

Air System Sizing Summary for GSHP

Project Name: Marion VA Retrofit - Bldng 6

06/07/2011
05:31PM

Air System Information

Air System Name	GSHP	Number of zones	7
Equipment Class	TERM	Floor Area	14689.0 ft²
Air System Type	GSHP	Location	Lafayette, Indiana

Sizing Calculation Information

Zone and Space Sizing Method: Sum of space airflow rates
Zone CFM
Space CFM Individual peak space loads

Heating Coil Sizing Data

Max coil load	81.0 MBH	Load occurs at	Des Htg
Coil CFM at Des Htg	1036 CFM	Ent. DB / Lvg DB	-5.0 / 68.9 °F
Max coil CFM	1036 CFM		
Water flow @ 20.0 °F drop	N/A		

Ventilation Fan Sizing Data

Actual max CFM	1036 CFM	Fan motor BHP	0.45 BHP
Standard CFM	1014 CFM	Fan motor kW	0.34 kW
Actual max CFM/ft²	0.07 CFM/ft²	Fan static	1.50 in wg

Outdoor Ventilation Air Data

Design airflow CFM	1036 CFM	CFM/person	33.43 CFM/person
CFM/ft²	0.07 CFM/ft²		

Zone Sizing Summary for GSHP

Project Name: Marion VA Retrofit - Bldg 6

06/07/2011
05:31PM

Air System Information

Air System Name GSHP
Equipment Class TERM
Air System Type GSHP
Number of zones 7
Floor Area 14589.0 ft²
Location Lafayette, Indiana

Sizing Calculation Information

Zone and Space Sizing Method:

Zone CFM Sum of space airflow rates
Space CFM Individual peak space loads

Calculation Months Jan to Dec
Sizing Data Calculated

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Air Flow (CFM)	Minimum Air Flow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft ²)	Zone CFM/ft ²
Zone 1	42.6	4181	4181	Jul 1400	87.2	5143.0	0.81
Zone 2	23.1	1532	1532	Aug 1400	32.4	1642.0	0.93
Zone 3	22.1	1668	1668	Jul 1400	28.6	1638.0	1.02
Zone 4	26.2	1802	1802	Jul 1400	32.8	1543.0	1.17
Zone 5	31.1	2077	2077	Aug 1400	37.0	1565.0	1.33
Zone 6	26.0	1861	1861	Jul 1400	34.2	1614.0	1.15
Zone 7	28.3	1897	1897	Jul 1400	36.8	1544.0	1.23

Terminal Unit Sizing Data - Cooling

Zone Name	Total Coil Load (MBH)	Sens Coil Load (MBH)	Coil Entering DB / WB (°F)	Coil Leaving DB / WB (°F)	Water Flow @ 10.0 °F (gpm)	Time of Peak Load
Zone 1	62.0	53.0	74.6 / 66.5	62.7 / 61.9	-	Aug 1300
Zone 2	32.1	26.9	75.6 / 64.9	59.0 / 58.0	-	Aug 1400
Zone 3	31.1	26.7	74.7 / 64.7	59.5 / 58.6	-	Aug 1400
Zone 4	34.1	29.6	74.8 / 64.5	59.2 / 58.3	-	Jul 1300
Zone 5	38.5	34.1	75.0 / 64.6	59.4 / 58.4	-	Aug 1400
Zone 6	34.1	29.9	74.7 / 64.6	59.5 / 58.5	-	Jul 1400
Zone 7	35.5	31.3	74.9 / 64.5	59.3 / 58.3	-	Jul 1400

Terminal Unit Sizing Data - Heating, Fan, Ventilation

Zone Name	Heating Coil Load (MBH)	Heating Coil Ent/Lvg DB (°F)	Htg Coil Water Flow @20.0 °F (gpm)	Fan Design Airflow (CFM)	Fan Motor (BHP)	Fan Motor (kW)	OA Vent Design Airflow (CFM)
Zone 1	82.4	69.6 / 88.3	-	4181	1.218	0.908	309
Zone 2	31.0	69.9 / 89.1	-	1532	0.446	0.333	149
Zone 3	27.1	70.0 / 85.4	-	1668	0.486	0.362	118
Zone 4	31.5	70.1 / 86.6	-	1802	0.525	0.391	123
Zone 5	35.7	70.1 / 86.4	-	2077	0.605	0.451	119
Zone 6	31.5	69.7 / 85.7	-	1861	0.542	0.404	112
Zone 7	34.1	69.7 / 86.7	-	1897	0.553	0.412	108

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft ²)	Space CFM/ft ²
Zone 1							
001	1	4.8	Sep 1200	305	6.1	267.0	1.14
002	1	13.0	Jul 1400	1326	28.0	1641.0	0.81

Zone Sizing Summary for GSHP

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft ²)	Space CFM/ft ²
003	1	2.7	Jul 1800	305	6.4	348.0	0.88
004	1	2.7	Jul 1800	307	6.5	348.0	0.88
005	1	13.0	Jul 1400	1311	27.7	1612.0	0.81
006	1	4.8	Sep 1200	304	6.1	270.0	1.13
BSMNT EAST CORRIDOR	1	0.3	Jan 1400	22	0.0	119.0	0.18
BSMNT MAIN CORRIDOR	1	2.6	Jul 1400	302	6.4	538.0	0.56
Zone 2							
102	1	23.1	Aug 1400	1532	32.4	1642.0	0.93
Zone 3							
100	1	1.8	Jun 1800	116	2.1	26.0	4.46
101	1	2.1	Jul 1400	135	2.7	100.0	1.35
103	1	2.3	Sep 1600	142	1.8	53.0	2.69
104	1	1.1	Jan 1400	68	0.0	139.0	0.49
105	1	0.3	Jan 1400	21	0.0	116.0	0.18
106	1	2.7	Aug 1200	172	3.6	146.0	1.18
107	1	2.2	Sep 1200	141	2.2	76.0	1.86
108	1	1.0	Jul 1400	118	2.5	161.0	0.73
109	1	2.2	Jul 1800	157	3.3	197.0	0.80
110	1	2.7	Jul 1400	197	4.2	155.0	1.27
111	1	0.6	Jan 1400	37	0.0	199.0	0.18
112	1	5.7	Aug 1200	362	6.2	270.0	1.34
Zone 4							
113	1	4.6	Jul 1800	358	7.6	531.0	0.67
114	1	6.7	Aug 1200	423	6.6	351.0	1.21
115	1	6.5	Sep 1200	412	6.1	330.0	1.25
116	1	9.6	Jul 1400	608	12.5	331.0	1.84
Zone 5							
200	1	11.4	Aug 1700	718	13.5	337.0	2.13
201	1	6.6	Aug 1200	417	7.0	330.0	1.26
202	1	5.8	Jul 1400	428	9.0	547.0	0.78
203	1	8.2	Aug 1200	515	7.5	351.0	1.47
Zone 6							
204	1	5.6	Aug 1200	351	6.6	253.0	1.39
205	1	1.8	Jul 1400	112	0.8	317.0	0.35
206	1	2.9	Jul 1400	201	4.2	138.0	1.46
207	1	2.9	Jul 1400	185	3.7	179.0	1.03
208	1	3.8	Jun 1800	242	4.1	152.0	1.59
209	1	5.0	Jul 1700	371	7.8	311.0	1.19
210	1	2.5	Sep 1200	156	2.5	99.0	1.58
211	1	3.8	Aug 1200	242	4.3	165.0	1.47
Zone 7							
212	1	6.9	Aug 1200	434	7.7	351.0	1.24
213	1	6.6	Aug 1200	417	7.0	330.0	1.26
214	1	9.8	Jul 1400	625	13.2	332.0	1.88
215	1	5.7	Jul 1400	422	8.9	531.0	0.79

Air System Design Load Summary for GSHP

Project Name: Marion VA Retrofit - Bldg 6

06/07/2011
05:31PM

ZONE LOADS	DESIGN COOLING				DESIGN HEATING			
	COOLING DATA AT Jul 1400 COOLING OA DB / WB 92.4 °F / 74.8 °F				HEATING DATA AT DES HTG HEATING OA DB / WB -5.0 °F / -6.2 °F			
	Details	Sensible (BTU/hr)	Latent (BTU/hr)		Details	Sensible (BTU/hr)	Latent (BTU/hr)	
Window & Skylight Solar Loads	1800 ft²	69045	-		1800 ft²	-	-	
Wall Transmission	7975 ft²	26465	-		7975 ft²	95805	-	
Roof Transmission	4723 ft²	12645	-		4723 ft²	12045	-	
Window Transmission	1800 ft²	17548	-		1800 ft²	79380	-	
Skylight Transmission	0 ft²	0	-		0 ft²	0	-	
Door Loads	63 ft²	313	-		63 ft²	1418	-	
Floor Transmission	5143 ft²	0	-		5143 ft²	18411	-	
Partitions	0 ft²	0	-		0 ft²	0	-	
Ceiling	0 ft²	0	-		0 ft²	0	-	
Overhead Lighting	16158 W	43053	-		0	0	-	
Task Lighting	0 W	0	-		0	0	-	
Electric Equipment	0 W	0	-		0	0	-	
People	31	5408	6355		0	0	0	
Infiltration	-	13366	10379		-	82006	0	
Miscellaneous	-	10500	0		-	0	0	
Safety Factor	0% / 0%	0	0		0%	0	0	
>> Total Zone Loads	-	198344	16734		-	289064	0	
Zone Conditioning	-	194724	16734		-	285373	0	
Plenum Wall Load	0%	0	-		0	0	-	
Plenum Roof Load	0%	0	-		0	0	-	
Plenum Lighting Load	0%	0	-		0	0	-	
Exhaust Fan Load	1036 CFM	0	-		1036 CFM	0	-	
Ventilation Load	1036 CFM	21366	17852		1036 CFM	81120	0	
Ventilation Fan Load	1036 CFM	1152	-		1036 CFM	-1152	-	
Space Fan Coil Fans	-	11133	-		-	-11133	-	
Duct Heat Gain / Loss	0%	0	-		0%	0	-	
>> Total System Loads	-	228375	34586		-	354209	0	
Heating Coil	-	0	-		-	80966	-	
Terminal Unit Cooling	-	228375	34792		-	0	0	
Terminal Unit Heating	-	0	-		-	273222	-	
>> Total Conditioning	-	228375	34792		-	354188	0	
Key:	Positive values are clg loads Negative values are htg loads				Positive values are htg loads Negative values are clg loads			

Ground Loop Design

Borehole Design Project Report - 6/7/2011



Project Name: Marion VA Geothermal Retrofit Bldg 6	
Designer Name:	
Date: 6/7/2011	Project Start Date: 2/22/2011
Client Name:	
Address Line 1:	
Address Line 2:	
City:	Phone:
State:	Fax:
Zip:	Email:

Calculation Results

Design Method:	Design Day	COOLING	HEATING
Total Length (ft):		5452.5	2966.2
Borehole Number:		27	27
Borehole Length (ft):		201.9	109.9
Ground Temperature Change (°F):		+1.6	+2.9
Unit Inlet (°F):		90.0	30.0
Unit Outlet (°F):		100.4	24.5
Total Unit Capacity (kBtu/Hr):		314.0	265.7
Peak Load (kBtu/Hr):		314.0	257.0
Peak Demand (kW):		27.6	23.7
Heat Pump EER/COP:		11.4	3.2
System EER/COP:		11.4	3.2
System Flow Rate (gpm):		78.5	64.3

Input Parameters

Fluid		Soil	
Flow Rate	3.0 gpm/ton	Ground Temperature:	54.6 °F
Fluid:	25% Propylene Glycol	Thermal Conductivity:	1.48 Btu/(h*ft*°F)
Specific Heat (Cp):	1.00 Btu/(°F*lbm)	Thermal Diffusivity:	1.03 ft^2/day
Density (rho):	62.4 lb/ft^3		
Piping			
Pipe Type:	3/4 in. (20 mm)		
Flow Type:	Turbulent - SDR11		
Pipe Resistance:	0.104 h*ft*°F/Btu		
U-Tube Configuration:	Single		
Radial Pipe Placement:	Average		
Borehole Diameter:	5.00 in		
Grout Thermal Conductivity:	0.88 Btu/(h*ft*°F)		
Borehole Thermal Resistance:	0.271 h*ft*°F/Btu		

Input Parameters (Cont.)

