Appendices

Included in this section are

Appendix A
Building Overview

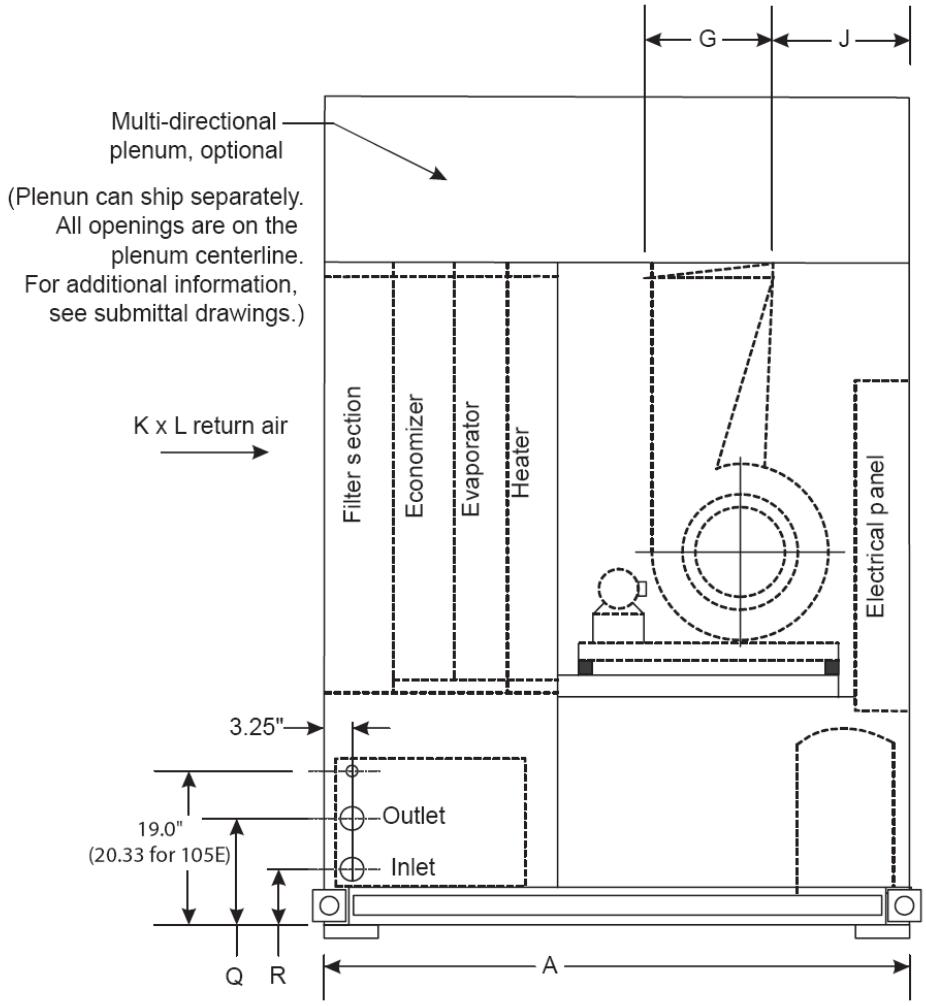
Appendix B
Alternative Mechanical Designs

Appendix C
Integration of Structural System and Constructability

Appendix A—Building Overview

1. McQuay Self-Contained Packaged DX Air Handling Unit with Economizer Coil.
2. Sample Space and Coil Loads for Space FL-1 NE System 1—VAV-DX/Electric.

1. McQuay Self-Contained Packaged DX Air Handling Unit with Economizer Coil.



Appendix 2. Sample Space and Coil Loads for Space FL-1 NE System 1—VAV-DX/Electric.

The internal loads of the heating coil show a positive value which means the space needs cooling even in the winter. The envelope heating loads are negative which means the parallel fan powered box will be activated to supply warm are to that space.

