

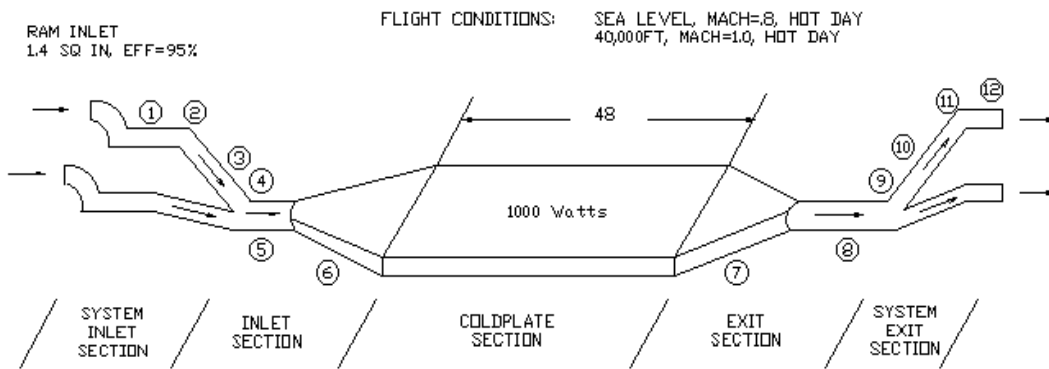
Ram Air Cooling Example

This example demonstrates the Ram cooling/heating capabilities and the use of pressure drop analysis.

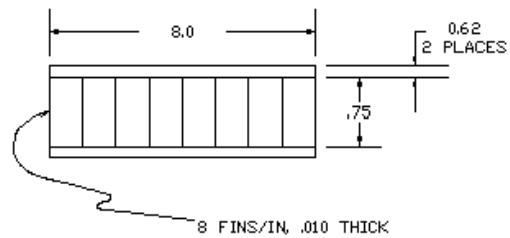
Assume an electronics assembly that dissipates 1000 Watts of power is to be ram air cooled using the geometry of the cooling system shown to the below. Determine the mass flow rate through the system, the pressure drop and Mach number through each duct, the cooling air temperatures, and the cold plate temperatures. Use the flight conditions shown and the pressure loss parameters for each section that are shown in the table.

To keep the model simple for demonstration purposes set the number of nodes along the width to 4 and the number along the length to 12.

Assume an all aluminum construction.



SECTION	DIA OR WIDTH	HEIGHT	LENGTH	K
①	1.3	0.0	2.0	--
②	1.3	0.0	--	1.0
③	1.3	0.0	12.0	--
④	1.3	0.0	--	1.6
⑤	2.0	2.0	4.0	0.5
⑥	2.0	.87	1.5	0.2
⑦	2.0	.87	1.5	0.2
⑧	2.0	2.0	4.0	-0.2
⑨	1.3	0.0	--	1.4
⑩	1.3	0.0	12.0	--
⑪	1.3	0.0	--	1.0
⑫	1.3	0.0	2.0	--

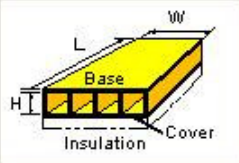


Input the geometry of the cold plate on this tab.

Flow Thru Cooling [?] [X]

Geometry | Material | Fluid Properties | Power Dissipation | Pressure Drop | External Heat Transfer | Generate Plots

Geometry



Length (in.)

Width (in.)

Fin Height (in.) Variable

Base Thickness (in.) Variable

Cover Thickness (in.)


Insulation Thickness (in.) Variable

Type of Fins

- 11.44-3/8w
- 11.5-3/8w
- 17.8-3/8w
- 3/32-12.22
- PF4
- PF9
- PLANE FIN 11.1
- RECTANGULAR**

View fin description

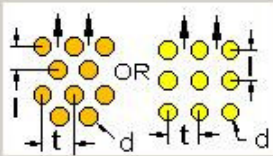
For Plate Fins Only



Fin Thickness (in.) Variable

Fin Density (fins/in.) Variable

For Pins Fins Only

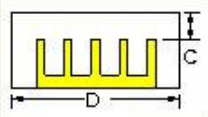


Lateral Spacing (in.) Variable

Transverse Spacing (in.) Variable

Pin Diameter (in.) Variable

For Bypass Flow Only



Duct Width (in.) Variable

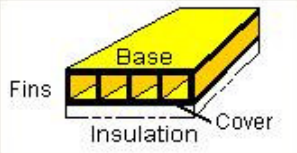
Cover Clearance (in.) Variable

Model Description | OK | Cancel | SaveAs | Save | Help

Select Default Aluminum Properties on this tab

Flow Thru Cooling [?] [X]

Geometry | Material | Fluid Properties | Power Dissipation | Pressure Drop | External Heat Transfer | Generate Plots



Set/Reset Properties to Aluminum

Component	Material	Thermal Cond (W/in.-C)	Specific Heat (W-min./lb-C)	Density (lb/in.^3)
Base	Default Aluminum Properties	3.92	7.07	0.098
Fins	Default Aluminum Properties	3.92	7.07	0.098
Cover	Default Aluminum Properties	3.92	7.07	0.098
Insulation (if used)	None			

Model Description | | | | |

Select Ram Flow Analysis and input parameters.