Pattern		Modeling Time Period	
Vertical Grid Arrangement:	9 x 3	Prediction Time:	10.0 years
Borehole Number:	27	Long Term Soil Temperatures:	
Borehole Separation:	20.0 ft	<i>Cooling:</i>	56.2 °F
Boreholes per Parallel Circuit:	1	<i>Heating:</i>	57.5 °F
Fixed Length Mode	Off		
Grid File	None		
File:			
Default Heat Pumps		Optional Boiler/Cooling Tower	
Manufacturer:	ClimateMaster		Tower Boiler
Series:	TS Tranquility 20th SS ECM	Load Balance	0 % 0 %
Design Heat Pump Inlet Load Temperatures:		Capacity (kBtu/Hr)	0.0 0.0
	<i>Cooling (WB) Heating (DB)</i>	Cooling Tower Flow Rate (gpm):	0.0
Water to Air:	67 °F 70 °F	Cooling Range (°F):	10.3
Water to Water:	55 °F 100 °F	Annual Operating Hours (hr/yr):	0
Extra kW		Loads File	
Pump Power	0.0 kW	<i>s\Engineering\Mechanical\Bldng 6 loads.zon</i>	
Cooling Tower Pump:	0.0 kW		
Cooling Tower Fan:	0.0 kW		
Additional Power	0.0 kW		
Loads			
Design Day Loads			Annual Equivalent Full-Load Hours <i>COOLING</i> 994 <i>HEATING</i> 1299 Days Occupied per Week: 7.0
<i>Time of Day</i>	<i>Heat Gains (kBtu/Hr)</i>	<i>Heat Losses (kBtu/Hr)</i>	
8 a.m. - Noon	67.8	257.0	
Noon - 4 p.m.	314.0	92.6	
4 p.m. - 8 p.m.	67.8	92.6	
8 p.m. - 8 a.m.	67.8	92.6	
Monthly Loads on Next Page			

Monthly Loads Data								
	Cooling				Heating			
	Total	(kBtu)	Peak	(kBtu/hr)	Total	(kBtu)	Peak	(kBtu/hr)
January		2		1		89300		257
February		13		5		71922		224
March		1882		65		38500		176
April		8668		127		12528		152
May		37303		210		500		42
June		64054		256		0		0
July		80954		314		0		0
August		69897		288		0		0
September		37440		243		851		39
October		11282		142		11578		113
November		516		24		39851		151
December		88		10		68855		202
Total		312099				333885		
Hours at Peak				3.0				3.0

Hourly Loads Data

Included: None

Filename: None

Piping Loop Head Loss Calculator - System Designer for HVAC Systems

Input

Optional Input

Output

Marion VA Geothermal Retrofit - Building 6

Liquid **30% Prop Glycol**
 Temp **40** °F
 Den **64.67** lbm/ft³
 Vis **3.97E-03** lbm/ft-s **5.91** cps

Coils	Flow gpm	Rated Flow gpm	Rated Δh @ 60°F ft. water	Inlet Size inches	Inlet Vel fps	Re(in)	Rated Vel fps	Re(rated)	Δh Ft. Liquid
Ht. Pump	0	12	12	1	0.0	0	#####	#DIV/0!	0.0
	0	0	0	0	0.0	0	0.0	0	0.0
	0	0	0	0	0.0	0	0.0	0	0.0
Coil sub-total									0.0

Flow gpm	Nom. Dia. Inches	DR OD ÷ t	I.D. in.	Roughness (for HDPE in ft.)	Vel fps	Re	Δh(ft) 100 ft.	Length ft.	Fitting Selector	Leqv ft	Qty.	Fitting Selector	Leqv ft	Qty.	Fitting Selector	Leqv ft	Qty.	Δh Ft. Liquid
39.8	3	11	2.86	0.00007	2.0	7706	0.87	400	ButtTeeRun	5	1	Butt90	26	2	5-LoopHdrLastT	30	0	4.0
35.4	3	11	2.86	0.00007	1.8	6854	0.71	20	ButtTeeRun	5	1	ButtRed	10	1	5-LoopHdrLastT	30	0	0.3
31.1	2	11	1.94	0.00007	3.4	8873	3.56	20	ButtTeeRun	4	1	ButtRed	7	0	5-LoopHdrLastT	30	0	0.9
26.6	2	11	1.94	0.00007	2.9	7589	2.72	20	ButtTeeRun	4	1	ButtRed	7	0	5-LoopHdrLastT	30	0	0.7
22.2	2	11	1.94	0.00007	2.4	6334	1.99	20	ButtTeeRun	4	1	ButtRed	7	1	5-LoopHdrLastT	30	0	0.6
17.7	1.5	11	1.55	0.00007	3.0	6313	3.88	20	ButtTeeRun	3	1	ButtRed	6	1	5-LoopHdrLastT	30	0	1.1
13.3	1.25	11	1.36	0.00007	2.9	5429	4.50	20	ButtTeeRun	3	1	ButtRed	5	1	5-LoopHdrLastT	30	0	1.3
8.9	1	11	1.08	0.00007	3.1	4586	6.81	20	ButtTeeRun	3	1	ButtRed	4	1	5-LoopHdrLastT	30	0	1.9
4.4	0.75	11	0.86	0.00007	2.4	2840	5.44	424	Butt90	5	2	UniCoil	8	1	5-LoopHdrLastT	30	0	24.1
39.8	3	11	2.86	0.00007	2.0	7706	0.87	400	ButtTeeBr	26	1	Butt90	26	3	5-LoopHdrLastT	30	0	4.4
0	1	11	1.08	0.00007	0.0	0	0.00	0	Butt90	8	0	ButtRed	4	0	5-LoopHdrLastT	30	0	0.0
HDPE sub-total																		39.0

Flow gpm	Nom. Dia. Inches	Schedule 40 or 80	I.D. in.	Pipe Mat'l for Rghness in ft.	Vel fps	Re	Δh(ft) 100 ft.	Length ft.	Fitting Selector	Leqv ft	Qty.	Fitting Selector	Leqv ft	Qty.	Fitting Selector	Leqv ft	Qty.	Δh Ft. Liquid
0	4	40	4.03	GalvSteel-New	0.0	0	0.00	0	90 L	5.7	2	45 L	4.0	0	T-Branch	45.6	0	0.0
0	4	40	4.03	Steel-New	0.0	0	0.00	0	90 L	5.7	2	Reducer	2.3	0	90 L	5.7	0	0.0
0	4	40	4.03	PVC	0.0	0	0.00	0	T-Straight	6.8	2	Reducer	2.3	0	90 L	5.7	0	0.0
0	3	40	3.07	PVC	0.0	0	0.00	0	T-Straight	5.4	2	Reducer	1.8	0	90 L	4.5	0	0.0
0	3	40	3.07	PVC	0.0	0	0.00	0	T-Straight	5.4	2	Reducer	1.8	0	90 L	4.5	0	0.0
0	3	40	3.07	PVC	0.0	0	0.00	0	T-Straight	5.4	2	Reducer	1.8	0	90 L	4.5	0	0.0
Fe/Br sub-total																		0.0

Other Fittings & Valves	Flow gpm	Cv @ 60°F gpm	Quantity	Inlet Size inches	Inlet Vel fps	Re(in)	Rated Vel fps	Re(rated)	Δh Ft. Liquid
ball valve	0	23	2	1	0.0	0	#####	#DIV/0!	0.0
	0	0	0	2	0.0	0	0.0	0	0.0
	0	0	0	2	0.0	0	0.0	0	0.0
Fitting sub-total									0.0

Open Systems Only ►►

Elevation

Total Loss

SF

TOTAL

0

39.0

1.15

44.9

Air System Sizing Summary for GSHP

Project Name: Marion VA Retrofit - Bldng 51-52

06/07/2011
05:30PM

Air System Information

Air System Name	GSHP	Number of zones	3
Equipment Class	TERM	Floor Area	4510.0 ft²
Air System Type	GSHP	Location	Lafayette, Indiana

Sizing Calculation Information

Zone and Space Sizing Method: Sum of space airflow rates
Zone CFM
Space CFM Individual peak space loads

Heating Coil Sizing Data

Max coil load	34.4 MBH	Load occurs at	Des Htg
Coil CFM at Des Htg	440 CFM	Ent. DB / Lvg DB	-5.0 / 68.9 °F
Max coil CFM	440 CFM		
Water flow @ 20.0 °F drop	N/A		

Ventilation Fan Sizing Data

Actual max CFM	440 CFM	Fan motor BHP	0.19 BHP
Standard CFM	431 CFM	Fan motor kW	0.14 kW
Actual max CFM/ft²	0.10 CFM/ft²	Fan static	1.50 in wg

Outdoor Ventilation Air Data

Design airflow CFM	440 CFM	CFM/person	25.89 CFM/person
CFM/ft²	0.10 CFM/ft²		

Zone Sizing Summary for GSHP

Project Name: Marion VA Retrofit - Bldng 51-52

06/07/2011
05:30PM

Air System Information

Air System Name

Equipment Class

Air System Type

GSHP

TERM

GSHP

Number of zones

Floor Area

Location

3

4510.0 ft²

Lafayette, Indiana

Sizing Calculation Information

Zone and Space Sizing Method:

Zone CFM

Space CFM

Sum of space airflow rates

Individual peak space loads

Calculation Months

Sizing Data

Jan to Dec

Calculated

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Air Flow (CFM)	Minimum Air Flow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft ²)	Zone CFM/ft ²
Zone 1	8.6	1266	1266	Jul 1400	26.7	1410.0	0.90
Zone 2	25.7	2059	2059	Jul 1400	34.5	1892.0	1.09
Zone 3	23.9	1634	1634	Jul 1400	32.6	1208.0	1.35

Terminal Unit Sizing Data - Cooling

Zone Name	Total Coil Load (MBH)	Sens Coil Load (MBH)	Coil Entering DB / WB (°F)	Coil Leaving DB / WB (°F)	Water Flow @ 10.0 °F (gpm)	Time of Peak Load
Zone 1	15.9	13.5	75.9 / 68.8	65.8 / 65.1	-	Aug 1400
Zone 2	36.3	30.6	74.8 / 65.5	60.7 / 59.8	-	Aug 1300
Zone 3	31.7	27.6	74.7 / 64.2	58.7 / 57.7	-	Jul 1400

Terminal Unit Sizing Data - Heating, Fan, Ventilation

Zone Name	Heating Coil Load (MBH)	Heating Coil Ent/Lvg DB (°F)	Htg Coil Water Flow @20.0 °F (gpm)	Fan Design Airflow (CFM)	Fan Motor (BHP)	Fan Motor (kW)	OA Vent Design Airflow (CFM)
Zone 1	25.0	69.8 / 88.5	-	1266	0.369	0.275	169
Zone 2	33.3	70.2 / 85.5	-	2059	0.600	0.447	169
Zone 3	31.2	70.0 / 88.0	-	1634	0.476	0.355	102

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft ²)	Space CFM/ft ²
Zone 1							
001	1	8.6	Jul 1400	1266	26.7	1410.0	0.90
Zone 2							
100A	1	5.2	Jul 1400	359	7.6	287.0	1.25
101	1	3.6	Jul 1000	226	3.3	118.0	1.91
102	1	3.5	Jul 1000	222	3.1	106.0	2.09
102A	1	1.0	Jan 1400	60	0.0	94.0	0.64
103	1	1.8	Sep 1400	130	2.7	41.0	3.16
103A	1	1.5	Aug 1400	183	3.9	181.0	1.01
104	1	1.8	Sep 1400	144	3.0	44.0	3.26
105	1	0.9	Jan 1400	57	0.0	77.0	0.74
106	1	1.1	Jan 1400	68	0.0	138.0	0.49
107	1	1.1	Jan 1400	69	0.0	144.0	0.48
107A	1	0.7	Aug 2100	86	1.8	65.0	1.32
108	1	2.5	Jul 1400	158	2.8	195.0	0.81

Zone Sizing Summary for GSHP

Project Name: Marion VA Retrofit - Bldng 51-52

06/07/2011
05:30PM

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
1ST FLOOR EAST CORRIDOR	1	1.5	Aug 1400	187	4.0	244.0	0.77
1ST FLOOR WEST CORRIDOR	1	0.9	Jul 1400	112	2.4	158.0	0.71
Zone 3							
200	1	0.7	Aug 2300	80	1.7	20.0	3.98
201	1	16.5	Aug 1400	1042	20.1	829.0	1.26
202	1	0.7	Jul 1400	56	1.2	74.0	0.76
203	1	2.4	Jul 1400	186	3.9	124.0	1.50
204	1	3.9	Jul 1400	270	5.7	161.0	1.67