Room Checksums
By ae

FL-1 NE

COOLING COIL PEAK

Peaked at Time: Mo/Hr: 7 / 15
Outside Air: OADB/WB/HR: 90 / 74 / 101

	Space Sens. + Lat. Btu/h	Plenum Sens. + Lat Btu/h	Net Total Btu/h	Percent Of Total (%)
Envelope Loads				
Skylite Solar	0	0	0	0.00
Skylite Cond	0	0	0	0.00
Roof Cond	0	0	0	0.00
Glass Solar	54,721	0	54,721	6.82
Glass Cond	9,345	0	9,345	1.16
Wall Cond	17,872	0	17,872	2.23
Partition	0		0	0.00
Exposed Floor	0		0	0.00
Infiltration	0		0	0.00
Sub Total ==>	81,938	0	81,938	10.21
Internal Loads				
Lights	511,950	0	511,950	63.80
People	45,000		45,000	5.61
Misc	0	0	0	0.00
Sub Total ==>	556,950	0	556,950	69.40
Ceiling Load	0	0	0	0.00
Ventilation Load	0	0	123,211	15.35
Ov/Undr Sizing	0		0	0.00
Exhaust Heat		-741	-741	-0.09
Sup. Fan Heat			32,889	4.10
Ret. Fan Heat		8,222	8,222	1.02
Duct Heat Pkup		0	0	0.00
Reheat at Design			0	0.00
Grand Total ==>	638,888	7,481	802,469	100.00

CLG SPACE PEAK

Mo/Hr: 7 / 11
OADB: 83

	Space Sensible Btu/h	Percent Of Total (%)
Envelope Loads		
Skylite Solar	0	0.00
Skylite Cond	0	0.00
Roof Cond	0	0.00
Glass Solar	76,050	12.11
Glass Cond	4,623	0.74
Wall Cond	10,426	1.66
Partition	0	0.00
Exposed Floor	0	0.00
Infiltration	0	0.00
Sub Total ==>	91,100	14.51
Internal Loads		
Lights	511,950	81.51
People	25,000	3.98
Misc	0	0.00
Sub Total ==>	536,950	85.49
Ceiling Load	0	0.00
Ventilation Load	0	0.00
Ov/Undr Sizing	0	0.00
Grand Total ==>	628,050	100.00

HEATING COIL PEAK

Mo/Hr: 13 / 1
OADB: 14

	Space Peak Space Sens Btu/h	Coil Peak Tot Sens Btu/h	Percent Of Total (%)
Envelope Loads			
Skylite Solar	0	0	0.00
Skylite Cond	0	0	0.00
Roof Cond	0	0	0.00
Glass Solar	0	0	0.00
Glass Cond	-42,110	-42,110	22.04
Wall Cond	-37,648	-37,648	19.70
Partition	0	0	0.00
Exposed Floor	0	0	0.00
Infiltration	0	0	0.00
Sub Total ==>	-79,758	-79,758	41.74
Internal Loads			
Lights	511,950	511,950	-267.91
People	25,000	25,000	-13.08
Misc	0	0	0.00
Sub Total ==>	536,950	536,950	-280.99
Ceiling Load	0	0	0.00
Ventilation Load	0	0	0.00
Ov/Undr Sizing	-536,950	-536,950	280.99
Exhaust Heat		0	0.00
OA Preheat Diff.		-111,336	58.26
RA Preheat Diff.		0	0.00
Additional Reheat		0	0.00
System Plenum Heat		0	0.00
Grand Total ==>	-79,758	-191,094	100.00

TEMPERATURES

	Cooling	Heating
SADB	55.0	70.0
Plenum	75.0	70.0
Return	75.3	70.0
Ret/OA	76.6	14.0
Fn MtrTD	0.1	0.0
Fn BldTD	0.2	0.0
Fn Frict	0.7	0.1

AIRFLOWS

	Cooling	Heating
Vent	2,500	0
Infil	0	0
Supply	28,161	0
MinStop/Rh	0	0
Return	28,161	0
Exhaust	2,500	0
Rm Exh	0	0
Auxil	0	0

ENGINEERING CKS

	Cooling	Heating
% OA	8.9	
cfm/ft²	1.13	0.00
cfm/ton	421.11	
ft²/ton	373.85	
Btu/hr·ft²	32.10	-4.45
No. People	100	

COOLING COIL SELECTION

	Total Capacity ton	Total Capacity MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB °F	Enter WB °F	Enter HR gr/lb	Leave DB °F	Leave WB °F	Leave HR gr/lb
Main Clg	66.9	802.5	701.1	27,750	76.6	61.7	58.5	53.9	51.6	53.3
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	66.9	802.5								