Flow Thru Cooling

Geometry | Material | Fluid Properties | Power Dissipation | Pressure Drop | External Heat Transfer | Generate Plots

Fluid Temperature, Pressure or Altitude

Inlet Fluid Temperature (C)

Input one or more matching pressures/altitudes below:

Inlet Fluid Pressure (lb/in²)

Exit Fluid Pressure (lb/in²)

Inlet Fluid Altitude (ft)

Exit Fluid Altitude (ft)

Variable

Type of Cooling Fluid

- AIR
- COOLANOL20
- COOLANOL25
- EG_H2O_30/70
- EG_H2O_40/60
- EG_H2O_50/50
- EG_H2O_60/40
- ENGINE OIL
- FC75
- GALDEN-HT110

Fluid Flow Rate

Input one or more:

Mass Flow Rate (lb/min) Variable

Volume Flow Rate (ft³/min) Variable

Predict Flow Rate That Results In:

Cold Plate Temperature (C) of

Fluid Exit Temperature (C) of

Pressure Drop (in.-H2O) of

Time Varying

Mil-Std-210 Environment And Ram Air Cooling

Model Description

Mil-Std-210 Environment and Ram Air Cooling

Mil-Std-210 Environment

Mach Number Variable

Ambient Altitude (ft)

Type of Day Hot Standard Cold

Fluid Flow Rate

(Input one or more)

Ram Air Cooled Yes No

Mass Flow Rate (lb/min) Variable

Volume Flow Rate (ft³/min) Variable

Predict Flow Rate That Results In:

Cold Plate Temperature (C) of

Fluid Exit Temperature (C) of

Pressure Drop (in.-H2O) of

Ram Inlet Parameters

Ram Area Inlet (in.²)

Ram Inlet (Scoop) Efficiency (%)

Altitude and Mach No. Pairs

	Mach No.	Altitude (ft)
1	0.8	0
2	1	40000
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		

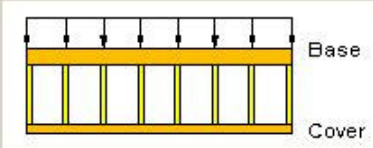
Altitude vs Mach No. graph showing a curve.

Input the power here.

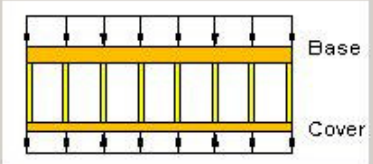
Flow Thru Cooling [?] [X]

Geometry | Material | Fluid Properties | **Power Dissipation** | Pressure Drop | External Heat Transfer | Generate Plots

Cold Plate Power Dissipation

One Side Only  Base
Cover

Base Plate Power (Watts)


Both Sides  Base
Cover

Base Plate Power (Watts)

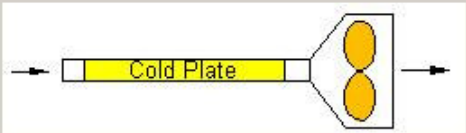
Cover Plate Power (Watts)

Fan Power Dissipation

None Inlet Fan Exit Fan



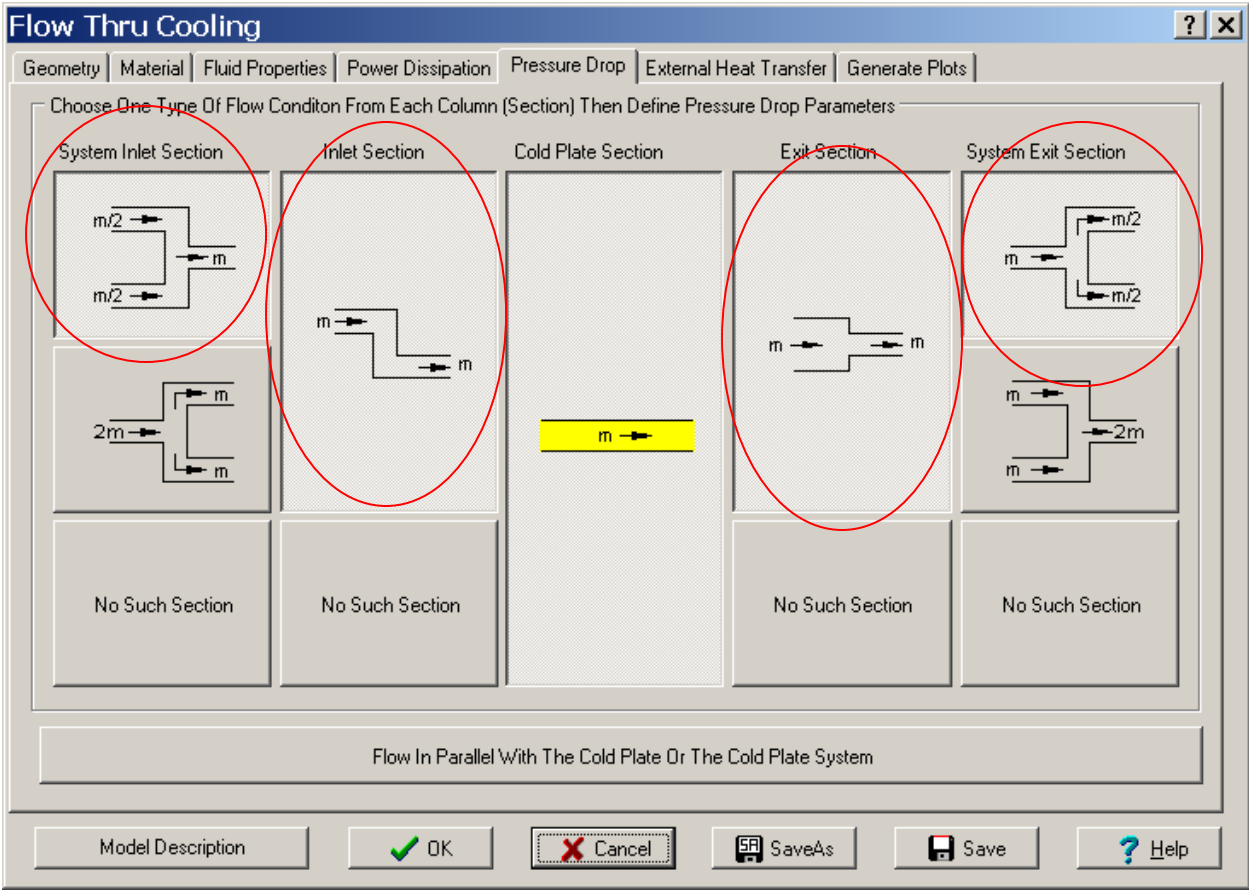
Fan Inlet Power (Watts)