Air System Design Load Summary for GSHP

Project Name: Marion VA Retrofit - Bldg 51-52

06/07/2011
05:30PM

ZONE LOADS	DESIGN COOLING				DESIGN HEATING			
	COOLING DATA AT Jul 1400 COOLING OA DB / WB 92.4 °F / 74.8 °F				HEATING DATA AT DES HTG HEATING OA DB / WB -5.0 °F / -6.2 °F			
	Details	Sensible (BTU/hr)	Latent (BTU/hr)		Details	Sensible (BTU/hr)	Latent (BTU/hr)	
Window & Skylight Solar Loads	336 ft²	13090	-		336 ft²	-	-	-
Wall Transmission	3563 ft²	11444	-		3563 ft²	42803	-	-
Roof Transmission	1208 ft²	3234	-		1208 ft²	3081	-	-
Window Transmission	336 ft²	3003	-		336 ft²	13583	-	-
Skylight Transmission	0 ft²	0	-		0 ft²	0	-	-
Door Loads	168 ft²	836	-		168 ft²	3780	-	-
Floor Transmission	1410 ft²	0	-		1410 ft²	6533	-	-
Partitions	0 ft²	0	-		0 ft²	0	-	-
Ceiling	0 ft²	0	-		0 ft²	0	-	-
Overhead Lighting	4961 W	13221	-		0	0	-	-
Task Lighting	0 W	0	-		0	0	-	-
Electric Equipment	0 W	0	-		0	0	-	-
People	17	2966	3485		0	0	0	0
Infiltration	-	3930	2510		-	24110	0	0
Miscellaneous	-	6500	0		-	0	0	0
Safety Factor	0% / 0%	0	0		0%	0	0	0
>> Total Zone Loads	-	58223	5995		-	93890	0	0
Zone Conditioning	-	57845	5995		-	93536	0	0
Plenum Wall Load	0%	0	-		0	0	-	-
Plenum Roof Load	0%	0	-		0	0	-	-
Plenum Lighting Load	0%	0	-		0	0	-	-
Exhaust Fan Load	440 CFM	0	-		440 CFM	0	-	-
Ventilation Load	440 CFM	9157	5731		440 CFM	34498	0	0
Ventilation Fan Load	440 CFM	489	-		440 CFM	-489	-	-
Space Fan Coil Fans	-	3676	-		-	-3676	-	-
Duct Heat Gain / Loss	0%	0	-		0%	0	-	-
>> Total System Loads	-	71168	11726		-	123868	0	0
Heating Coil	-	0	-		-	34391	-	-
Terminal Unit Cooling	-	71168	11798		-	0	0	0
Terminal Unit Heating	-	0	-		-	89477	-	-
>> Total Conditioning	-	71168	11798		-	123868	0	0
Key:	Positive values are clg loads Negative values are htg loads				Positive values are htg loads Negative values are clg loads			

Ground Loop Design

Borehole Design Project Report - 6/7/2011



Project Name: Marion VA Geothermal Retrofit Bldg 52	
Designer Name:	
Date: 6/7/2011	Project Start Date: 2/22/2011
Client Name:	
Address Line 1:	
Address Line 2:	
City:	Phone:
State:	Fax:
Zip:	Email:

Calculation Results

Design Method:	Design Day	COOLING	HEATING
Total Length (ft):		1679.3	1063.0
Borehole Number:		9	9
Borehole Length (ft):		186.6	118.1
Ground Temperature Change (°F):		+0.8	+1.3
Unit Inlet (°F):		90.0	30.0
Unit Outlet (°F):		100.9	24.5
Total Unit Capacity (kBtu/Hr):		128.5	105.0
Peak Load (kBtu/Hr):		97.0	84.0
Peak Demand (kW):		10.3	7.6
Heat Pump EER/COP:		9.4	3.2
System EER/COP:		9.4	3.2
System Flow Rate (gpm):		24.3	21.0

Input Parameters

Fluid		Soil	
Flow Rate	3.0 gpm/ton	Ground Temperature:	54.6 °F
Fluid:	25% Propylene Glycol	Thermal Conductivity:	1.48 Btu/(h*ft*°F)
Specific Heat (Cp):	1.00 Btu/(°F*lbm)	Thermal Diffusivity:	1.03 ft^2/day
Density (rho):	62.4 lb/ft^3		
Piping			
Pipe Type:	3/4 in. (20 mm)		
Flow Type:	Turbulent - SDR11		
Pipe Resistance:	0.104 h*ft*°F/Btu		
U-Tube Configuration:	Single		
Radial Pipe Placement:	Average		
Borehole Diameter:	5.00 in		
Grout Thermal Conductivity:	0.88 Btu/(h*ft*°F)		
Borehole Thermal Resistance:	0.271 h*ft*°F/Btu		

Input Parameters (Cont.)

Pattern	Modeling Time Period																		
Vertical Grid Arrangement: 3 x 3 Borehole Number: 9 Borehole Separation: 20.0 ft Boreholes per Parallel Circuit: 1 Fixed Length Mode: Off Grid File: None File:	Prediction Time: 10.0 years Long Term Soil Temperatures: <i>Cooling:</i> 55.4 °F <i>Heating:</i> 55.9 °F																		
Default Heat Pumps	Optional Boiler/Cooling Tower																		
Manufacturer: ClimateMaster Series: TS Tranquility 20th SS ECM Design Heat Pump Inlet Load Temperatures: <i>Cooling (WB)</i> <i>Heating (DB)</i> Water to Air: 67 °F 70 °F Water to Water: 55 °F 100 °F	<table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 80%;"></th><th style="width: 10%; text-align: center;">Tower</th><th style="width: 10%; text-align: center;">Boiler</th></tr> <tr> <td>Load Balance</td><td style="text-align: center;">0 %</td><td style="text-align: center;">0 %</td></tr> <tr> <td>Capacity (kBtu/Hr)</td><td style="text-align: center;">0.0</td><td style="text-align: center;">0.0</td></tr> <tr> <td>Cooling Tower Flow Rate (gpm):</td><td style="text-align: center;">0.0</td><td></td></tr> <tr> <td>Cooling Range (°F):</td><td style="text-align: center;">10.4</td><td></td></tr> <tr> <td>Annual Operating Hours (hr/yr):</td><td style="text-align: center;">0</td><td></td></tr> </table>		Tower	Boiler	Load Balance	0 %	0 %	Capacity (kBtu/Hr)	0.0	0.0	Cooling Tower Flow Rate (gpm):	0.0		Cooling Range (°F):	10.4		Annual Operating Hours (hr/yr):	0	
	Tower	Boiler																	
Load Balance	0 %	0 %																	
Capacity (kBtu/Hr)	0.0	0.0																	
Cooling Tower Flow Rate (gpm):	0.0																		
Cooling Range (°F):	10.4																		
Annual Operating Hours (hr/yr):	0																		
Extra kW	Loads File																		
Pump Power: 0.0 kW Cooling Tower Pump: 0.0 kW Cooling Tower Fan: 0.0 kW Additional Power: 0.0 kW	<i>s\Engineering\Mechanical\Bldng 52 loads.zon</i>																		
Loads																			
<div style="display: flex; justify-content: space-between; align-items: flex-start;"> <div style="width: 60%;"> <p style="text-align: center;">Design Day Loads</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;"><i>Time of Day</i></th><th style="text-align: center;"><i>Heat Gains (kBtu/Hr)</i></th><th style="text-align: center;"><i>Heat Losses (kBtu/Hr)</i></th></tr> </thead> <tbody> <tr> <td style="text-align: center;">8 a.m. - Noon</td><td style="text-align: center;">17.7</td><td style="text-align: center;">84.0</td></tr> <tr> <td style="text-align: center;">Noon - 4 p.m.</td><td style="text-align: center;">97.0</td><td style="text-align: center;">31.4</td></tr> <tr> <td style="text-align: center;">4 p.m. - 8 p.m.</td><td style="text-align: center;">17.7</td><td style="text-align: center;">31.4</td></tr> <tr> <td style="text-align: center;">8 p.m. - 8 a.m.</td><td style="text-align: center;">17.7</td><td style="text-align: center;">31.4</td></tr> </tbody> </table> </div> <div style="width: 35%; padding-top: 10px;"> <p style="text-align: center;">Annual Equivalent Full-Load Hours</p> <p style="text-align: center;"><i>COOLING</i> 886 <i>HEATING</i> 1393</p> <p style="text-align: center;">Days Occupied per Week: 7.0</p> </div> </div>		<i>Time of Day</i>	<i>Heat Gains (kBtu/Hr)</i>	<i>Heat Losses (kBtu/Hr)</i>	8 a.m. - Noon	17.7	84.0	Noon - 4 p.m.	97.0	31.4	4 p.m. - 8 p.m.	17.7	31.4	8 p.m. - 8 a.m.	17.7	31.4			
<i>Time of Day</i>	<i>Heat Gains (kBtu/Hr)</i>	<i>Heat Losses (kBtu/Hr)</i>																	
8 a.m. - Noon	17.7	84.0																	
Noon - 4 p.m.	97.0	31.4																	
4 p.m. - 8 p.m.	17.7	31.4																	
8 p.m. - 8 a.m.	17.7	31.4																	
Monthly Loads on Next Page																			

Monthly Loads Data								
	Cooling				Heating			
	Total	(kBtu)	Peak	(kBtu/hr)	Total	(kBtu)	Peak	(kBtu/hr)
January	0		0		29910		84	
February	0		0		24563		73	
March	432		19		14131		56	
April	2031		32		5587		49	
May	9608		62		749		14	
June	17393		72		9		3	
July	23032		97		0		0	
August	19764		90		1		1	
September	10344		75		750		14	
October	3178		41		4661		35	
November	157		6		13741		47	
December	29		3		22871		62	
Total	85968				116973			
Hours at Peak			3.0				3.0	

Hourly Loads Data

Included: None

Filename: None

Piping Loop Head Loss Calculator - System Designer for HVAC Systems

Input

Optional Input

Output

Marion VA Geothermal Retrofit - Building 51-52

Liquid	30% Prop Glycol
Temp	40 °F
Den	64.67 lbm/ft3
Vis	3.97E-03 lbm/ft-s 5.91 cps

Coils	Flow gpm	Rated Flow gpm	Rated Δh @ 60°F ft. water	Inlet Size inches	Inlet Vel fps	Re(in)	Rated Vel fps	Re(rated)	Δh Ft. Liquid
Ht. Pump	0	12	12	1	0.0	0	#####	#DIV/0!	0.0
	0	0	0	0	0.0	0	0.0	0	0.0
	0	0	0	0	0.0	0	0.0	0	0.0
Coil sub-total									0.0

HDPE Piping															Coil sub-total					0.0
Flow gpm	Nom. Dia. Inches	DR OD ÷ t	I.D. in.	Roughness (for HDPE in ft.)	Vel fps	Re	Δ h(ft) 100 ft.	Length ft.	Fitting Selector	Leqv ft	Qty.	Fitting Selector	Leqv ft	Qty.	Fitting Selector	Leqv ft	Qty.	Δ h Ft. Liquid		
13.3	1.5	11	1.55	0.00007	2.2	4743	2.38	110	ButtTeeRun	3	1	Butt90	12	2	ButtRed	6	1	3.4		
8.9	1.25	11	1.36	0.00007	2.0	3633	2.27	20	ButtTeeRun	3	1	ButtRed	5	1	5-LoopHdrLastT	30	0	0.6		
4.4	0.75	11	0.86	0.00007	2.4	2840	5.44	393	Butt90	5	2	UniCoil	8	1	5-LoopHdrLastT	30	0	22.4		
13.3	1.5	11	1.55	0.00007	2.2	4743	2.38	110	ButtTeeBr	12	1	Butt90	12	3	5-LoopHdrLastT	30	0	3.8		
0	1	11	1.08	0.00007	0.0	0	0.00	0	Butt90	8	0	ButtRed	4	0	5-LoopHdrLastT	30	0	0.0		
HDPE sub-total									30.2											

Steel/Brass																	HDPE sub-total					30.2
Flow gpm	Nom. Dia. Inches	Schedule 40 or 80	I.D. in.	Pipe Mat'l for Rghness in ft.	Vel fps	Re	Δ h(ft) 100 ft.	Length ft.	Fitting Selector	Leqv ft	Qty.	Fitting Selector	Leqv ft	Qty.	Fitting Selector	Leqv ft	Qty.	Δ h Ft. Liquid				
0	4	40	4.03	GalvSteel-New	0.0	0	0.00	0	90 L	5.7	2	45 L	4.0	0	T-Branch	45.6	0	0.0				
0	4	40	4.03	Steel-New	0.0	0	0.00	0	90 L	5.7	2	Reducer	2.3	0	90 L	5.7	0	0.0				
0	4	40	4.03	PVC	0.0	0	0.00	0	T-Straight	6.8	2	Reducer	2.3	0	90 L	5.7	0	0.0				
0	3	40	3.07	PVC	0.0	0	0.00	0	T-Straight	5.4	2	Reducer	1.8	0	90 L	4.5	0	0.0				
0	3	40	3.07	PVC	0.0	0	0.00	0	T-Straight	5.4	2	Reducer	1.8	0	90 L	4.5	0	0.0				
0	3	40	3.07	PVC	0.0	0	0.00	0	T-Straight	5.4	2	Reducer	1.8	0	90 L	4.5	0	0.0				
Fe/Br sub-total									0.0													

Other Fittings & Valves	Flow gpm	Cv @ 60°F gpm	Quantity	Inlet Size inches	Inlet Vel fps	Re(in)	Rated Vel fps	Re(rated)	Δh Ft. Liquid
ball valve	0	23	2	1	0.0	0	#####	#DIV/0!	0.0
	0	0	0	2	0.0	0	0.0	0	0.0
	0	0	0	2	0.0	0	0.0	0	0.0
Fitting sub-total									0.0

Open Systems Only

►►

Elevation

Total Loss

SF

TOTAL

1.15

34.8

30.2

Air System Sizing Summary for GSHP Entire Bldng

Project Name: Marion VA Retrofit - Bldng 65

06/07/2011
05:32PM

Air System Information

Air System Name	GSHP Entire Bldng	Number of zones	3
Equipment Class	TERM	Floor Area	6038.0 ft²
Air System Type	GSHP	Location	Lafayette, Indiana

Sizing Calculation Information

Zone and Space Sizing Method: Sum of space airflow rates
Zone CFM
Space CFM Individual peak space loads