AREAS

	Gross Total ft²	Glass ft²	Glass (%)
Floor	25,000		
Part	0		
ExFlr	0		
Roof	0	0	0
Wall	5,968	1,442	24

HEATING COIL SELECTION

	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Main Htg	0.0	0	0.0	0.0
Aux Htg	-79.8	0	0.0	0.0
Preheat	-111.3	2,500	14.0	53.9
Reheat	0.0	0	0.0	0.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-191.1			

Appendix B—Alternative Mechanical Designs

1. DOAS Analysis.
2. Supply Air Requirements for VAV System.
3. Mixed Air Conditions.
4. McQuay Air Handling Unit Example Selection Procedure.
5. Mixed Air Dry and Wet Bulb Temperatures.
6. SEMCO Air Handling Unit Example Selection Procedure.
7. Radiant Panel Optimization.
8. System Calcs.
9. Energy Consumption per System.
10. Energy Rates.
11. Yearly Operating Cost.
12. Emissions Generated per System.
13. Floor 4 Systems Analysis Energy Consumption Results.
14. Chilled Water Distribution Schematic—DOAS/Radiant, System 5.

1. DOAS Analysis.

The following figures and tables show the difference in required cooling capacity for the three difference configurations of a DOAS air handling unit.

1. With Enthalpy Wheel and Sensible Wheel.
2. With Enthalpy Wheel.
3. Without Heat Recovery.

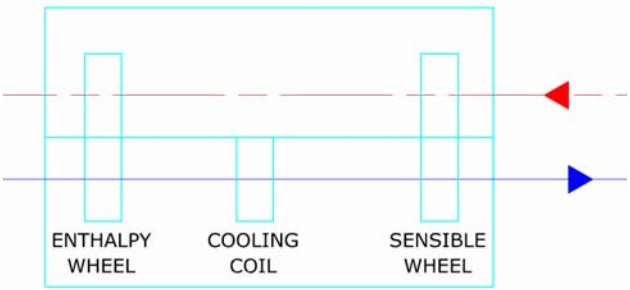


Figure D1. DOAS AHU with Enthalpy Wheel and Sensible Wheel.

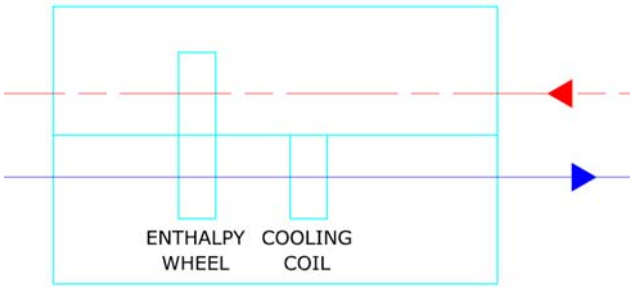


Figure D2. DOAS AHU with Enthalpy Wheel.

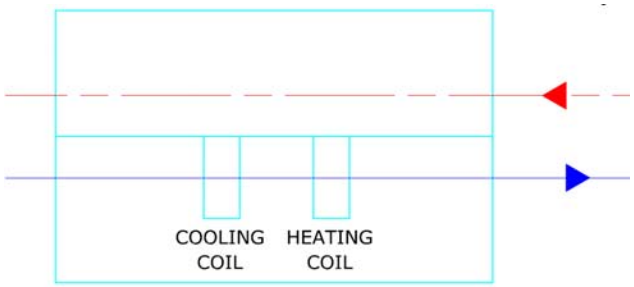


Figure D3. DOAS AHU without Heat Recovery.

With Enthalpy Wheel and Sensible Wheel.