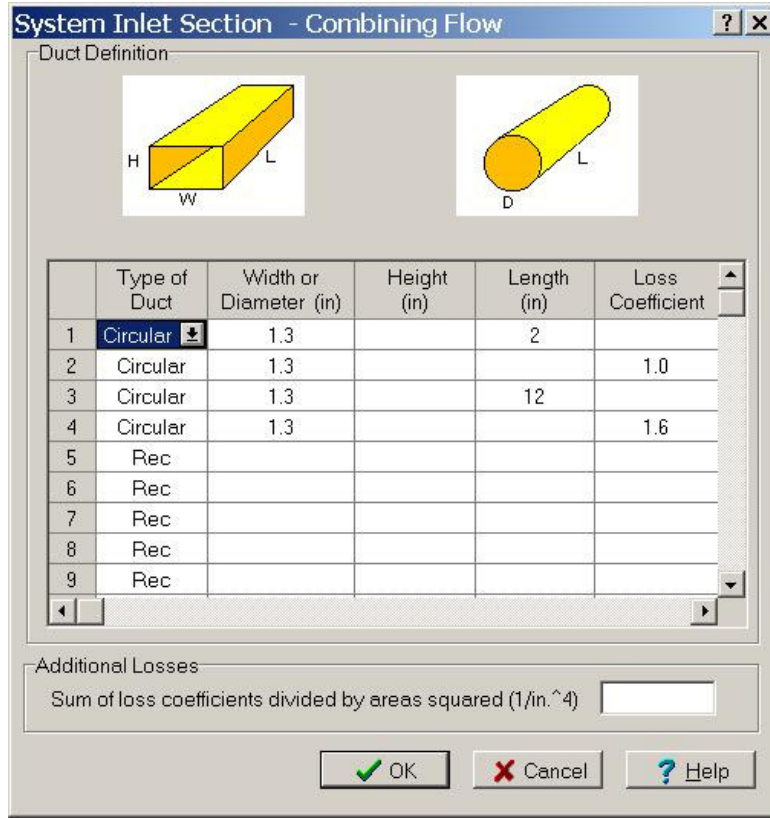
Fan Exit Power (Watts)

Model Description | | | | |

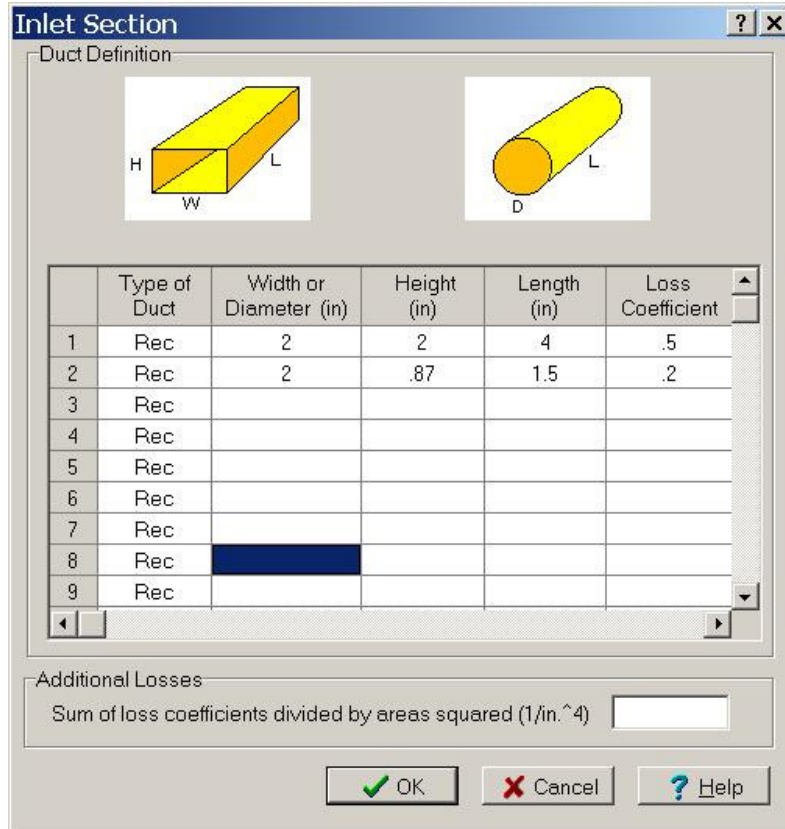
Each of the "Section" buttons is selected to specify the duct dimensions (pressure loss parameters) shown on the table on the first page.



The “System Inlet Section” geometry goes here – Section 1 through 4.



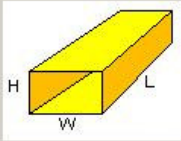
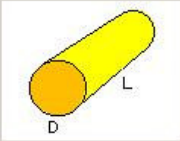
The “Inlet Section” geometry goes here – Section 5 and 6.



The "Exit Section" geometry goes here – Section 7 and 8.