Heating Coil Sizing Data

Max coil load	61.5 MBH	Load occurs at	Des Htg
Coil CFM at Des Htg	787 CFM	Ent. DB / Lvg DB	-5.0 / 68.9 °F
Max coil CFM	787 CFM		
Water flow @ 20.0 °F drop	N/A		

Ventilation Fan Sizing Data

Actual max CFM	787 CFM	Fan motor BHP	0.34 BHP
Standard CFM	770 CFM	Fan motor kW	0.26 kW
Actual max CFM/ft²	0.13 CFM/ft²	Fan static	1.50 in wg

Outdoor Ventilation Air Data

Design airflow CFM	787 CFM	CFM/person	9.26 CFM/person
CFM/ft²	0.13 CFM/ft²		

Zone Sizing Summary for GSHP Entire Bldg

Project Name: Marion VA Retrofit - Bldg 65

06/07/2011
05:32PM

Air System Information

Air System Name GSHP Entire Bldg
Equipment Class TERM
Air System Type GSHP
Number of zones 3
Floor Area 6038.0 ft²
Location Lafayette, Indiana

Sizing Calculation Information

Zone and Space Sizing Method:

Zone CFM Sum of space airflow rates
Space CFM Individual peak space loads

Calculation Months Jan to Dec
Sizing Data Calculated

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Air Flow (CFM)	Minimum Air Flow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft ²)	Zone CFM/ft ²
Zone 1	24.4	2119	2119	Jul 1400	41.4	1550.0	1.37
Zone 2	45.6	3470	3470	Aug 1400	73.3	2266.0	1.53
Zone 3	51.8	3706	3706	Jul 1700	77.6	2222.0	1.67

Terminal Unit Sizing Data - Cooling

Zone Name	Total Coil Load (MBH)	Sens Coil Load (MBH)	Coil Entering DB / WB (°F)	Coil Leaving DB / WB (°F)	Water Flow @ 10.0 °F (gpm)	Time of Peak Load
Zone 1	34.8	27.1	74.0 / 66.3	61.9 / 61.2	-	Jul 1200
Zone 2	66.7	55.3	75.3 / 65.5	60.2 / 59.3	-	Aug 1500
Zone 3	73.5	60.5	75.2 / 65.3	59.8 / 58.9	-	Jul 1400

Terminal Unit Sizing Data - Heating, Fan, Ventilation

Zone Name	Heating Coil Load (MBH)	Heating Coil Ent/Lvg DB (°F)	Htg Coil Water Flow @20.0 °F (gpm)	Fan Design Airflow (CFM)	Fan Motor (BHP)	Fan Motor (kW)	OA Vent Design Airflow (CFM)
Zone 1	39.1	69.9 / 87.3	-	2119	0.617	0.460	118
Zone 2	70.5	70.0 / 89.3	-	3470	1.011	0.754	336
Zone 3	72.3	69.7 / 88.1	-	3706	1.080	0.805	333

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft ²)	Space CFM/ft ²
Zone 1							
100	1	2.6	Jul 1400	178	3.8	135.0	1.32
101	1	3.8	Jul 1400	292	6.2	155.0	1.88
102	1	1.5	Jul 1400	130	2.7	195.0	0.67
103	1	2.8	Jul 1400	174	3.1	113.0	1.54
104	1	1.4	Jul 1400	90	0.3	135.0	0.67
105	1	4.5	Sep 1400	281	4.7	170.0	1.65
106	1	1.2	Jul 1400	151	3.2	64.0	2.37
107	1	3.3	Jul 1400	416	8.8	330.0	1.26
108	1	4.2	Jul 1400	406	8.6	253.0	1.61
Zone 2							
109	1	8.3	Jul 1400	611	12.9	408.0	1.50
110	1	36.4	Sep 1400	2628	55.5	1743.0	1.51
111	1	1.8	Jul 1400	232	4.9	115.0	2.01
Zone 3							

Zone Sizing Summary for GSHP Entire Bldng

Project Name: Marion VA Retrofit - Bldng 65

06/07/2011
05:32PM

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft ²)	Space CFM/ft ²
112	1	0.8	Jul 1400	53	0.4	149.0	0.35
113	1	45.1	Jul 1600	3105	65.6	1875.0	1.66
114	1	3.5	Jul 1700	271	5.7	100.0	2.71
115	1	3.1	Jul 1000	277	5.8	98.0	2.82

Air System Design Load Summary for GSHP Entire Bldg

Project Name: Marion VA Retrofit - Bldg 65

06/07/2011
05:32PM

ZONE LOADS	DESIGN COOLING				DESIGN HEATING			
	COOLING DATA AT Jul 1200 COOLING OA DB / WB 88.2 °F / 73.7 °F				HEATING DATA AT DES HTG HEATING OA DB / WB -5.0 °F / -6.2 °F			
	Details	Sensible (BTU/hr)	Latent (BTU/hr)		Details	Sensible (BTU/hr)	Latent (BTU/hr)	
Window & Skylight Solar Loads	1035 ft²	38338	-		1035 ft²	-	-	
Wall Transmission	3597 ft²	10217	-		3597 ft²	43211	-	
Roof Transmission	6038 ft²	14451	-		6038 ft²	15398	-	
Window Transmission	1035 ft²	8103	-		1035 ft²	45644	-	
Skylight Transmission	0 ft²	0	-		0 ft²	0	-	
Door Loads	189 ft²	755	-		189 ft²	4253	-	
Floor Transmission	6038 ft²	0	-		6038 ft²	13767	-	
Partitions	0 ft²	0	-		0 ft²	0	-	
Ceiling	0 ft²	0	-		0 ft²	0	-	
Overhead Lighting	6642 W	16564	-		0	0	-	
Task Lighting	0 W	0	-		0	0	-	
Electric Equipment	0 W	0	-		0	0	-	
People	85	13539	17425		0	0	0	
Infiltration	-	9072	8085		-	70031	0	
Miscellaneous	-	2500	0		-	0	0	
Safety Factor	0% / 0%	0	0		0%	0	0	
>> Total Zone Loads	-	113541	25510		-	192304	0	
Zone Conditioning	-	114793	25510		-	189643	0	
Plenum Wall Load	0%	0	-		0	0	-	
Plenum Roof Load	0%	0	-		0	0	-	
Plenum Lighting Load	0%	0	-		0	0	-	
Exhaust Fan Load	787 CFM	0	-		787 CFM	0	-	
Ventilation Load	787 CFM	12937	11926		787 CFM	61624	0	
Ventilation Fan Load	787 CFM	875	-		787 CFM	-875	-	
Space Fan Coil Fans	-	6890	-		-	-6890	-	
Duct Heat Gain / Loss	0%	0	-		0%	0	-	
>> Total System Loads	-	135496	37435		-	243501	0	
Heating Coil	-	0	-		-	61508	-	
Terminal Unit Cooling	-	135496	37201		-	0	0	
Terminal Unit Heating	-	0	-		-	181982	-	
>> Total Conditioning	-	135496	37201		-	243490	0	
Key:	Positive values are clg loads Negative values are htg loads				Positive values are htg loads Negative values are clg loads			

Ground Loop Design

Borehole Design Project Report - 6/7/2011



Project Name: Marion VA Geothermal Retrofit Bldg 65	
Designer Name:	
Date: 6/7/2011	Project Start Date: 2/22/2011
Client Name:	
Address Line 1:	
Address Line 2:	
City:	Phone:
State:	Fax:
Zip:	Email:

Calculation Results

Design Method:	Design Day	COOLING	HEATING
Total Length (ft):		3177.6	2425.4
Borehole Number:		18	18
Borehole Length (ft):		176.5	134.7
Ground Temperature Change (°F):		+0.3	+0.4
Unit Inlet (°F):		90.0	30.0
Unit Outlet (°F):		100.4	24.5
Total Unit Capacity (kBtu/Hr):		220.8	180.0
Peak Load (kBtu/Hr):		196.0	180.0
Peak Demand (kW):		17.5	16.5
Heat Pump EER/COP:		11.2	3.2
System EER/COP:		11.2	3.2
System Flow Rate (gpm):		49.0	45.0

Input Parameters

Fluid		Soil	
Flow Rate	3.0 gpm/ton	Ground Temperature:	54.6 °F
Fluid:	25% Propylene Glycol	Thermal Conductivity:	1.48 Btu/(h*ft*°F)
Specific Heat (Cp):	1.00 Btu/(°F*lbm)	Thermal Diffusivity:	1.03 ft^2/day
Density (rho):	62.4 lb/ft^3		
Piping			
Pipe Type:	3/4 in. (20 mm)		
Flow Type:	Turbulent - SDR11		
Pipe Resistance:	0.104 h*ft*°F/Btu		
U-Tube Configuration:	Single		
Radial Pipe Placement:	Average		
Borehole Diameter:	5.00 in		
Grout Thermal Conductivity:	0.88 Btu/(h*ft*°F)		
Borehole Thermal Resistance:	0.271 h*ft*°F/Btu		

Input Parameters (Cont.)

Pattern	Modeling Time Period																		
Vertical Grid Arrangement: 3 x 6 Borehole Number: 18 Borehole Separation: 20.0 ft Boreholes per Parallel Circuit: 1 Fixed Length Mode: Off Grid File: None File:	Prediction Time: 10.0 years Long Term Soil Temperatures: <i>Cooling:</i> 54.9 °F <i>Heating:</i> 55 °F																		
Default Heat Pumps	Optional Boiler/Cooling Tower																		
Manufacturer: ClimateMaster Series: TS Tranquility 20th SS ECM Design Heat Pump Inlet Load Temperatures: <i>Cooling (WB)</i> <i>Heating (DB)</i> Water to Air: 67 °F 70 °F Water to Water: 55 °F 100 °F	<table style="width: 100%; border-collapse: collapse;"> <tr> <th></th><th style="text-align: center;">Tower</th><th style="text-align: center;">Boiler</th></tr> <tr> <td>Load Balance</td><td style="text-align: center;">0 %</td><td style="text-align: center;">0 %</td></tr> <tr> <td>Capacity (kBtu/Hr)</td><td style="text-align: center;">0.0</td><td style="text-align: center;">0.0</td></tr> <tr> <td>Cooling Tower Flow Rate (gpm):</td><td style="text-align: center;">0.0</td><td></td></tr> <tr> <td>Cooling Range (°F):</td><td style="text-align: center;">10.1</td><td></td></tr> <tr> <td>Annual Operating Hours (hr/yr):</td><td style="text-align: center;">0</td><td></td></tr> </table>		Tower	Boiler	Load Balance	0 %	0 %	Capacity (kBtu/Hr)	0.0	0.0	Cooling Tower Flow Rate (gpm):	0.0		Cooling Range (°F):	10.1		Annual Operating Hours (hr/yr):	0	
	Tower	Boiler																	
Load Balance	0 %	0 %																	
Capacity (kBtu/Hr)	0.0	0.0																	
Cooling Tower Flow Rate (gpm):	0.0																		
Cooling Range (°F):	10.1																		
Annual Operating Hours (hr/yr):	0																		
Extra kW	Loads File																		
Pump Power: 0.0 kW Cooling Tower Pump: 0.0 kW Cooling Tower Fan: 0.0 kW Additional Power: 0.0 kW	<i>s\Engineering\Mechanical\Bldng 65 loads.zon</i>																		
Loads																			
<div style="display: flex; justify-content: space-between; align-items: flex-start;"> <div style="width: 60%;"> <p style="text-align: center;">Design Day Loads</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;"><i>Time of Day</i></th><th style="text-align: center;"><i>Heat Gains (kBtu/Hr)</i></th><th style="text-align: center;"><i>Heat Losses (kBtu/Hr)</i></th></tr> </thead> <tbody> <tr> <td style="text-align: center;">8 a.m. - Noon</td><td style="text-align: center;">33.2</td><td style="text-align: center;">180.0</td></tr> <tr> <td style="text-align: center;">Noon - 4 p.m.</td><td style="text-align: center;">196.0</td><td style="text-align: center;">73.3</td></tr> <tr> <td style="text-align: center;">4 p.m. - 8 p.m.</td><td style="text-align: center;">33.2</td><td style="text-align: center;">73.3</td></tr> <tr> <td style="text-align: center;">8 p.m. - 8 a.m.</td><td style="text-align: center;">33.2</td><td style="text-align: center;">73.3</td></tr> </tbody> </table> </div> <div style="width: 35%; padding-top: 10px;"> <p style="text-align: center;">Annual Equivalent Full-Load Hours</p> <p style="text-align: center;"><i>COOLING</i> 813 <i>HEATING</i> 1504</p> <p style="text-align: center;">Days Occupied per Week: 7.0</p> </div> </div>		<i>Time of Day</i>	<i>Heat Gains (kBtu/Hr)</i>	<i>Heat Losses (kBtu/Hr)</i>	8 a.m. - Noon	33.2	180.0	Noon - 4 p.m.	196.0	73.3	4 p.m. - 8 p.m.	33.2	73.3	8 p.m. - 8 a.m.	33.2	73.3			
<i>Time of Day</i>	<i>Heat Gains (kBtu/Hr)</i>	<i>Heat Losses (kBtu/Hr)</i>																	
8 a.m. - Noon	33.2	180.0																	
Noon - 4 p.m.	196.0	73.3																	
4 p.m. - 8 p.m.	33.2	73.3																	
8 p.m. - 8 a.m.	33.2	73.3																	
Monthly Loads on Next Page																			