Enthalpy Wheel and Sensible Wheel										
		FL-1 NE	FL-1 NW	FL-1 SE	FL-1 SW	FL-1 T	FL-2 NE	FL-2 NW	FL-2 SE	FL-2 SW
Room Properties	Area [SF]	25000	25000	24000	24000	27500	29000	29000	29000	29000
	Floor to Ceiling Height [FT]	12.5	12.5	12.5	12.5	29	13.5	13.5	13.5	13.5
	Plenum Depth [FT]	3	3	3	3	3	3	3	3	3
	Floor to Floor Height [FT]	15.5	15.5	15.5	15.5	32	16.5	16.5	16.5	16.5
	Volume [CF]	312500	312500	300000	300000	797500	391500	391500	391500	391500
	Occupancy	100	100	100	100	100	100	100	100	100
Ventilation Air Requirement to Satisfy Standard 62.1		2500	2500	2500	2500	2500	2800	2800	2800	2800
Latent Load Satisfied by Standard 62.1 Vent. Requirement		34000	34000	34000	34000	34000	38080	38080	38080	38080
Supply Air Required to Satisfy Latent Load at 44F/Saturated		1471	1471	1471	1471	1471	1471	1471	1471	1471
Room Loads	Q_SEN [btu/hr]	628050	590601	617350	535906	659122	701334	679160	705800	699202
	Q_LAT [btu/hr]	20000	20000	20000	20000	20000	20000	20000	20000	20000
Required Outdoor Air Quantity	[cfm]	2500	2500	2500	2500	2500	2800	2800	2800	2800
Enthalpy Wheel Charac.	ES	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
	EL	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Sensible Wheel Charc.	ES	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
A - OA Outdoor Air entering enthalpy wheel	DBT [F]	92	92	92	92	92	92	92	92	92
	WBT [F]	75	75	75	75	75	75	75	75	75
	% RH	47	47	47	47	47	47	47	47	47
	W [g/lb]	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5
	h [Btu/lb]	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4
B - OA-EW Outdoor Air leaving enthalpy wheel entering cooling coil	DBT [F]	68.4	68.4	68.4	68.4	68.4	68.4	68.4	68.4	68.4
	% RH	60	52	52	52	52	52	52	52	52
	W [g/lb]	72.7	72.7	72.7	72.7	72.7	72.7	72.7	72.7	72.7
	h [Btu/lb]	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2
C - OA-SW Outdoor Air leaving cooling coil entering sensible wheel	DBT [F]	45	45	45	45	45	45	45	45	45
	% RH	100	100	100	100	100	100	100	100	100
	W [g/lb]	44.0	44.0	44.0	44.0	44.0	44.0	44.0	44.0	44.0
	W [lbm/lba]	0.00629	0.00629	0.00629	0.00629	0.00629	0.00629	0.00629	0.00629	0.00629
	DPT [F]	45	45	45	45	45	45	45	45	45
	h [Btu/lb]	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6
D - SA Supply Air leaving sensible wheel entering room	DBT [F]	55	55	55	55	55	55	55	55	55
	% RH	52	52	52	52	52	52	52	52	52
	W [g/lb]	44.0	44.0	44.0	44.0	44.0	44.0	44.0	44.0	44.0
	h [Btu/lb]	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2
	rho [lb/cf]	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073
E - RA Exhaust Air leaving room entering sensible wheel	DBT [F]	75	75	75	75	75	75	75	75	75
	WBT [F]	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4
	DPT [F]	55	55	55	55	55	55	55	55	55
	% RH	50	50	50	50	50	50	50	50	50
	W [g/lb]	64	64	64	64	64	64	64	64	64
	ΔW = Wroom - Wsa	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
	h [Btu/lb]	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2
F - EA Exhaust Air leaving sensible wheel	DBT [F]	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5
	% RH	100	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5
	W [g/lb]	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0
	h [Btu/lb]	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6
DOAS										
Cooling Coil Loads	Sensible Load [Btu/hr]	63180	63180	63180	63180	63180	70762	70762	70762	70762
	Latent Load [Btu/hr]	48790	48790	48790	48790	48790	54645	54645	54645	54645
	Total Load [Btu/hr]	111970	111970	111970	111970	111970	125406	125406	125406	125406
	Total Load [tons]	9.33	9.33	9.33	9.33	9.33	10.45	10.45	10.45	10.45
SA Cooling Capacity	[Btu/hr]	54000	54000	54000	54000	54000	60480	60480	60480	60480
North SA	[cfm]	2500	2500				2800	2800		
South SA	[cfm]			2500	2500	2500			2800	2800
Parallel System										
Total Load	[Btu/hr]	574050	536601	563350	481906	605122	640854	618680	645320	638722
	[tons]	47.84	44.72	46.95	40.16	50.43	53.40	51.56	53.78	53.23
Total Chiller Size	[tons]	57.17	54.05	56.28	49.49	59.76	63.86	62.01	64.23	63.68

With Enthalpy Wheel.