Exit Section [?] [X]

Duct Definition

	Type of Duct	Width or Diameter (in)	Height (in)	Length (in)	Loss Coefficient
1	Rec	2	.87	1.5	.2
2	Rec	2	2	4	-2
3	Rec				
4	Rec				
5	Rec				
6	Rec				
7	Rec				
8	Rec				
9	Rec				

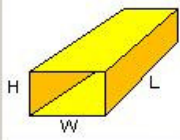
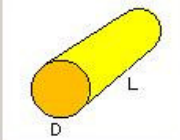
Additional Losses
Sum of loss coefficients divided by areas squared (1/in.^4)

OK Cancel Help

The "System Exit Section" geometry goes here – Section 9 through 12.

System Exit Section - Splitting Flow [?] [X]

Duct Definition

	Type of Duct	Width or Diameter (in)	Height (in)	Length (in)	Loss Coefficient
1	Circular	1.3			1.4
2	Circular	1.3		12	
3	Circular	1.3			1
4	Circular	1.3		2	
5	Rec				
6	Rec				
7	Rec				
8	Rec				
9	Rec				

Additional Losses
Sum of loss coefficients divided by areas squared (1/in.^4)

OK Cancel Help

The number of nodes along the length and width are defined below. The model is now ready to be run.

Nonisothermal Analysis

Analysis **Nodes** Power Conductors Arrays Comments

Cold Plate Nodes

Number of nodes along width:

Number of nodes along length:

Number of coolant passes:

Example: 5 Nodes along Length, 4 Nodes along Width

Flow Direction →

Length				
4	8	12	16	20
3	7	11	15	19
2	6	10	14	18
1	5	9	13	17
Width				

Node Layout Scheme

Coolant Pass Scheme

List of Extra Nodes

	Node Number	Initial Temperature (C)	Thermal Mass (W-min./C)	Comment Number
1				
2				
3				
4				
5				

Thermal Mass:
 D = Density
 V = Volume per Node
 Cp = Specific Heat
 Thermal Mass = D x V x Cp

Groups of Extra Nodes

	Number of Nodes	Starting Node Number	Increment Value	Initial Temperature (C)	Thermal Mass (W-min./C)	Comment Number
1						
2						
3						
4						
5						

OK Cancel SaveAs Save Help

The isothermal results are shown below; they are always calculated prior to calculating of non-isothermal results. These results are for Sea Level and Mach =.8.

```

***** VARIABLE INPUTS *****
THE TYPE OF FINS SPECIFIED ARE:                RECTANGULAR
FIN HEIGHT, INCHES                             0.750
BASE THICKNESS, INCHES                         0.062
FIN THICKNESS, INCHES                          0.0100
FIN DENSITY, FINS PER INCH                     8.0
THE OUTSIDE MACH NO. IS                        0.80
ATMOSPHERE:HOT      DAY      0. FEET      39.0 DEG C  14.70 LBS/IN2
RAM INLET STAGNATION TEMP AND PRESS IN DEG C AND PSI  79.0  22.02
RAM INLET STATIC TEMP. AND PRESS. IN DEG C AND PSI  76.3  21.44
ADIABATIC COMPRESSION EFFICIENCY IN PERCENT      95.
          RAM AIR FLOWRATE CALCULATIONS ARE TURNED ON
THE POWER APPLIED TO ONE SIDE ONLY, WATTS      1000.00
THE COOLING FLUID IS:                          AIR

***** INTERMEDIATE CALCULATED PARAMETERS *****
FREE FLOW CROSS SECTIONAL AREA, IN2            5.52
HYDRAULIC DIAMETER, INCHES                    0.199
COLDPLATE WEIGHT, LBS                          6.94
TOTAL MASS FLOWRATE, LBS/MIN                  25.82
COLD PLATE MASS FLOWRATE, LBS/MIN             25.82
TOTAL VOL FLOWRATE, [GAL/MIN] FT3/MIN [ 2486.7] 332.43
COLDPLATE VOL FLOWRATE, [GAL/MIN] FT3/MIN [ 2486.7] 332.43
COLDPLATE VELOCITY, FT/SEC                    144.53
REYNOLDS NUMBER                              13416.
EQUIVALENT FRICTION LOSS COEFFICIENT, KFRICION 6.38
INLET LOSS COEFFICIENT, KINLET                0.84
EXIT LOSS COEFFICIENT, KEXIT                  -0.70
FILM COEFFICIENT, [BTU/(HR-FT2-F)] W/(IN2-C) [ 35.16] 0.1288
THE FIN EFFICIENCY WITH HEAT ON ONE SIDE ONLY IS 0.465

***** PRESSURE *****
INLET PRESSURE, [LB/IN2] INCHES-H2O [ 21.438] 593.669
INLET PRESSURE DROP, INCHES-H2O              4.650
ACCELERATION PRESSURE DROP, INCHES-H2O       0.749
FRICTIONAL PRESSURE DROP, INCHES-H2O         30.960
EXIT PRESSURE DROP, INCHES-H2O               -4.306
FLOWLOSS SYSTEM INLET PRESSURE DROPS, INCHES-H2O 54.165
FLOWLOSS INLET PRESSURE DROPS, INCHES-H2O    19.036
FLOWLOSS EXIT PRESSURE DROPS, INCHES-H2O     15.033
FLOWLOSS SYSTEM EXIT PRESSURE DROPS, INCHES-H2O 66.303
TOTAL PRESSURE DROP, INCHES-H2O              186.590
EXIT PRESSURE, [LB/IN2] INCHES-H2O [ 14.700] 407.079
DENSITY RATIO TIME PRESSURE DROP, INCHES-H2O 189.4384

***** THERMAL RESISTANCE *****
THERMAL RESISTANCE FROM INLET FLUID TO COLDPLATE, C/W 0.007
THERMAL RESISTANCE FROM LOCAL FLUID TO COLDPLATE, C/W 0.003

***** TEMPERATURES *****
STATIC INLET FLUID TEMPERATURE, DEG C        76.3
STAGNATION FLUID TEMP RISE ALONG COLDPLATE, DEG C 5.1
TOTAL STAGNATION FLUID TEMP RISE, DEG C      5.1
STATIC EXIT FLUID TEMPERATURE, DEG C         81.2
ISOTHERMAL COLDPLATE TEMPERATURE, DEG C     83.2
MAXIMUM COLDPLATE TEMPERATURE, DEG C        85.1
    
```

The predicted cold plate and fluid temperatures as well as the power at each node are shown below for Sea Level and Mach =.8

INLET FLUID TEMPERATURE= 76.3 C				

CP TEMP				
FLD TEMP				
POWER				
NODE NO.				