Monthly Loads Data								
	Cooling				Heating			
	Total	(kBtu)	Peak	(kBtu/hr)	Total	(kBtu)	Peak	(kBtu/hr)
January	0		0		67739		180	
February	0		0		55209		154	
March	483		24		32332		124	
April	2762		65		13447		104	
May	16736		116		1177		44	
June	34319		149		4		3	
July	44866		196		0		0	
August	38181		178		0		0	
September	17655		143		1648		50	
October	4096		74		12298		83	
November	163		16		33555		106	
December	17		3		53399		132	
Total	159278				270808			
Hours at Peak			3.0				3.0	

Hourly Loads Data

Included: None

Filename: None

Piping Loop Head Loss Calculator - System Designer for HVAC Systems

Input

Optional Input

Output

Marion VA Geothermal Retrofit - Building 65

Liquid	30% Prop Glycol
Temp	40 °F
Den	64.67 lbm/ft ³
Vis	3.97E-03 lbm/ft-s
	5.91 cps

Coils	Flow gpm	Rated Flow gpm	Rated Δh @ 60°F ft. water	Inlet Size inches	Inlet Vel fps	Re(in)	Rated Vel fps	Re(rated)	Δh Ft. Liquid
Ht. Pump	0	12	12	1	0.0	0	####	#DIV/0!	0.0
	0	0	0	0	0.0	0	0.0	0	0.0
	0	0	0	0	0.0	0	0.0	0	0.0
Coil sub-total									0.0

HDPE Piping															Coil sub-total					0.0
Flow gpm	Nom. Dia. Inches	DR OD ÷ t	I.D. in.	Roughness (for HDPE in ft.)	Vel fps	Re	Δh(ft) 100 ft.	Length ft.	Fitting Selector	Leqv ft	Qty.	Fitting Selector	Leqv ft	Qty.	Fitting Selector	Leqv ft	Qty.	Δh Ft. Liquid		
26.6		2	11	1.94	0.00007	2.9	7589	2.72	255	ButtTeeRun	4	1	Butt90	17	2	5-LoopHdrLastT	30	0	8.0	
22.2		2	11	1.94	0.00007	2.4	6325	1.98	20	ButtTeeRun	4	1	ButtRed	7	0	5-LoopHdrLastT	30	0	0.5	
17.7		2	11	1.94	0.00007	1.9	5062	1.35	20	ButtTeeRun	4	1	ButtRed	7	1	5-LoopHdrLastT	30	0	0.4	
13.3		1.5	11	1.55	0.00007	2.3	4747	2.38	20	ButtTeeRun	3	1	ButtRed	6	1	5-LoopHdrLastT	30	0	0.7	
8.9		1.25	11	1.36	0.00007	2.0	3625	2.26	20	ButtTeeRun	3	1	ButtRed	5	1	5-LoopHdrLastT	30	0	0.6	
4.4		0.75	11	0.86	0.00007	2.5	2865	5.58	374	Butt90	5	2	UniCoil	8	1	5-LoopHdrLastT	30	0	21.9	
26.6		2	11	1.94	0.00007	2.9	7589	2.72	255	ButtTeeBr	16	1	Butt90	17	3	5-LoopHdrLastT	30	0	8.8	
		1	11	1.08	0.00007	0.0	0	0.00		ButtTeeRun	3		Butt90	8		5-LoopHdrLastT	30	0	0.0	
HDPE sub-total									40.9											

Steel/Brass										HDPE sub-total										40.9
Flow gpm	Nom. Dia. Inches	Schedule 40 or 80	I.D. in.	Pipe Mat'l for Rghness in ft.	Vel fps	Re	Δ h(ft) 100 ft.	Length ft.	Fitting Selector	Leqv ft	Qty.	Fitting Selector	Leqv ft	Qty.	Fitting Selector	Leqv ft	Qty.	Δ h Ft. Liquid		
0.0		4	40	4.03	GalvSteel-New	0.0	0	0.00	0	90 L	5.7	2	45 L	4.0	0	T-Branch	45.6	0	0.0	
0.0		4	40	4.03	Steel-New	0.0	0	0.00	0	90 L	5.7	2	Reducer	2.3	0	90 L	5.7	0	0.0	
0.0		4	40	4.03	PVC	0.0	0	0.00	0	T-Straight	6.8	2	Reducer	2.3	0	90 L	5.7	0	0.0	
0.0		3	40	3.07	PVC	0.0	0	0.00	0	T-Straight	5.4	2	Reducer	1.8	0	90 L	4.5	0	0.0	
0.0		3	40	3.07	PVC	0.0	0	0.00	0	T-Straight	5.4	2	Reducer	1.8	0	90 L	4.5	0	0.0	
0.0		3	40	3.07	PVC	0.0	0	0.00	0	T-Straight	5.4	2	Reducer	1.8	0	90 L	4.5	0	0.0	
Fe/Br sub-total																		0.0		

Other Fittings & Valves	Flow gpm	Cv @ 60°F gpm	Quantity	Inlet Size inches	Inlet Vel fps	Re(in)	Rated Vel fps	Re(rated)	Δh Ft. Liquid
ball valve	0	23	2	1	0.0	0	####	#DIV/0!	0.0
	0	0	0	2	0.0	0	0.0	0	0.0
	0	0	0	2	0.0	0	0.0	0	0.0

Open Systems Only

►►

Elevation

Total Loss

SF

TOTAL

0
40.9
1.15
47.0

Air System Sizing Summary for GSHP

Project Name: Marion VA Retrofit - Bldg 114

06/07/2011
05:26PM

Air System Information

Air System Name GSHP
Equipment Class TERM
Air System Type GSHP

Number of zones 5
Floor Area 543.0 ft²
Location Lafayette, Indiana

Sizing Calculation Information

Zone and Space Sizing Method:

Zone CFM Sum of space airflow rates
Space CFM Individual peak space loads

Calculation Months Jan to Dec
Sizing Data Calculated

Zone Sizing Summary for GSHP

Project Name: Marion VA Retrofit - Bldng 114

06/07/2011
05:26PM

Air System Information

Air System Name

Equipment Class

Air System Type

GSHP

TERM

GSHP

Number of zones

Floor Area

Location

5

543.0 ft²

Lafayette, Indiana

Sizing Calculation Information

Zone and Space Sizing Method:

Zone CFM

Space CFM

Sum of space airflow rates

Individual peak space loads

Calculation Months

Sizing Data

Jan to Dec

Calculated

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Air Flow (CFM)	Minimum Air Flow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft²)	Zone CFM/ft²
Zone 1	4.3	276	276	Sep 1400	5.5	143.0	1.93
Zone 2	6.8	471	471	Jul 1400	9.4	180.0	2.61
Zone 3	3.1	183	183	Sep 1400	3.7	49.0	3.73
Zone 4	1.1	157	157	Jul 1400	3.2	49.0	3.21
Zone 5	3.8	349	349	Jul 1400	7.0	122.0	2.86

Terminal Unit Sizing Data - Cooling

Zone Name	Total Coil Load (MBH)	Sens Coil Load (MBH)	Coil Entering DB / WB (°F)	Coil Leaving DB / WB (°F)	Water Flow (gpm) @ 10.0 °F	Time of Peak Load
Zone 1	5.1	4.6	75.2 / 63.3	57.0 / 55.9	-	Sep 1400
Zone 2	8.2	7.3	75.3 / 63.3	57.0 / 55.9	-	Jul 1400
Zone 3	3.4	3.2	74.8 / 62.7	57.0 / 55.8	-	Sep 1400
Zone 4	1.3	1.2	74.5 / 63.1	57.0 / 55.9	-	Jul 1400
Zone 5	4.6	4.1	75.0 / 63.2	57.0 / 55.9	-	Jul 1400

Terminal Unit Sizing Data - Heating, Fan, Ventilation

Zone Name	Heating Coil Load (MBH)	Heating Coil Ent/Lvg DB (°F)	Htg Coil Water Flow @20.0 °F (gpm)	Fan Design Airflow (CFM)	Fan Motor (BHP)	Fan Motor (kW)	OA Vent Design Airflow (CFM)
Zone 1	6.3	67.1 / 90.0	-	276	0.081	0.060	14
Zone 2	10.6	67.4 / 90.0	-	471	0.137	0.102	21
Zone 3	3.7	69.6 / 90.0	-	183	0.053	0.040	3
Zone 4	3.2	69.4 / 90.0	-	157	0.046	0.034	3
Zone 5	7.6	68.1 / 90.0	-	349	0.102	0.076	12

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
Zone 1							
101 OFFICE	1	4.3	Sep 1400	276	5.5	143.0	1.93
Zone 2							
102 DISPATCH	1	6.8	Jul 1400	471	9.4	180.0	2.61
Zone 3							
101A STORAGE	1	3.1	Sep 1400	183	3.7	49.0	3.73
Zone 4							
101B TOILET	1	1.1	Jul 1400	157	3.2	49.0	3.21
Zone 5							

Zone Sizing Summary for GSHP

Project Name: Marion VA Retrofit - Bldg 114

06/07/2011
05:26PM

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft ²)	Space CFM/ft ²
103 OFFICE	1	3.5	Jul 1400	300	6.0	95.0	3.16
103A EVIDENCE	1	0.3	Jul 2300	49	1.0	27.0	1.81

Air System Design Load Summary for GSHP

Project Name: Marion VA Retrofit - Bldg 114

06/07/2011
05:26PM

ZONE LOADS	DESIGN COOLING				DESIGN HEATING			
	COOLING DATA AT Aug 1400 COOLING OA DB / WB 92.4 °F / 74.8 °F				HEATING DATA AT DES HTG HEATING OA DB / WB -5.0 °F / -6.2 °F			
	Details	Sensible (BTU/hr)	Latent (BTU/hr)		Details	Sensible (BTU/hr)	Latent (BTU/hr)	
Window & Skylight Solar Loads	173 ft²	7270	-	-	173 ft²	-	-	-
Wall Transmission	1093 ft²	2856	-	-	1093 ft²	13308	-	-
Roof Transmission	543 ft²	1345	-	-	543 ft²	1403	-	-
Window Transmission	173 ft²	1583	-	-	173 ft²	7722	-	-
Skylight Transmission	0 ft²	0	-	-	0 ft²	0	-	-
Door Loads	42 ft²	196	-	-	42 ft²	958	-	-
Floor Transmission	543 ft²	0	-	-	543 ft²	2153	-	-
Partitions	0 ft²	0	-	-	0 ft²	0	-	-
Ceiling	0 ft²	0	-	-	0 ft²	0	-	-
Overhead Lighting	616 W	1642	-	-	0	0	-	-
Task Lighting	0 W	0	-	-	0	0	-	-
Electric Equipment	0 W	0	-	-	0	0	-	-
People	4	698	820	0	0	0	0	0
Infiltration	-	500	588	0	-	3270	0	0
Miscellaneous	-	2000	0	0	-	0	0	0
Safety Factor	0% / 0%	0	0	0	0%	0	0	0
>> Total Zone Loads	-	18091	1408	0	-	28813	0	0
Zone Conditioning	-	17892	1408	0	-	28499	0	0
Plenum Wall Load	0%	0	-	-	0	0	-	-
Plenum Roof Load	0%	0	-	-	0	0	-	-
Plenum Lighting Load	0%	0	-	-	0	0	-	-
Exhaust Fan Load	0 CFM	0	-	-	0 CFM	0	-	-
Ventilation Load	38 CFM	756	926	0	50 CFM	3930	0	0
Ventilation Fan Load	0 CFM	0	-	-	0 CFM	0	-	-
Space Fan Coil Fans	-	751	-	-	-	-1003	-	-
Duct Heat Gain / Loss	0%	0	-	-	0%	0	-	-
>> Total System Loads	-	19398	2333	0	-	31426	0	0
Terminal Unit Cooling	-	19398	2334	0	-	0	0	0
Terminal Unit Heating	-	0	-	-	-	31426	-	-
>> Total Conditioning	-	19398	2334	0	-	31426	0	0
Key:	Positive values are clg loads Negative values are htg loads				Positive values are htg loads Negative values are clg loads			

Ground Loop Design

Borehole Design Project Report - 6/7/2011



Project Name: Marion VA Geothermal Retrofit Bldg 114	
Designer Name:	
Date: 6/7/2011	Project Start Date: 2/22/2011
Client Name:	
Address Line 1:	
Address Line 2:	
City:	Phone:
State:	Fax:
Zip:	Email:

Calculation Results

Design Method:	Design Day	COOLING	HEATING
Total Length (ft):		486.6	279.1
Borehole Number:		3	3
Borehole Length (ft):		162.2	93.0
Ground Temperature Change (°F):		+1.0	+1.7
Unit Inlet (°F):		90.0	30.0
Unit Outlet (°F):		100.9	24.4
Total Unit Capacity (kBtu/Hr):		30.5	25.0
Peak Load (kBtu/Hr):		24.0	25.0
Peak Demand (kW):		2.6	2.2
Heat Pump EER/COP:		9.3	3.4
System EER/COP:		9.3	3.4
System Flow Rate (gpm):		6.0	6.3

Input Parameters

Fluid		Soil	
Flow Rate	3.0 gpm/ton	Ground Temperature:	54.6 °F
Fluid:	25% Propylene Glycol	Thermal Conductivity:	1.48 Btu/(h*ft*°F)
Specific Heat (Cp):	1.00 Btu/(°F*lbm)	Thermal Diffusivity:	1.03 ft^2/day
Density (rho):	62.4 lb/ft^3		
Piping			
Pipe Type:	3/4 in. (20 mm)		
Flow Type:	Turbulent - SDR11		
Pipe Resistance:	0.104 h*ft*°F/Btu		
U-Tube Configuration:	Single		
Radial Pipe Placement:	Average		
Borehole Diameter:	5.00 in		
Grout Thermal Conductivity:	0.88 Btu/(h*ft*°F)		
Borehole Thermal Resistance:	0.271 h*ft*°F/Btu		

Input Parameters (Cont.)