		Enthalpy Wheel Only								
		FL-1 NE	FL-1 NW	FL-1 SE	FL-1 SW	FL-1 T	FL-2 NE	FL-2 NW	FL-2 SE	FL-2 SW
Room Properties	Area [SF]	25000	25000	24000	24000	27500	29000	29000	29000	29000
	Floor to Ceiling Height [FT]	12.5	12.5	12.5	12.5	29	13.5	13.5	13.5	13.5
	Plenum Depth [FT]	3	3	3	3	3	3	3	3	3
	Floor to Floor Height [FT]	15.5	15.5	15.5	15.5	32	16.5	16.5	16.5	16.5
	Volume [CF]	312500	312500	300000	300000	797500	391500	391500	391500	391500
	Occupancy	100	100	100	100	100	100	100	100	100
Ventilation Air Requirement to Satisfy Standard 62.1		2500	2500	2500	2500	2500	2800	2800	2800	2800
Latent Load Satisfied by Standard 62.1 Vent. Requirement		34000	34000	34000	34000	34000	38080	38080	38080	38080
Supply Air Required to Satisfy Latent Load at 44F/Saturated		1471	1471	1471	1471	1471	1471	1471	1471	1471
Room Loads	Q_SEN [btu/hr]	517725	480276	510438	428994	540264	577357	555183	581823	575225
	Q_LAT [btu/hr]	20000	20000	20000	20000	20000	20000	20000	20000	20000
Required Outdoor Air Quantity	[cfm]	2500	2500	2500	2500	2500	2800	2800	2800	2800
Enthalpy Wheel Charac.	ES	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
	EL	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
A - OA Outdoor Air entering enthalpy wheel	DBT [F]	92	92	92	92	92	92	92	92	92
	WBT [F]	75	75	75	75	75	75	75	75	75
	% RH	47	47	47	47	47	47	47	47	47
	W [g/lb]	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5
	h [Btu/lb]	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4
B - OA-EW Outdoor Air leaving enthalpy wheel entering cooling coil	DBT [F]	78.4	78.4	78.4	78.4	78.4	78.4	78.4	78.4	78.4
	% RH	52	52	52	52	52	52	52	52	52
	W [g/lb]	73.9	73.9	73.9	73.9	73.9	73.9	73.9	73.9	73.9
	h [Btu/lb]	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2
	rho [lb/cf]	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073
C - SA Supply Air leaving cooling coil entering room	DBT [F]	45	45	45	45	45	45	45	45	45
	% RH	100	100	100	100	100	100	100	100	100
	W [g/lb]	44	44	44	44	44	44	44	44	44
	W [lbm/lba]	0.00629	0.00629	0.00629	0.00629	0.00629	0.00629	0.00629	0.00629	0.00629
	DPT [F]	45	45	45	45	45	45	45	45	45
	h [Btu/lb]	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6
D - RA Exhaust Air leaving room entering enthalpy wheel	DBT [F]	75	75	75	75	75	75	75	75	75
	WBT [F]	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4
	DPT [F]	55	55	55	55	55	55	55	55	55
	% RH	50	50	50	50	50	50	50	50	50
	W [g/lb]	64	64	64	64	64	64	64	64	64
	ΔW = Wroom - Wsa	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
	h [Btu/lb]	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2
E - EA Exhaust Air leaving enthalpy wheel	DBT [F]	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0
	% RH	47.0	49.0	49.0	49.0	49.0	49.0	49.0	49.0	49.0
	W [g/lb]	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5
	h [Btu/lb]	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4
DOAS										
Cooling Coil Loads	Sensible Load [Btu/hr]	90180	90180	90180	90180	90180	101002	101002	101002	101002
	Latent Load [Btu/hr]	50830	50830	50830	50830	50830	56930	56930	56930	56930
	Total Load [Btu/hr]	141010	141010	141010	141010	141010	157931	157931	157931	157931
	Total Load [tons]	11.8	11.8	11.8	11.8	11.8	13.2	13.2	13.2	13.2
SA Cooling Capacity	[Btu/hr]	81000	81000	81000	81000	81000	90720	90720	90720	90720
North SA	[cfm]	2500	2500				2800	2800		
South SA	[cfm]			2500	2500	2500			2800	2800
Parallel System: Radiant Panels										
Total Load	[Btu/hr]	436725	399276	429438	347994	459264	486637	464463	491103	484505
	[tons]	36.39	33.27	35.79	29.00	38.27	40.55	38.71	40.93	40.38
Total Chiller Size	[tons]	48.14	45.02	47.54	40.75	50.02	53.71	51.87	54.09	53.54