V				
V				

79.6	79.6	79.6	79.6	
(76.7)	(76.7)	(76.7)	(76.7)	
20.83W	20.83W	20.83W	20.83W	
N 1	N 2	N 3	N 4	

80.0	80.0	80.0	80.0	
(77.1)	(77.1)	(77.1)	(77.1)	
20.83W	20.83W	20.83W	20.83W	
N 5	N 6	N 7	N 8	

80.5	80.5	80.5	80.5	
(77.5)	(77.5)	(77.5)	(77.5)	
20.83W	20.83W	20.83W	20.83W	
N 9	N 10	N 11	N 12	

80.9	80.9	80.9	80.9	
(78.0)	(78.0)	(78.0)	(78.0)	
20.83W	20.83W	20.83W	20.83W	
N 13	N 14	N 15	N 16	

81.3	81.3	81.3	81.3	
(78.4)	(78.4)	(78.4)	(78.4)	
20.83W	20.83W	20.83W	20.83W	
N 17	N 18	N 19	N 20	

81.7	81.7	81.7	81.7	
(78.8)	(78.8)	(78.8)	(78.8)	
20.83W	20.83W	20.83W	20.83W	
N 21	N 22	N 23	N 24	

82.2	82.2	82.2	82.2	
(79.2)	(79.2)	(79.2)	(79.2)	
20.83W	20.83W	20.83W	20.83W	
N 25	N 26	N 27	N 28	

82.6	82.6	82.6	82.6	
(79.6)	(79.6)	(79.6)	(79.6)	
20.83W	20.83W	20.83W	20.83W	
N 29	N 30	N 31	N 32	

83.0	83.0	83.0	83.0	
(80.1)	(80.1)	(80.1)	(80.1)	
20.83W	20.83W	20.83W	20.83W	
N 33	N 34	N 35	N 36	

83.4	83.4	83.4	83.4	
(80.5)	(80.5)	(80.5)	(80.5)	
20.83W	20.83W	20.83W	20.83W	
N 37	N 38	N 39	N 40	

83.9	83.9	83.9	83.9	
(80.9)	(80.9)	(80.9)	(80.9)	
20.83W	20.83W	20.83W	20.83W	
N 41	N 42	N 43	N 44	

84.3	84.3	84.3	84.3	
(81.3)	(81.3)	(81.3)	(81.3)	
20.83W	20.83W	20.83W	20.83W	
N 45	N 46	N 47	N 48	

FLUID TEMPERATURE OUT= 81.3				
V				
V				

AVERAGE COLDPLATE TEMP.=	81.9			
POWER DIRECTLY ON CP=	1000.00			
NO. OF ITERATIONS REQUIRED=	11			
ALLOW. NO. OF ITERATIONS=	1000			
TEMP. RELAXATION CRITERIA=	.00100			
PERCENT ENRGY BALANCE=	0.0002			