Pattern	Modeling Time Period																		
Vertical Grid Arrangement: 3 x 1 Borehole Number: 3 Borehole Separation: 20.0 ft Boreholes per Parallel Circuit: 1 Fixed Length Mode: Off Grid File: None File:	Prediction Time: 10.0 years Long Term Soil Temperatures: <i>Cooling:</i> 55.6 °F <i>Heating:</i> 56.3 °F																		
Default Heat Pumps	Optional Boiler/Cooling Tower																		
Manufacturer: Addison Series: Horizontal 1/2-10 Ton, HGY Design Heat Pump Inlet Load Temperatures: <i>Cooling (WB)</i> <i>Heating (DB)</i> Water to Air: 67 °F 70 °F Water to Water: 55 °F 100 °F	<table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 70%;"></th><th style="width: 15%; text-align: center;">Tower</th><th style="width: 15%; text-align: center;">Boiler</th></tr> <tr> <td>Load Balance</td><td style="text-align: center;">0 %</td><td style="text-align: center;">0 %</td></tr> <tr> <td>Capacity (kBtu/Hr)</td><td style="text-align: center;">0.0</td><td style="text-align: center;">0.0</td></tr> <tr> <td>Cooling Tower Flow Rate (gpm):</td><td style="text-align: center;">0.0</td><td></td></tr> <tr> <td>Cooling Range (°F):</td><td style="text-align: center;">10.3</td><td></td></tr> <tr> <td>Annual Operating Hours (hr/yr):</td><td style="text-align: center;">0</td><td></td></tr> </table>		Tower	Boiler	Load Balance	0 %	0 %	Capacity (kBtu/Hr)	0.0	0.0	Cooling Tower Flow Rate (gpm):	0.0		Cooling Range (°F):	10.3		Annual Operating Hours (hr/yr):	0	
	Tower	Boiler																	
Load Balance	0 %	0 %																	
Capacity (kBtu/Hr)	0.0	0.0																	
Cooling Tower Flow Rate (gpm):	0.0																		
Cooling Range (°F):	10.3																		
Annual Operating Hours (hr/yr):	0																		
Extra kW	Loads File																		
Pump Power: 0.0 kW Cooling Tower Pump: 0.0 kW Cooling Tower Fan: 0.0 kW Additional Power: 0.0 kW	<i>s\Engineering\Mechanical\Bldng 114 loads.zon</i>																		
Loads																			
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<i>Time of Day</i>	<i>Heat Gains (kBtu/Hr)</i>	<i>Heat Losses (kBtu/Hr)</i>																	
8 a.m. - Noon	10.7	25.0																	
Noon - 4 p.m.	24.0	7.2																	
4 p.m. - 8 p.m.	10.7	7.2																	
8 p.m. - 8 a.m.	10.7	7.2																	
Monthly Loads on Next Page																			

Monthly Loads Data							
	Cooling				Heating		
	Total	(kBtu)	Peak	(kBtu/hr)	Total	(kBtu)	Peak (kBtu/hr)
January		9		1	7584		25
February		2		0	5834		21
March		537		8	2572		15
April		1732		12	772		12
May		5092		18	28		2
June		7924		21	0		0
July		9639		24	0		0
August		8746		22	0		0
September		5437		19	52		2
October		2248		14	573		8
November		348		9	2696		13
December		123		6	5630		17
Total	41837				25741		
Hours at Peak				3.0			3.0

Hourly Loads Data

Included: None
Filename: None

Piping Loop Head Loss Calculator - System Designer for HVAC Systems

Input

Optional Input

Output

Marion VA Geothermal Retrofit - Building 114

Liquid	30% Prop Glycol
Temp	40 °F
Den	64.67 lbm/ft3
Vis	3.97E-03 lbm/ft-s 5.91 cps

Coils	Flow gpm	Rated Flow gpm	Rated Δh @ 60°F ft. water	Inlet Size inches	Inlet Vel fps	Re(in)	Rated Vel fps	Re(rated)	Δh Ft. Liquid
Ht. Pump	0	12	12	1	0.0	0	#####	#DIV/0!	0.0
	0	0	0	0	0.0	0	0.0	0	0.0
	0	0	0	0	0.0	0	0.0	0	0.0
Coil sub-total									0.0

HDPE Piping													Coil sub-total						0.0
Flow gpm	Nom. Dia. Inches	DR OD ÷ t	I.D. in.	Roughness (for HDPE in ft.)	Vel fps	Re	Δ h(ft) 100 ft.	Length ft.	Fitting Selector	Leqv ft	Qty.	Fitting Selector	Leqv ft	Qty.	Fitting Selector	Leqv ft	Qty.	Δ h Ft. Liquid	
13.3	1.5	11	1.55	0.00007	2.2	4743	2.38	30	ButtTeeRun	3	1	Butt90	12	2	ButtRed	6	1	1.5	
8.9	1.25	11	1.36	0.00007	2.0	3633	2.27	20	ButtTeeRun	3	1	ButtRed	5	1	5-LoopHdrLastT	30	0	0.6	
4.4	0.75	11	0.86	0.00007	2.4	2840	5.44	344	Butt90	5	2	UniCoil	8	1	5-LoopHdrLastT	30	0	19.7	
13.3	1.5	11	1.55	0.00007	2.2	4743	2.38	30	ButtTeeBr	12	1	Butt90	12	3	5-LoopHdrLastT	30	0	1.9	
0	1	11	1.08	0.00007	0.0	0	0.00	0	ButtTeeRun	3	0	Butt90	8	0	5-LoopHdrLastT	30	0	0.0	
HDPE sub-total									23.8										

Steel/Brass																	HDPE sub-total					23.8
Flow gpm	Nom. Dia. Inches	Schedule 40 or 80	I.D. in.	Pipe Mat'l for Rghness in ft.	Vel fps	Re	Δ h(ft) 100 ft.	Length ft.	Fitting Selector	Leqv ft	Qty.	Fitting Selector	Leqv ft	Qty.	Fitting Selector	Leqv ft	Qty.	Δ h Ft. Liquid				
0	4	40	4.03	GalvSteel-New	0.0	0	0.00	0	90 L	5.7	2	45 L	4.0	0	T-Branch	45.6	0	0.0				
0	4	40	4.03	Steel-New	0.0	0	0.00	0	90 L	5.7	2	Reducer	2.3	0	90 L	5.7	0	0.0				
0	4	40	4.03	PVC	0.0	0	0.00	0	T-Straight	6.8	2	Reducer	2.3	0	90 L	5.7	0	0.0				
0	3	40	3.07	PVC	0.0	0	0.00	0	T-Straight	5.4	2	Reducer	1.8	0	90 L	4.5	0	0.0				
0	3	40	3.07	PVC	0.0	0	0.00	0	T-Straight	5.4	2	Reducer	1.8	0	90 L	4.5	0	0.0				
0	3	40	3.07	PVC	0.0	0	0.00	0	T-Straight	5.4	2	Reducer	1.8	0	90 L	4.5	0	0.0				
Fe/Br sub-total									0.0													

Other Fittings & Valves	Flow gpm	Cv @ 60°F gpm	Quantity	Inlet Size inches	Inlet Vel fps	Re(in)	Rated Vel fps	Re(rated)	Δh Ft. Liquid
ball valve	0	23	2	1	0.0	0	#####	#DIV/0!	0.0
	0	0	0	2	0.0	0	0.0	0	0.0
	0	0	0	2	0.0	0	0.0	0	0.0
Fitting sub-total									0.0

Open Systems Only

►►

Elevation

Total Loss

SF

TOTAL

1.15

27.3

23.8

0

Air System Sizing Summary for GSHP

Project Name: Marion VA Retrofit - Bldng 170

06/07/2011
05:28PM

Air System Information

Air System Name	GSHP	Number of zones	3
Equipment Class	TERM	Floor Area	5649.0 ft²
Air System Type	GSHP	Location	Lafayette, Indiana

Sizing Calculation Information

Zone and Space Sizing Method: Sum of space airflow rates
Zone CFM
Space CFM Individual peak space loads

Heating Coil Sizing Data

Max coil load	45.0 MBH	Load occurs at	Des Htg
Coil CFM at Des Htg	576 CFM	Ent. DB / Lvg DB	-5.0 / 68.9 °F
Max coil CFM	576 CFM		
Water flow @ 20.0 °F drop	N/A		

Ventilation Fan Sizing Data

Actual max CFM	576 CFM	Fan motor BHP	0.25 BHP
Standard CFM	563 CFM	Fan motor kW	0.19 kW
Actual max CFM/ft²	0.10 CFM/ft²	Fan static	1.50 in wg

Outdoor Ventilation Air Data

Design airflow CFM	576 CFM	CFM/person	52.36 CFM/person
CFM/ft²	0.10 CFM/ft²		

Zone Sizing Summary for GSHP

Project Name: Marion VA Retrofit - Bldng 170

06/07/2011
05:28PM

Air System Information

Air System Name

Equipment Class

Air System Type

GSHP

TERM

GSHP

Number of zones

Floor Area

Location

3

5649.0 ft²

Lafayette, Indiana

Sizing Calculation Information

Zone and Space Sizing Method:

Zone CFM

Space CFM

Sum of space airflow rates

Individual peak space loads

Calculation Months

Sizing Data

Jan to Dec

Calculated

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Air Flow (CFM)	Minimum Air Flow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft²)	Zone CFM/ft²
Zone 1	11.8	921	921	Aug 1400	17.4	1022.0	0.90
Zone 2	16.5	1305	1305	Jul 1400	25.0	1593.0	0.82
Zone 3	49.2	6856	6856	Jul 1400	144.9	3034.0	2.26

Terminal Unit Sizing Data - Cooling

Zone Name	Total Coil Load (MBH)	Sens Coil Load (MBH)	Coil Entering DB / WB (°F)	Coil Leaving DB / WB (°F)	Water Flow @ 10.0 °F (gpm)	Time of Peak Load
Zone 1	17.9	13.9	75.4 / 66.4	61.0 / 60.2	-	Aug 1400
Zone 2	25.8	19.7	75.3 / 66.5	61.0 / 60.2	-	Jul 1300
Zone 3	72.7	64.7	73.9 / 67.5	65.0 / 64.3	-	Jul 1400

Terminal Unit Sizing Data - Heating, Fan, Ventilation

Zone Name	Heating Coil Load (MBH)	Heating Coil Ent/Lvg DB (°F)	Htg Coil Water Flow @20.0 °F (gpm)	Fan Design Airflow (CFM)	Fan Motor (BHP)	Fan Motor (kW)	OA Vent Design Airflow (CFM)
Zone 1	16.3	69.8 / 86.6	-	921	0.268	0.200	81
Zone 2	23.5	69.8 / 86.8	-	1305	0.380	0.283	131
Zone 3	134.5	69.5 / 88.0	-	6856	1.997	1.489	364

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
Zone 1							
108	1	2.3	Aug 1400	191	4.0	162.0	1.18
109	1	1.8	Jul 1400	112	0.8	316.0	0.35
106	1	0.5	Jul 1400	33	0.2	94.0	0.35
107	1	1.7	Aug 1400	121	2.5	102.0	1.18
114	1	1.9	Sep 1400	138	2.9	120.0	1.15
111	1	1.5	Aug 1400	97	2.0	96.0	1.01
112	1	1.9	Jul 1400	180	3.8	96.0	1.88
113	1	0.4	Jul 1400	49	1.0	36.0	1.37
Zone 2							
100	1	2.0	Jul 1400	218	4.6	186.0	1.17
101	1	7.8	Jul 1400	651	13.8	653.0	1.00
102	1	0.1	Jul 1400	6	0.0	16.0	0.35
103	1	0.4	Jul 1400	27	0.2	75.0	0.35
104	1	2.2	Jul 1400	141	0.9	336.0	0.42

Zone Sizing Summary for GSHP

Project Name: Marion VA Retrofit - Bldng 170

06/07/2011
05:28PM

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
105	1	4.0	Jul 1400	262	5.5	327.0	0.80
Zone 3							
110	1	49.2	Jul 1400	6856	144.9	3034.0	2.26