Without Heat Recovery.

		No Heat Recovery								
		FL-1 NE	FL-1 NW	FL-1 SE	FL-1 SW	FL-1 T	FL-2 NE	FL-2 NW	FL-2 SE	FL-2 SW
Room Properties	Area [SF]	25000	25000	24000	24000	27500	29000	29000	29000	29000
	Floor to Ceiling Height [FT]	12.5	12.5	12.5	12.5	29	13.5	13.5	13.5	13.5
	Plenum Depth [FT]	3	3	3	3	3	3	3	3	3
	Floor to Floor Height [FT]	15.5	15.5	15.5	15.5	32	16.5	16.5	16.5	16.5
	Volume [CF]	312500	312500	300000	300000	797500	391500	391500	391500	391500
	Occupancy	100	100	100	100	100	100	100	100	100
Ventilation Air Requirement to Satisfy Standard 62.1		2500	2500	2500	2500	2500	2800	2800	2800	2800
Latent Load Satisfied by Standard 62.1 Vent. Requirement		34000	34000	34000	34000	34000	38080	38080	38080	38080
Supply Air Required to Satisfy Latent Load at 44F/Saturated		1471	1471	1471	1471	1471	1471	1471	1471	1471
Room Loads	Q_SEN [btu/hr]	517725	480276	510438	428994	540264	577357	555183	581823	575225
	Q_LAT [btu/hr]	20000	20000	20000	20000	20000	20000	20000	20000	20000
Required Outdoor Air Quantity	[cfm]	2500	2500	2500	2500	2500	2800	2800	2800	2800
A - OA Outdoor Air entering cooling coil	DBT [F]	92	92	92	92	92	92	92	92	92
	WBT [F]	75	75	75	75	75	75	75	75	75
	% RH	47	47	47	47	47	47	47	47	47
	W [g/lb]	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5
	h [Btu/lb]	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4
B - SA Supply Air leaving cooling coil entering room	DBT [F]	55	55	55	55	55	55	55	55	55
	% RH	100	100	100	100	100	100	100	100	0
	W [g/lb]	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0
	h [Btu/lb]	27.9	27.9	27.9	27.9	27.9	27.9	27.9	27.9	27.9
D - RA Exhaust Air leaving room	DBT [F]	75	75	75	75	75	75	75	75	75
	WBT [F]	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4
	DPT [F]	55	55	55	55	55	55	55	55	55
	% RH	50	50	50	50	50	50	50	50	50
	W [g/lb]	64	64	64	64	64	64	64	64	64
	ΔW = Wroom - Wsa	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
	h [Btu/lb]	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2
DOAS										
Cooling Coil Loads	Sensible Load [Btu/hr]	99900	99900	99900	99900	99900	111888	111888	111888	111888
	Latent Load [Btu/hr]	84150	84150	84150	84150	84150	94248	94248	94248	94248
	Total Load [Btu/hr]	184050	184050	184050	184050	184050	206136	206136	206136	206136
	Total Load [tons]	153.4	153.4	153.4	153.4	153.4	171.8	171.8	171.8	171.8
SA Cooling Capacity	[Btu/hr]	54000	54000	54000	54000	54000	60480	60480	60480	60480
North SA	[cfm]	2500	2500				2800	2800		
South SA	[cfm]			2500	2500	2500			2800	2800
Parallel System										
Total Load	[Btu/hr]	463725	426276	456438	374994	486264	516877	494703	521343	514745
	[tons]	38.64	35.52	38.04	31.25	40.52	43.07	41.23	43.45	42.90
Total Chiller Size	[tons]	192.02	188.90	191.41	184.62	193.90	214.85	213.01	215.23	214.68

2. Supply Air Requirements for VAV System.

Based on the calculation procedure in the body of this report, the following airflows were found.