V				

The isothermal results are again shown below; they are always calculated prior to non-isothermal analysis. These results are for 40KFT and Mach =1.

```

***** VARIABLE INPUTS *****
THE TYPE OF FINS SPECIFIED ARE:                RECTANGULAR
FIN HEIGHT, INCHES                            0.750
BASE THICKNESS, INCHES                        0.062
FIN THICKNESS, INCHES                         0.0100
FIN DENSITY, FINS PER INCH                    8.0
THE OUTSIDE MACH NO. IS                       1.00
ATMOSPHERE:HOT      DAY      40000. FEET      -42.0 DEG C      2.72 LBS/IN2
RAM INLET STAGNATION TEMP AND PRESS IN DEG C AND PSI      4.2      5.03
RAM INLET STATIC TEMP. AND PRESS. IN DEG C AND PSI      1.8      4.87
ADIABATIC COMPRESSION EFFICIENCY IN PERCENT      95.
          RAM AIR FLOWRATE CALCULATIONS ARE TURNED ON
THE POWER APPLIED TO ONE SIDE ONLY, WATTS      1000.00
THE COOLING FLUID IS:                          AIR

***** INTERMEDIATE CALCULATED PARAMETERS *****
FREE FLOW CROSS SECTIONAL AREA, IN2            5.52
HYDRAULIC DIAMETER, INCHES                    0.199
COLDPLATE WEIGHT, LBS                          6.93
TOTAL MASS FLOWRATE, LBS/MIN                  7.08
COLD PLATE MASS FLOWRATE, LBS/MIN              7.08
TOTAL VOL FLOWRATE, [GAL/MIN] FT3/MIN [ 2545.0] 340.21
COLDPLATE VOL FLOWRATE, [GAL/MIN] FT3/MIN [ 2545.0] 340.21
COLDPLATE VELOCITY, FT/SEC                    147.92
REYNOLDS NUMBER                               4302.
EQUIVALENT FRICTION LOSS COEFFICIENT, KFRICION 7.80
INLET LOSS COEFFICIENT, KINLET                 0.84
EXIT LOSS COEFFICIENT, KEXIT                   -0.70
FILM COEFFICIENT, [BTU/(HR-FT2-F)] W/(IN2-C) [ 10.20] 0.0374
THE FIN EFFICIENCY WITH HEAT ON ONE SIDE ONLY IS 0.720

***** PRESSURE *****
INLET PRESSURE, [LB/IN2] INCHES-H2O [ 4.874] 134.975
INLET PRESSURE DROP, INCHES-H2O               1.252
ACCELERATION PRESSURE DROP, INCHES-H2O        0.452
FRICTIONAL PRESSURE DROP, INCHES-H2O          10.623
EXIT PRESSURE DROP, INCHES-H2O                -1.267
FLOWLOSS SYSTEM INLET PRESSURE DROPS, INCHES-H2O 14.903
FLOWLOSS INLET PRESSURE DROPS, INCHES-H2O     5.659
FLOWLOSS EXIT PRESSURE DROPS, INCHES-H2O      5.640
FLOWLOSS SYSTEM EXIT PRESSURE DROPS, INCHES-H2O 22.389
TOTAL PRESSURE DROP, INCHES-H2O               59.651
EXIT PRESSURE, [LB/IN2] INCHES-H2O [ 2.720] 75.324
DENSITY RATIO TIME PRESSURE DROP, INCHES-H2O 16.2324

***** THERMAL RESISTANCE *****
THERMAL RESISTANCE FROM INLET FLUID TO COLDPLATE, C/W 0.021
THERMAL RESISTANCE FROM LOCAL FLUID TO COLDPLATE, C/W 0.007

***** TEMPERATURES *****
STATIC INLET FLUID TEMPERATURE, DEG C         1.8
STAGNATION FLUID TEMP RISE ALONG COLDPLATE, DEG C 18.6
TOTAL STAGNATION FLUID TEMP RISE, DEG C       18.6
STATIC EXIT FLUID TEMPERATURE, DEG C          20.0
ISOTHERMAL COLDPLATE TEMPERATURE, DEG C      22.4
MAXIMUM COLDPLATE TEMPERATURE, DEG C         27.9
    
```

The predicted cold plate and fluid temperatures as well as the power at each node are shown below for 40KFT and Mach =1.

```

INLET FLUID TEMPERATURE=  1.8 C
                                V
                                V
-----
| CP TEMP |
| FLD TEMP|
| POWER   |
| NODE NO.|
-----
                                V
                                V
-----
| 10.4 | 10.4 | 10.4 | 10.4 |
| ( 3.4) | ( 3.4) | ( 3.4) | ( 3.4) |
| 20.83W | 20.83W | 20.83W | 20.83W |
| N 1 | N 2 | N 3 | N 4 |
-----
| 11.8 | 11.8 | 11.8 | 11.8 |
| ( 4.9) | ( 4.9) | ( 4.9) | ( 4.9) |
| 20.83W | 20.83W | 20.83W | 20.83W |
| N 5 | N 6 | N 7 | N 8 |
-----
| 13.3 | 13.3 | 13.3 | 13.3 |
| ( 6.5) | ( 6.5) | ( 6.5) | ( 6.5) |
| 20.83W | 20.83W | 20.83W | 20.83W |
| N 9 | N 10 | N 11 | N 12 |
-----
| 14.9 | 14.9 | 14.9 | 14.9 |
| ( 8.0) | ( 8.0) | ( 8.0) | ( 8.0) |
| 20.83W | 20.83W | 20.83W | 20.83W |
| N 13 | N 14 | N 15 | N 16 |
-----
| 16.4 | 16.4 | 16.4 | 16.4 |
| ( 9.6) | ( 9.6) | ( 9.6) | ( 9.6) |
| 20.83W | 20.83W | 20.83W | 20.83W |
| N 17 | N 18 | N 19 | N 20 |
-----
| 18.0 | 18.0 | 18.0 | 18.0 |
| ( 11.1) | ( 11.1) | ( 11.1) | ( 11.1) |
| 20.83W | 20.83W | 20.83W | 20.83W |
| N 21 | N 22 | N 23 | N 24 |
-----
| 19.5 | 19.5 | 19.5 | 19.5 |
| ( 12.7) | ( 12.7) | ( 12.7) | ( 12.7) |
| 20.83W | 20.83W | 20.83W | 20.83W |
| N 25 | N 26 | N 27 | N 28 |
-----
| 21.1 | 21.1 | 21.1 | 21.1 |
| ( 14.2) | ( 14.2) | ( 14.2) | ( 14.2) |
| 20.83W | 20.83W | 20.83W | 20.83W |
| N 29 | N 30 | N 31 | N 32 |
-----
| 22.6 | 22.6 | 22.6 | 22.6 |
| ( 15.7) | ( 15.7) | ( 15.7) | ( 15.7) |
| 20.83W | 20.83W | 20.83W | 20.83W |
| N 33 | N 34 | N 35 | N 36 |
-----
| 24.1 | 24.1 | 24.1 | 24.1 |
| ( 17.3) | ( 17.3) | ( 17.3) | ( 17.3) |
| 20.83W | 20.83W | 20.83W | 20.83W |
| N 37 | N 38 | N 39 | N 40 |
-----
| 25.7 | 25.7 | 25.7 | 25.7 |
| ( 18.8) | ( 18.8) | ( 18.8) | ( 18.8) |
| 20.83W | 20.83W | 20.83W | 20.83W |
| N 41 | N 42 | N 43 | N 44 |
-----
| 27.1 | 27.1 | 27.1 | 27.1 |
| ( 20.4) | ( 20.4) | ( 20.4) | ( 20.4) |
| 20.83W | 20.83W | 20.83W | 20.83W |
| N 45 | N 46 | N 47 | N 48 |
-----
                                V
                                V
                                V
AVERAGE COLDPLATE TEMP.=  18.7
POWER DIRECTLY ON CP=  1000.00
NO. OF ITERATIONS REQUIRED=  18
ALLOW. NO. OF ITERATIONS= 1000
TEMP. RELAXATION CRITERIA=.00100
PERCENT ENGERY BALANCE=  0.0000
                                V
                                V
                                V
FLUID TEMPERATURE OUT=  20.4
    
```

Detailed Pressure Drop Results at each Section for the two different conditions– Sea Level, Mach =.8, and 40KFT, Mach = 1 – are listed on the next page. They are contained in the .dlp file.