Air System Design Load Summary for GSHP

Project Name: Marion VA Retrofit - Bldg 170

06/07/2011
05:28PM

ZONE LOADS	DESIGN COOLING				DESIGN HEATING			
	COOLING DATA AT Jul 1400 COOLING OA DB / WB 92.4 °F / 74.8 °F				HEATING DATA AT DES HTG HEATING OA DB / WB -5.0 °F / -6.2 °F			
	Details	Sensible (BTU/hr)	Latent (BTU/hr)		Details	Sensible (BTU/hr)	Latent (BTU/hr)	
Window & Skylight Solar Loads	36 ft²	1207	-		36 ft²	-	-	-
Wall Transmission	3811 ft²	12189	-		3811 ft²	45782	-	-
Roof Transmission	5649 ft²	15124	-		5649 ft²	14406	-	-
Window Transmission	36 ft²	351	-		36 ft²	1588	-	-
Skylight Transmission	0 ft²	0	-		0 ft²	0	-	-
Door Loads	834 ft²	7272	-		834 ft²	30183	-	-
Floor Transmission	2615 ft²	0	-		2615 ft²	4623	-	-
Partitions	0 ft²	0	-		0 ft²	0	-	-
Ceiling	0 ft²	0	-		0 ft²	0	-	-
Overhead Lighting	5911 W	15632	-		0	0	-	-
Task Lighting	0 W	0	-		0	0	-	-
Electric Equipment	0 W	0	-		0	0	-	-
People	11	1923	2255		0	0	0	0
Infiltration	-	19137	7677		-	90703	0	0
Miscellaneous	-	4500	0		-	0	0	0
Safety Factor	0% / 0%	0	0		0%	0	0	0
>> Total Zone Loads	-	77334	9932		-	187285	0	0
Zone Conditioning	-	78750	9932		-	181722	0	0
Plenum Wall Load	0%	0	-		0	0	-	-
Plenum Roof Load	0%	0	-		0	0	-	-
Plenum Lighting Load	0%	0	-		0	0	-	-
Exhaust Fan Load	576 CFM	0	-		576 CFM	0	-	-
Ventilation Load	576 CFM	12194	5945		576 CFM	44919	0	0
Ventilation Fan Load	576 CFM	640	-		576 CFM	-640	-	-
Space Fan Coil Fans	-	6732	-		-	-6732	-	-
Duct Heat Gain / Loss	0%	0	-		0%	0	-	-
>> Total System Loads	-	98317	15877		-	219269	0	0
Heating Coil	-	0	-		-	45000	-	-
Terminal Unit Cooling	-	98317	17887		-	0	0	0
Terminal Unit Heating	-	0	-		-	174269	-	-
>> Total Conditioning	-	98317	17887		-	219269	0	0
Key:	Positive values are clg loads Negative values are htg loads				Positive values are htg loads Negative values are clg loads			

Ground Loop Design

Borehole Design Project Report - 6/7/2011



Project Name: Marion VA Geothermal Retrofit Bldg 170	
Designer Name:	
Date: 6/7/2011	Project Start Date: 2/22/2011
Client Name:	
Address Line 1:	
Address Line 2:	
City:	Phone:
State:	Fax:
Zip:	Email:

Calculation Results

Design Method:	Design Day	COOLING	HEATING
Total Length (ft):		1875.2	2930.6
Borehole Number:		15	15
Borehole Length (ft):		125.0	195.4
Ground Temperature Change (°F):		-3.3	-2.1
Unit Inlet (°F):		90.0	30.0
Unit Outlet (°F):		100.2	24.4
Total Unit Capacity (kBtu/Hr):		241.9	188.3
Peak Load (kBtu/Hr):		142.0	179.0
Peak Demand (kW):		11.3	15.8
Heat Pump EER/COP:		12.5	3.3
System EER/COP:		12.5	3.3
System Flow Rate (gpm):		35.5	44.8

Input Parameters

Fluid		Soil	
Flow Rate	3.0 gpm/ton	Ground Temperature:	54.6 °F
Fluid:	25% Propylene Glycol	Thermal Conductivity:	1.48 Btu/(h*ft*°F)
Specific Heat (Cp):	1.00 Btu/(°F*lbm)	Thermal Diffusivity:	1.03 ft^2/day
Density (rho):	62.4 lb/ft^3		
Piping			
Pipe Type:	3/4 in. (20 mm)		
Flow Type:	Turbulent - SDR11		
Pipe Resistance:	0.104 h*ft*°F/Btu		
U-Tube Configuration:	Single		
Radial Pipe Placement:	Average		
Borehole Diameter:	5.00 in		
Grout Thermal Conductivity:	0.88 Btu/(h*ft*°F)		
Borehole Thermal Resistance:	0.271 h*ft*°F/Btu		

Input Parameters (Cont.)

Pattern	Modeling Time Period
Vertical Grid Arrangement: 3 x 5	Prediction Time: 10.0 years
Borehole Number: 15	Long Term Soil Temperatures:
Borehole Separation: 20.0 ft	<i>Cooling:</i> 51.3 °F
Boreholes per Parallel Circuit: 1	<i>Heating:</i> 52.5 °F
Fixed Length Mode: Off	
Grid File: None	
File:	
Default Heat Pumps	Optional Boiler/Cooling Tower
Manufacturer: ClimateMaster	Tower Boiler
Series: TS Tranquility 20th SS ECM	Load Balance 0 % 0 %
Design Heat Pump Inlet Load Temperatures:	Capacity (kBtu/Hr) 0.0 0.0
<i>Cooling (WB)</i> <i>Heating (DB)</i>	Cooling Tower Flow Rate (gpm): 0.0
Water to Air: 67 °F 70 °F	Cooling Range (°F): 11.3
Water to Water: 55 °F 100 °F	Annual Operating Hours (hr/yr): 0
Extra kW	Loads File
Pump Power 0.0 kW	<i>s\Engineering\Mechanical\Bldng 170 loads.zon</i>
Cooling Tower Pump: 0.0 kW	
Cooling Tower Fan: 0.0 kW	
Additional Power 0.0 kW	
Loads	
Design Day Loads	
<i>Time of Day</i>	<i>Heat Gains (kBtu/Hr)</i>
<i>Heat Losses (kBtu/Hr)</i>	Annual Equivalent Full-Load Hours
8 a.m. - Noon	9.7 179.0
Noon - 4 p.m.	142.0 82.3
4 p.m. - 8 p.m.	9.7 82.3
8 p.m. - 8 a.m.	9.7 82.3
	COOLING 527 HEATING 1883
	Days Occupied per Week: 7.0
Monthly Loads on Next Page	

Monthly Loads Data							
	Cooling				Heating		
	Total	(kBtu)	Peak	(kBtu/hr)	Total	(kBtu)	Peak (kBtu/hr)
January	0		0		73243		179
February	0		0		62525		155
March	148		9		43480		132
April	739		29		24676		117
May	6095		73		7320		61
June	15188		98		1061		27
July	23601		142		109		14
August	18944		130		512		27
September	8133		108		6741		63
October	1843		40		20312		88
November	64		2		39488		108
December	10		2		57563		134
Total	74765				337030		
Hours at Peak			3.0				3.0

Hourly Loads Data

Included: None

Filename: None

Piping Loop Head Loss Calculator - System Designer for HVAC Systems

Input

Optional Input

Output

Marion VA Geothermal Retrofit - Building 170

Liquid	30% Prop Glycol
Temp	40 °F
Den	64.67 lbm/ft ³
Vis	3.97E-03 lbm/ft-s
	5.91 cps

Coils	Flow gpm	Rated Flow gpm	Rated Δh @ 60°F ft. water	Inlet Size inches	Inlet Vel fps	Re(in)	Rated Vel fps	Re(rated)	Δh Ft. Liquid
Ht. Pump	0	12	12	1	0.0	0	#####	#DIV/0!	0.0
	0	0	0	0	0.0	0	0.0	0	0.0
	0	0	0	0	0.0	0	0.0	0	0.0
Coil sub-total									0.0

Flow gpm	Nom. Dia. Inches	DR OD ÷ t	I.D. in.	Roughness (for HDPE in ft.)	Vel fps	Re	Δh(ft) 100 ft.	Length ft.	Fitting Selector	Leqv ft	Qty.	Fitting Selector	Leqv ft	Qty.	Fitting Selector	Leqv ft	Qty.	Δh Ft. Liquid
22.2	2	11	1.94	0.00007	2.4	6334	1.99	80	ButtTeeRun	4	1	Butt90	17	1	5-LoopHdrLastT	30	0	2.0
17.7	2	11	1.94	0.00007	1.9	5050	1.35	20	ButtTeeRun	4	1	ButtRed	7	1	5-LoopHdrLastT	30	0	0.4
13.3	1.5	11	1.55	0.00007	2.2	4743	2.38	20	ButtTeeRun	3	1	ButtRed	6	1	5-LoopHdrLastT	30	0	0.7
8.9	1.25	11	1.36	0.00007	2.0	3633	2.27	20	ButtTeeRun	3	1	ButtRed	5	1	Butt90	10	0	0.6
4.4	0.75	11	0.86	0.00007	2.4	2840	5.44	270	Butt90	5	2	UniCoil	8	1	5-LoopHdrLastT	30	0	15.7
22.2	2	11	1.94	0.00007	2.4	6334	1.99	80	ButtTeeBr	16	1	Butt90	17	3	5-LoopHdrLastT	30	0	2.9
0	1	11	1.08	0.00007	0.0	0	0.00	0	ButtTeeRun	3	0	Butt90	8	0	5-LoopHdrLastT	30	0	0.0
HDPE sub-total																		22.4

Flow gpm	Nom. Dia. Inches	Schedule 40 or 80	I.D. in.	Pipe Mat'l for Rghness in ft.	Vel fps	Re	Δh(ft) 100 ft.	Length ft.	Fitting Selector	Leqv ft	Qty.	Fitting Selector	Leqv ft	Qty.	Fitting Selector	Leqv ft	Qty.	Δh Ft. Liquid
0	4	40	4.03	GalvSteel-New	0.0	0	0.00	0	90 L	5.7	2	45 L	4.0	0	T-Branch	45.6	0	0.0
0	4	40	4.03	Steel-New	0.0	0	0.00	0	90 L	5.7	2	Reducer	2.3	0	90 L	5.7	0	0.0
0	4	40	4.03	PVC	0.0	0	0.00	0	T-Straight	6.8	2	Reducer	2.3	0	90 L	5.7	0	0.0
0	3	40	3.07	PVC	0.0	0	0.00	0	T-Straight	5.4	2	Reducer	1.8	0	90 L	4.5	0	0.0
0	3	40	3.07	PVC	0.0	0	0.00	0	T-Straight	5.4	2	Reducer	1.8	0	90 L	4.5	0	0.0
0	3	40	3.07	PVC	0.0	0	0.00	0	T-Straight	5.4	2	Reducer	1.8	0	90 L	4.5	0	0.0
Fe/Br sub-total																		0.0

Other Fittings & Valves	Flow gpm	Cv @ 60°F gpm	Quantity	Inlet Size inches	Inlet Vel fps	Re(in)	Rated Vel fps	Re(rated)	Δh Ft. Liquid
ball valve	0	23	2	1	0.0	0	#####	#DIV/0!	0.0
	0	0	0	2	0.0	0	0.0	0	0.0
	0	0	0	2	0.0	0	0.0	0	0.0
Fitting sub-total									0.0

Open Systems Only ►►

Elevation

Total Loss

SF

TOTAL

22.4
1.15
25.8

Air System Sizing Summary for GSHP

Project Name: Marion VA Retrofit - Bldng 173

06/07/2011
05:29PM

Air System Information

Air System Name	GSHP	Number of zones	2
Equipment Class	TERM	Floor Area	2137.0 ft²
Air System Type	GSHP	Location	Lafayette, Indiana

Sizing Calculation Information

Zone and Space Sizing Method: Sum of space airflow rates
Zone CFM
Space CFM Individual peak space loads

Heating Coil Sizing Data

Max coil load	15.6 MBH	Load occurs at	Des Htg
Coil CFM at Des Htg	200 CFM	Ent. DB / Lvg DB	-5.0 / 68.9 °F
Max coil CFM	200 CFM		
Water flow @ 20.0 °F drop	N/A		

Ventilation Fan Sizing Data

Actual max CFM	200 CFM	Fan motor BHP	0.09 BHP
Standard CFM	195 CFM	Fan motor kW	0.07 kW
Actual max CFM/ft²	0.09 CFM/ft²	Fan static	1.50 in wg

Outdoor Ventilation Air Data

Design airflow CFM	200 CFM	CFM/person	24.95 CFM/person
CFM/ft²	0.09 CFM/ft²		

Zone Sizing Summary for GSHP

Project Name: Marion VA Retrofit - Bldng 173

06/07/2011
05:29PM

Air System Information

Air System Name GSHP
Equipment Class TERM
Air System Type GSHP
Number of zones 2
Floor Area 2137.0 ft²
Location Lafayette, Indiana

Sizing Calculation Information

Zone and Space Sizing Method:

Zone CFM Sum of space airflow rates
Space CFM Individual peak space loads

Calculation Months Jan to Dec
Sizing Data Calculated

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Air Flow (CFM)	Minimum Air Flow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft ²)	Zone CFM/ft ²
Zone 1	28.7	1854	1854	Aug 1400	33.3	1281.0	1.45
Zone 2	16.9	1260	1260	Jul 1400	23.1	856.0	1.47

