01147	0.00232	0.00090	0.00000	0.99993	0.00000
16.03	0.00003	0.00020	0.04917	0.00076	0.01230	0.00274	0.00115	0.00000	0.99996	0.00000
17.03	0.00003	0.00021	0.05472	0.00090	0.01295	0.00321	0.00141	0.00000	0.99997	0.00000
18.03	0.00004	0.00022	0.06041	0.00103	0.01353	0.00371	0.00170	0.00000	0.99998	0.00000
19.03	0.00004	0.00023	0.06624	0.00114	0.01408	0.00425	0.00201	0.00000	0.99999	0.00000
20.03	0.00005	0.00024	0.07218	0.00127	0.01461	0.00481	0.00233	0.00000	0.99999	0.00000
21.03	0.00005	0.00025	0.07824	0.00140	0.01509	0.00539	0.00265	0.00001	1.00000	0.00000
22.03	0.00006	0.00026	0.08439	0.00154	0.01556	0.00598	0.00296	0.00001	1.00000	0.00000
23.03	0.00006	0.00026	0.09064	0.00168	0.01599	0.00659	0.00327	0.00001	1.00000	0.00000
24.03	0.00006	0.00027	0.09697	0.00183	0.01640	0.00721	0.00359	0.00001	1.00000	0.00000
25.03	0.00007	0.00028	0.10337	0.00198	0.01680	0.00784	0.00390	0.00002	1.00000	0.00000
26.03	0.00007	0.00029	0.10984	0.00214	0.01716	0.00848	0.00421	0.00002	1.00000	0.00000
27.03	0.00008	0.00029	0.11638	0.00228	0.01751	0.00912	0.00452	0.00003	1.00000	0.00000
28.03	0.00008	0.00030	0.12298	0.00235	0.01783	0.00976	0.00484	0.00003	1.00000	0.00000
29.03	0.00009	0.00031	0.12964	0.00253	0.01813	0.01039	0.00514	0.00004	1.00000	0.00000
30.03	0.00009	0.00032	0.13633	0.00266	0.01846	0.01104	0.00560	0.00004	1.00000	0.00000
31.03	0.00009	0.00032	0.14301	0.00276	0.01881	0.01172	0.00585	0.00005	1.00000	0.00001
32.03	0.00010	0.00033	0.14961	0.00286	0.01909	0.01241	0.00601	0.00006	1.00000	0.00001

33.03	0.00010	0.00034	0,15533	0.00305	0.01937	0.01313	0.00667	0.00006	1.00000
0.00001									
34.03	0.00013	0.00034	0.16124	0.00311	0.01968	0.01388	0.00684	0.00007	1.00000
0.00001									
35.03	0.00040	0.00035	0·16730	0.00317	0.01991	0.01464	0.00697	0.00008	1.00000
0.00001									
36.00	0.00102	0.00036	0,17365	0.00323	0.02008	0.01513	0.00710	0.00009	1.00000
0.00001									