RAM AIR COOLING INPUT AND RESULTS DATA

DAY	MACH-A/C	ALT	T-AMB	P-AMB	EFF	ARAMI	T-STAG	P-STAG	T-STAT	P-STAT	RHO-S	MACH-RAM	M-DOT
HOT	0.80	0.	39.0	14.70	95.	1.4000	79.0	22.02	76.3	21.44	0.0921	0.196	12.911

***** INPUT ***** RESULTS *****

SYSTEM INLET FLOWLOSS INPUT AND RESULTS DATA

WIDTH OR DIA	HEIGHT	LENGTH	K	M-DOT	f	RHO-IN	RHO-EX	MACH-IN	MACH-EX	DP-ACC	DP-f	DP-K	DP-TOT	PRESS-I	PRESS-E
1.300	0.000	2.00	0.000	12.911	0.0098	0.0920	0.0918	0.206	0.207	0.068	1.074	0.000	1.142	593.67	592.53
1.300	0.000	0.00	1.000	12.911	0.0000	0.0918	0.0890	0.207	0.213	0.000	0.000	18.011	18.011	592.53	574.52
1.300	0.000	12.00	0.000	12.911	0.0065	0.0890	0.0883	0.213	0.215	0.301	4.394	0.000	4.695	574.52	569.82
1.300	0.000	0.00	1.600	12.911	0.0000	0.0883	0.0836	0.215	0.227	0.000	0.000	30.317	30.317	569.82	539.50
SUB-TOTALS										0.370	5.467	48.328	54.165		

THE TOTAL PRESSURE DROP ACROSS THE INLET SYSTEM IS 54.165

INLET FLOWLOSS INPUT AND RESULTS DATA

WIDTH OR DIA	HEIGHT	LENGTH	K	M-DOT	f	RHO-IN	RHO-EX	MACH-IN	MACH-EX	DP-ACC	DP-f	DP-K	DP-TOT	PRESS-I	PRESS-E
2.000	2.000	4.00	0.500	25.822	0.0089	0.0836	0.0828	0.151	0.152	0.163	0.617	4.310	5.091	539.50	534.41
2.000	0.870	1.50	0.200	25.822	0.0097	0.0828	0.0807	0.350	0.359	2.453	2.217	9.276	13.946	534.41	520.47
SUB-TOTALS										2.617	2.833	13.586	19.036		

THE TOTAL PRESSURE DROP ACROSS THE INLET IS 19.036

COLDPLATE FLOWLOSS INPUT AND RESULTS DATA

WIDTH OR DIA	HEIGHT	LENGTH	K	IN/EX	M-DOT	f	RHO-IN	RHO-EX	MACH-IN	MACH-EX	DP-ACC	DP-f	DP-KI/KE	DP-TOT	PRESS-I	PRESS-E
8.000	0.750	48.00	0.996		25.822	0.0066	0.0807	0.0747	0.113	0.121	0.749	30.960	4.650	32.053	520.47	488.41
			-0.854										-4.306			

EXIT FLOWLOSS INPUT AND RESULTS DATA

WIDTH OR DIA	HEIGHT	LENGTH	K	M-DOT	f	RHO-IN	RHO-EX	MACH-IN	MACH-EX	DP-ACC	DP-f	DP-K	DP-TOT	PRESS-I	PRESS-E
2.000	0.870	1.50	0.200	25.822	0.0097	0.0747	0.0722	0.385	0.399	3.568	2.468	10.329	16.365	488.41	472.05
2.000	2.000	4.00	-0.200	25.822	0.0089	0.0722	0.0724	0.174	0.173	-0.056	0.710	-1.986	-1.332	472.05	473.38
SUB-TOTALS										3.512	3.179	8.343	15.033		

THE TOTAL PRESSURE DROP ACROSS THE EXIT IS 15.033

SYSTEM EXIT FLOWLOSS INPUT AND RESULTS DATA

WIDTH OR DIA	HEIGHT	LENGTH	K	M-DOT	f	RHO-IN	RHO-EX	MACH-IN	MACH-EX	DP-ACC	DP-f	DP-K	DP-TOT	PRESS-I	PRESS-E
1.300	0.000	0.00	1.400	12.911	0.0000	0.0724	0.0674	0.261	0.280	0.000	0.000	32.646	32.646	473.38	440.74
1.300	0.000	12.00	0.000	12.911	0.0065	0.0674	0.0664	0.280	0.284	0.731	5.828	0.000	6.558	440.74	434.18
1.300	0.000	0.00	1.000	12.911	0.0000	0.0664	0.0625	0.284	0.302	0.000	0.000	25.283	25.283	434.18	408.89
1.300	0.000	2.00	0.000	12.911	0.0098	0.0625	0.0622	0.302	0.303	0.232	1.583	0.000	1.815	408.89	407.08
SUB-TOTALS										0.963	7.411	57.929	66.303		