Terminal Unit Sizing Data - Cooling

Zone Name	Total Coil Load (MBH)	Sens Coil Load (MBH)	Coil Entering DB / WB (°F)	Coil Leaving DB / WB (°F)	Water Flow @ 10.0 °F (gpm)	Time of Peak Load
Zone 1	36.5	31.8	75.1 / 64.4	58.9 / 57.9	-	Jul 1400
Zone 2	21.2	18.6	74.9 / 65.4	60.9 / 60.0	-	Aug 1400

Terminal Unit Sizing Data - Heating, Fan, Ventilation

Zone Name	Heating Coil Load (MBH)	Heating Coil Ent/Lvg DB (°F)	Htg Coil Water Flow @20.0 °F (gpm)	Fan Design Airflow (CFM)	Fan Motor (BHP)	Fan Motor (kW)	OA Vent Design Airflow (CFM)
Zone 1	31.3	69.8 / 85.8	-	1854	0.540	0.403	122
Zone 2	22.3	70.1 / 86.9	-	1260	0.367	0.274	78

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft ²)	Space CFM/ft ²
Zone 1							
100	1	1.1	Aug 1400	115	2.4	42.0	2.73
101	1	27.6	Aug 1400	1739	30.9	1239.0	1.40
Zone 2							
102	1	1.4	Jul 1400	120	2.5	176.0	0.68
103	1	1.2	Aug 1400	115	2.4	42.0	2.73
104	1	1.8	Jul 1000	113	1.7	42.0	2.68
105	1	2.1	Jul 1000	131	2.1	51.0	2.56
106	1	4.6	Jul 1700	287	4.0	189.0	1.52
107	1	6.9	Jul 1400	495	10.5	356.0	1.39

Air System Design Load Summary for GSHP

Project Name: Marion VA Retrofit - Bldg 173

06/07/2011
05:29PM

ZONE LOADS	DESIGN COOLING				DESIGN HEATING			
	COOLING DATA AT Jul 1400 COOLING OA DB / WB 92.4 °F / 74.8 °F				HEATING DATA AT DES HTG HEATING OA DB / WB -5.0 °F / -6.2 °F			
	Details	Sensible (BTU/hr)	Latent (BTU/hr)		Details	Sensible (BTU/hr)	Latent (BTU/hr)	
Window & Skylight Solar Loads	294 ft²	13495	-		294 ft²	-	-	-
Wall Transmission	2038 ft²	9207	-		2038 ft²	17937	-	-
Roof Transmission	2137 ft²	5721	-		2137 ft²	5450	-	-
Window Transmission	294 ft²	2864	-		294 ft²	12955	-	-
Skylight Transmission	0 ft²	0	-		0 ft²	0	-	-
Door Loads	84 ft²	418	-		84 ft²	1890	-	-
Floor Transmission	1948 ft²	0	-		1948 ft²	5552	-	-
Partitions	0 ft²	0	-		0 ft²	0	-	-
Ceiling	0 ft²	0	-		0 ft²	0	-	-
Overhead Lighting	2351 W	6264	-		0	0	-	-
Task Lighting	0 W	0	-		0	0	-	-
Electric Equipment	0 W	0	-		0	0	-	-
People	8	1396	1640		0	0	0	0
Infiltration	-	2070	1839		-	12700	0	0
Miscellaneous	-	4000	0		-	0	0	0
Safety Factor	0% / 0%	0	0		0%	0	0	0
>> Total Zone Loads	-	45435	3479		-	56484	0	0
Zone Conditioning	-	43783	3479		-	56123	0	0
Plenum Wall Load	0%	0	-		0	0	-	-
Plenum Roof Load	0%	0	-		0	0	-	-
Plenum Lighting Load	0%	0	-		0	0	-	-
Exhaust Fan Load	200 CFM	0	-		200 CFM	0	-	-
Ventilation Load	200 CFM	4067	3827		200 CFM	15643	0	0
Ventilation Fan Load	200 CFM	222	-		200 CFM	-222	-	-
Space Fan Coil Fans	-	2309	-		-	-2309	-	-
Duct Heat Gain / Loss	0%	0	-		0%	0	-	-
>> Total System Loads	-	50380	7306		-	69236	0	0
Heating Coil	-	0	-		-	15593	-	-
Terminal Unit Cooling	-	50380	7290		-	0	0	0
Terminal Unit Heating	-	0	-		-	53643	-	-
>> Total Conditioning	-	50380	7290		-	69236	0	0
Key:	Positive values are clg loads Negative values are htg loads				Positive values are htg loads Negative values are clg loads			

Ground Loop Design

Borehole Design Project Report - 6/7/2011



Project Name: Marion VA Geothermal Retrofit Bldg 173	
Designer Name:	
Date: 6/7/2011	Project Start Date: 2/22/2011
Client Name:	
Address Line 1:	
Address Line 2:	
City:	Phone:
State:	Fax:
Zip:	Email:

Calculation Results

Design Method:	Design Day	COOLING	HEATING
Total Length (ft):		1102.3	661.4
Borehole Number:		6	6
Borehole Length (ft):		183.7	110.2
Ground Temperature Change (°F):		+0.7	+1.2
Unit Inlet (°F):		90.0	30.0
Unit Outlet (°F):		100.3	24.5
Total Unit Capacity (kBtu/Hr):		67.0	54.8
Peak Load (kBtu/Hr):		67.0	53.0
Peak Demand (kW):		5.7	4.8
Heat Pump EER/COP:		11.8	3.2
System EER/COP:		11.8	3.2
System Flow Rate (gpm):		16.8	13.3

Input Parameters

Fluid		Soil	
Flow Rate	3.0 gpm/ton	Ground Temperature:	54.6 °F
Fluid:	25% Propylene Glycol	Thermal Conductivity:	1.48 Btu/(h*ft*°F)
Specific Heat (Cp):	1.00 Btu/(°F*lbm)	Thermal Diffusivity:	1.03 ft^2/day
Density (rho):	62.4 lb/ft^3		
Piping			
Pipe Type:	3/4 in. (20 mm)		
Flow Type:	Turbulent - SDR11		
Pipe Resistance:	0.104 h*ft*°F/Btu		
U-Tube Configuration:	Single		
Radial Pipe Placement:	Average		
Borehole Diameter:	5.00 in		
Grout Thermal Conductivity:	0.88 Btu/(h*ft*°F)		
Borehole Thermal Resistance:	0.271 h*ft*°F/Btu		

Input Parameters (Cont.)

Pattern		Modeling Time Period	
Vertical Grid Arrangement:	3 x 2	Prediction Time:	10.0 years
Borehole Number:	6	Long Term Soil Temperatures:	
Borehole Separation:	20.0 ft		<i>Cooling:</i> 55.3 °F
Boreholes per Parallel Circuit:	1		<i>Heating:</i> 55.8 °F
Fixed Length Mode	Off		
Grid File	None		
File:			
Default Heat Pumps		Optional Boiler/Cooling Tower	
Manufacturer:	ClimateMaster		Tower Boiler
Series:	TS Tranquility 20th SS ECM	Load Balance	0 % 0 %
Design Heat Pump Inlet Load Temperatures:		Capacity (kBtu/Hr)	0.0 0.0
	<i>Cooling (WB) Heating (DB)</i>	Cooling Tower Flow Rate (gpm):	0.0
Water to Air:	67 °F 70 °F	Cooling Range (°F):	10.3
Water to Water:	55 °F 100 °F	Annual Operating Hours (hr/yr):	0
Extra kW		Loads File	
Pump Power	0.0 kW	<i>s\Engineering\Mechanical\Bldng 173 loads.zon</i>	
Cooling Tower Pump:	0.0 kW		
Cooling Tower Fan:	0.0 kW		
Additional Power	0.0 kW		
Loads			
Design Day Loads			Annual Equivalent Full-Load Hours <i>COOLING</i> 899 <i>HEATING</i> 1333
<i>Time of Day</i>	<i>Heat Gains (kBtu/Hr)</i>	<i>Heat Losses (kBtu/Hr)</i>	
8 a.m. - Noon	11.4	53.0	Days Occupied per Week: 7.0
Noon - 4 p.m.	67.0	19.0	
4 p.m. - 8 p.m.	11.4	19.0	
8 p.m. - 8 a.m.	11.4	19.0	
Monthly Loads on Next Page			

Monthly Loads Data							
	Cooling				Heating		
	Total	(kBtu)	Peak	(kBtu/hr)	Total	(kBtu)	Peak (kBtu/hr)
January		2		1	18341		53
February		13		2	14691		45
March		542		19	8137		37
April		1994		34	3051		32
May		7345		47	262		13
June		12268		57	0		0
July		15396		67	0		0
August		13112		60	0		0
September		7076		52	450		14
October		2295		34	2899		25
November		148		7	8623		31
December		35		5	14173		42
Total		60226			70627		
Hours at Peak				3.0			3.0

Hourly Loads Data

Included: None

Filename: None

Piping Loop Head Loss Calculator - System Designer for HVAC Systems

Input

Optional Input

Output

Marion VA Geothermal Retrofit - Building 173

Liquid	30% Prop Glycol
Temp	40 °F
Den	64.67 lbm/ft3
Vis	3.97E-03 lbm/ft-s 5.91 cps

Coils	Flow gpm	Rated Flow gpm	Rated Δh @ 60°F ft. water	Inlet Size inches	Inlet Vel fps	Re(in)	Rated Vel fps	Re(rated)	Δh Ft. Liquid
Ht. Pump	0	12	12	1	0.0	0	####	#DIV/0!	0.0
	0	0	0	0	0.0	0	0.0	0	0.0
	0	0	0	0	0.0	0	0.0	0	0.0
Coil sub-total									0.0

HDPE Piping															Coil sub-total					0.0
Flow gpm	Nom. Dia. Inches	DR OD ÷ t	I.D. in.	Roughness (for HDPE in ft.)	Vel fps	Re	Δ h(ft) 100 ft.	Length ft.	Fitting Selector	Leqv ft	Qty.	Fitting Selector	Leqv ft	Qty.	Fitting Selector	Leqv ft	Qty.	Δ h Ft. Liquid		
13.3	1.5	11	1.55	0.00007	2.2	4743	2.38	190	ButtTeeRun	3	1	Butt90	12	2	ButtRed	6	1	5.3		
8.9	1.25	11	1.36	0.00007	2.0	3633	2.27	20	ButtTeeRun	3	1	ButtRed	5	1	5-LoopHdrLastT	30	0	0.6		
4.4	0.75	11	0.86	0.00007	2.4	2840	5.44	387	Butt90	5	2	UniCoil	8	1	5-LoopHdrLastT	30	0	22.1		
13.3	1.5	11	1.55	0.00007	2.2	4743	2.38	190	ButtTeeBr	12	1	Butt90	12	3	Butt90	12	0	5.7		
0	1	11	1.08	0.00007	0.0	0	0.00	0	ButtTeeRun	3	0	Butt90	8	0	5-LoopHdrLastT	30	0	0.0		
HDPE sub-total									33.7											

Steel/Brass																	HDPE sub-total					33.7
Flow gpm	Nom. Dia. Inches	Schedule 40 or 80	I.D. in.	Pipe Mat'l for Rghness in ft.	Vel fps	Re	Δ h(ft) 100 ft.	Length ft.	Fitting Selector	Leqv ft	Qty.	Fitting Selector	Leqv ft	Qty.	Fitting Selector	Leqv ft	Qty.	Δ h Ft. Liquid				
0	4	40	4.03	GalvSteel-New	0.0	0	0.00	0	90 L	5.7	2	45 L	4.0	0	T-Branch	45.6	0	0.0				
0	4	40	4.03	Steel-New	0.0	0	0.00	0	90 L	5.7	2	Reducer	2.3	0	90 L	5.7	0	0.0				
0	4	40	4.03	PVC	0.0	0	0.00	0	T-Straight	6.8	2	Reducer	2.3	0	90 L	5.7	0	0.0				
0	3	40	3.07	PVC	0.0	0	0.00	0	T-Straight	5.4	2	Reducer	1.8	0	90 L	4.5	0	0.0				
0	3	40	3.07	PVC	0.0	0	0.00	0	T-Straight	5.4	2	Reducer	1.8	0	90 L	4.5	0	0.0				
0	3	40	3.07	PVC	0.0	0	0.00	0	T-Straight	5.4	2	Reducer	1.8	0	90 L	4.5	0	0.0				
Fe/Br sub-total									0.0													

Other Fittings & Valves	Flow gpm	Cv @ 60°F gpm	Quantity	Inlet Size inches	Inlet Vel fps	Re(in)	Rated Vel fps	Re(rated)	Δh Ft. Liquid
ball valve	0	23	2	1	0.0	0	####	#DIV/0!	0.0
	0	0	0	2	0.0	0	0.0	0	0.0
	0	0	0	2	0.0	0	0.0	0	0.0
Fitting sub-total									0.0

Open Systems Only

►►

Elevation

Total Loss

SF

TOTAL

1.15

38.8