1 liquid fraction

time	room 11	room 12	room 13	room 14	room 15	room 16	room 17	room 18	room
0.00	0.00000	0.00000	0,00000	0.00000	0.00000	0,00000	0.00000	0.00000	
0.02	0.00000	0.00000	0.00000	0.00000	0.00080	0,00000	0.00000	0.00000	
0.04	0.00000	0.00000	0.00000	0.00000	0.00300	0,00000	0.00000	0.00000	
0.06	0.00000	0.00000	0·00000	0.00000	0.00656	0.00000	0.00000	0.00000	
0.08	0.00000	0.00000	0.00000	0.00000	0.01146	0,00000	0.00000	0.00000	
0.10	0.00000	0.00000	0,00000	0.00000	0.01766	0,00000	0.00000	0.00000	
0.20	0.00000	0.00000	0.00008	0.00000	0.07201	0.00000	0.00000	0.00000	
0.28	0.00000	0.00000	0.00000	0.00000	0.13944	0.00000	0.00000	0.00000	
0.40	0.00000	0.00000	0.00000	0.00000	0.25565	0.08000	0.00000	0.00000	
0.46	0.00000	0.00000	0.00000	0.00000	0.32759	0.00000	0.00000	0.00000	
0.59	0.00000	0.00000	0.00000	0.00000	0.46667	0.00000	0.00000	0.00000	
0.69	0.00000	0.00000	0,00000	0.00000	0.55761	0.00008	0.00000	0.00000	
0.79	0.00000	0.00000	0.00000	0.00000	0.62926	0,00000	0.00000	0.00000	
0.89	0.00000	0.00000	0.00000	0.00000	0.67552	8.00000	0.00000	0.00000	
0.99	0.00000	0.00000	0.00000	0.00000	0.69906	0.00000	0.00000	0.00000	
2.03	0.00000	0.00000	0.00000	0.00000	0.91491	0.00000	0.00000	0.00000	
3.03	0.00000	0.00000	0.00000	0.00000	0.98451	0,00000	0.00000	0.00000	
4.03	0.00000	0.00000	8.00000	0.00000	0.99579	0.00000	0.00000	0.00000	
5.03	0.00000	0.00000	0,00000	0.00000	0.99889	8.00000	0.00000	0.00000	
6.03	0.00000	0.00002	8.00000	0.00000	0.99963	0.00000	0.00000	0.00000	
7.03	0.00000	0.00008	0,00000	0.00000	0.99987	0,00000	0.00000	0.00000	
8.03	0.00000	0.00015	0.00000	0.00000	0.99996	0.00000	0.00000	0.00000	
9.03	0.00000	0.00023	0.00000	0.00000	0.99998	0.00000	0.00000	0.00000	
10.03	0.00000	0.00031	0,00000	0.00000	0.99999	0,00000	0.00000	0.00000	
11.03	0.00000	0.00040	0,00008	0.00000	1.00000	0.00000	0.00000	0.00000	
12.03	0.00000	0.00050	0,00000	0.00000	1.00000	0.00000	0.00000	0.00000	
13.03	0.00000	0.00060	0,00000	0.00000	1.00000	0,00000	0.00000	0.00000	
14.03	0.00000	0.00073	0.00000	0.00000	1.00000	0.00000	0.00000	0.00000	
15.03	0.00000	0.00086	0.00000	0.00000	1.00000	0'00000	0.00000	0.00000	
16.03	0.00000	0.00098	0.00000	0.00000	1.00000	0,00000	0.00000	0.00000	

17.03	0.00000	0.00109	0.00000	0.00000	1.00000	0.00000	0.00000	0.00000
18.03	0.00000	0.00121	0.00000	0.00000	1.00000	0.00000	0.00000	0.00000
19.03	0.00000	0.00133	0.00000	0.00000	1.00000	0.00000	0.00000	0.00000
20.03	0.00000	0.00146	0.00000	0.00000	1.00000	0.00000	0.00000	0.00000
21.03	0.00000	0.00160	0.00000	0.00000	1.00000	0.00000	0.00000	0.00000
22.03	0.00000	0.00173	0.00000	0.00000	1.00000	0.00000	0.00000	0.00000
23.03	0.00000	0.00187	0.00000	0.00000	1.00000	0.00000	0.00000	0.00000
24.03	0.00000	0.00201	0.00000	0.00000	1.00000	0.00000	0.00000	0.00000
25.03	0.00000	0.00215	0.00000	0.00000	1.00000	0.00000	0.00000	0.00000
26.03	0.00000	0.00229	0.00000	0.00000	1.00000	0.00000	0.00000	0.00000
27.03	0.00000	0.00243	0.00000	0.00000	1.00000	0.00000	0.00000	0.00000
28.03	0.00000	0.00254	0.00000	0.00000	1.00000	0.00000	0.00000	0.00000
29.03	0.00000	0.00269	0.00000	0.00000	1.00000	0.00000	0.00000	0.00000
30.03	0.00000	0.00285	0.00000	0.00000	1.00000	0.00000	0.00000	0.00000
31.03	0.00000	0.00292	0.00000	0.00000	1.00000	0.00000	0.00000	0.00000
32.03	0.00000	0.00303	0.00000	0.00000	1.00000	0.00000	0.00000	0.00000
33.03	0.00001	0.00322	0.00000	0.00000	1.00000	0.00000	0.00000	0.00000
34.03	0.00001	0.00328	0.00000	0.00000	1.00000	0.00000	0.00000	0.00000
35.03	0.00001	0.00334	0.00000	0.00000	1.00000	0.00000	0.00000	0.00000
36.00	0.00001	0.00339	0.00000	0.00000	1.00000	0.00000	0.00000	0.00000

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13 ABSTRACT (200 words or less)

The INGEN (INput GENerator) computer program has been developed as a preprocessor to simplify input generation for the COBRA-NC computer program. INGEN uses several empirical correlations and geometric assumptions to simplify the data input requirements for the COBRA-NC computer code. The simplified input scheme is obtained at the expense of much flexibility provided by COBRA-NC. For more complex problems requiring additional flexibility however, INGEN may be used to provide a skeletal input file to which the more detailed input may be added. This report decribes the input requirements for INGEN and describes the algorithms and correlations used to generate the COBRA-NC input

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