THE TOTAL PRESSURE DROP ACROSS THE SYSTEM EXIT IS 66.303

ACCELERATION TOTAL	8.209
FRICTIONAL TOTAL	49.851
FITTING OR TURN TOTAL	128.530
THE TOTAL PRESSURE DROP ACROSS THE WHOLE SYSTEM IS	186.590
DENSITY RATIO TIMES PRESSURE DROP	189.4383

RAM AIR COOLING INPUT AND RESULTS DATA

DAY	MACH-A/C	ALT	T-AMB	P-AMB	EFF	ARAMI	T-STAG	P-STAG	T-STAT	P-STAT	RHO-S	MACH-RAM	M-DOT
HOT	1.00	40000.	-42.0	2.72	95.	1.4000	4.2	5.03	1.8	4.87	0.0266	0.209	3.542

***** INPUT ***** RESULTS *****

SYSTEM INLET FLOWLOSS INPUT AND RESULTS DATA

WIDTH OR DIA	HEIGHT	LENGTH	K	M-DOT	f	RHO-IN	RHO-EX	MACH-IN	MACH-EX	DP-ACC	DP-f	DP-K	DP-TOT	PRESS-I	PRESS-E
1.300	0.000	2.00	0.000	3.542	0.0139	0.0266	0.0265	0.221	0.222	0.029	0.394	0.000	0.423	134.97	134.55
1.300	0.000	0.00	1.000	3.542	0.0000	0.0265	0.0256	0.222	0.230	0.000	0.000	4.707	4.707	134.55	129.85
1.300	0.000	12.00	0.000	3.542	0.0091	0.0256	0.0252	0.230	0.233	0.131	1.618	0.000	1.749	129.85	128.10
1.300	0.000	0.00	1.600	3.542	0.0000	0.0252	0.0237	0.233	0.248	0.000	0.000	8.024	8.024	128.10	120.07
SUB-TOTALS										0.160	2.012	12.731	14.903		

THE TOTAL PRESSURE DROP ACROSS THE INLET SYSTEM IS 14.903

INLET FLOWLOSS INPUT AND RESULTS DATA

WIDTH OR DIA	HEIGHT	LENGTH	K	M-DOT	f	RHO-IN	RHO-EX	MACH-IN	MACH-EX	DP-ACC	DP-f	DP-K	DP-TOT	PRESS-I	PRESS-E
2.000	2.000	4.00	0.500	7.083	0.0126	0.0237	0.0234	0.165	0.167	0.055	0.231	1.148	1.434	120.07	118.64
2.000	0.870	1.50	0.200	7.083	0.0136	0.0234	0.0225	0.384	0.398	0.902	0.837	2.486	4.225	118.64	114.41
SUB-TOTALS										0.957	1.068	3.634	5.659		

THE TOTAL PRESSURE DROP ACROSS THE INLET IS 5.659

COLDPLATE FLOWLOSS INPUT AND RESULTS DATA

WIDTH OR DIA	HEIGHT	LENGTH	K	IN/EX	M-DOT	f	RHO-IN	RHO-EX	MACH-IN	MACH-EX	DP-ACC	DP-f	DP-KI/KE	DP-TOT	PRESS-I	PRESS-E
8.000	0.750	48.00	0.996		7.083	0.0081	0.0225	0.0191	0.125	0.143	0.452	10.623	1.252	11.061	114.41	103.35
													-0.854	-1.267		

EXIT FLOWLOSS INPUT AND RESULTS DATA

WIDTH OR DIA	HEIGHT	LENGTH	K	M-DOT	f	RHO-IN	RHO-EX	MACH-IN	MACH-EX	DP-ACC	DP-f	DP-K	DP-TOT	PRESS-I	PRESS-E
2.000	0.870	1.50	0.200	7.083	0.0136	0.0191	0.0180	0.454	0.482	1.844	1.036	3.076	5.957	103.35	97.40
2.000	2.000	4.00	-0.200	7.083	0.0126	0.0180	0.0181	0.210	0.209	-0.019	0.302	-0.599	-0.317	97.40	97.71
SUB-TOTALS										1.825	1.338	2.477	5.640		

THE TOTAL PRESSURE DROP ACROSS THE EXIT IS 5.640

SYSTEM EXIT FLOWLOSS INPUT AND RESULTS DATA

WIDTH OR DIA	HEIGHT	LENGTH	K	M-DOT	f	RHO-IN	RHO-EX	MACH-IN	MACH-EX	DP-ACC	DP-f	DP-K	DP-TOT	PRESS-I	PRESS-E
1.300	0.000	0.00	1.400	3.542	0.0000	0.0181	0.0162	0.315	0.351	0.000	0.000	10.020	10.020	97.71	87.69
1.300	0.000	12.00	0.000	3.542	0.0091	0.0162	0.0156	0.351	0.364	0.563	2.584	0.000	3.147	87.69	84.55
1.300	0.000	0.00	1.000	3.542	0.0000	0.0156	0.0141	0.364	0.404	0.000	0.000	8.251	8.251	84.55	76.29
1.300	0.000	2.00	0.000	3.542	0.0139	0.0141	0.0139	0.404	0.409	0.224	0.747	0.000	0.971	76.29	75.32
SUB-TOTALS										0.788	3.331	18.271	22.389		

THE TOTAL PRESSURE DROP ACROSS THE SYSTEM EXIT IS 22.389

 ACCELERATION TOTAL 4.181
 FRICTIONAL TOTAL 18.371
 FITTING OR TURN TOTAL 37.099
 THE TOTAL PRESSURE DROP ACROSS THE WHOLE SYSTEM IS 59.651
 DENSITY RATIO TIMES PRESSURE DROP 16.2324