			Std. 62.1	Summer							Winter				
			Vent. Air	Supply Air				Outdoor Air	Supply Air	Return Air	Supply Air		Outdoor Air	Supply Air	Return Air
	Occupancy	Floor Area	CFM	Sensible Load	CFM	Latent Load	CFM	CFM	CFM	CFM	Sensible Load	CFM	CFM	CFM	CFM
FLOOR 1															
FL-1 NE	100	25000	2500	628050	29076	20000	2451	2500	31576	29076	454693	28067	2500	30567	28067
FL-1 NW	100	25000	2500	590601	27343	20000	2451	2500	29843	27343	468519	28921	2500	31421	28921
FL-1 SE	100	24000	2500	617350	28581	20000	2451	2500	31081	28581	462339	28539	2500	31039	28539
FL-1 SW	100	24000	2500	535906	24810	20000	2451	2500	27310	24810	490562	30282	2500	32782	30282
FL-1 T	100	27500	2700	659122	30515	20000	2451	2700	33215	30515	467564	28862	2700	31562	28862
FLOOR 2															
FL-2 NE	100	29000	2800	701334	32469	20000	2451	2800	35269	32469	539666	33313	2800	36113	33313
FL-2 NW	100	29000	2800	679160	31443	20000	2451	2800	34243	31443	551052	34016	2800	36816	34016
FL-2 SE	100	29000	2800	705800	32676	20000	2451	2800	35476	32676	566174	34949	2800	37749	34949
FL-2 SW	100	29000	2800	699202	32370	20000	2451	2800	35170	32370	571899	35302	2800	38102	35302
FLOOR 3															
FL-3 NE	100	29000	2800	711863	32957	20000	2451	2800	35757	32957	372900	23019	2800	25819	23019
FL-3 NW	100	29000	2800	742208	34361	20000	2451	2800	37161	34361	373045	23027	2800	25827	23027
FL-3 SE	100	29000	2800	704972	32638	20000	2451	2800	35438	32638	522584	32258	2800	35058	32258
FL-3 SW	100	29000	2800	716604	33176	20000	2451	2800	35976	33176	524713	32390	2800	35190	32390
FL-3 T	100	28000	2800	666900	30875	20000	2451	2800	33675	30875	371753	22948	2800	25748	22948
FLOOR 5															
FL-5 E	100	19250	2500	497134	23015	20000	2451	2500	25515	23015	224206	13840	2500	16340	13840
FL-5 W	100	19250	2500	514744	23831	20000	2451	2500	26331	23831	225693	13932	2500	16432	13932

3. Mixed Air Conditions.

For the DOAS/VAV application, the outdoor air is mixed with the VAV supply air after both are conditioned separately. The temperature of the mixed air had to be calculated to check if it is within an acceptable range. Supplying air between 54F and 56F is acceptable.

Space	VAV Supply Air Quantity CFM	VAV Supply Air Dry Bulb T F	DOAS Supply Air Quantity CFM	DOAS Supply Air Dry Bulb Te F	Mixed Supply Air Quantity CFM	Mixed Supply Air Dry Bulb F
FLOOR 1						
FL-1 NE	25200	55	2500	45	27700	54.10
FL-1 NW	25200	55	2500	45	27700	54.10
FL-1 SE	23750	55	2500	45	26250	54.05
FL-1 SW	23750	55	2500	45	26250	54.05
FL-1 T	27300	55	2500	45	29800	54.16
FLOOR 2						
FL-2 NE	28500	55	2800	45	31300	54.11
FL-2 NW	28500	55	2800	45	31300	54.11
FL-2 SE	29000	55	2800	45	31800	54.12
FL-2 SW	29000	55	2800	45	31800	54.12
FLOOR 3						
FL-3 NE	30000	55	2800	45	32800	54.15
FL-3 NW	30000	55	2800	45	32800	54.15
FL-3 SE	29450	55	2800	45	32250	54.13
FL-3 SW	29450	55	2800	45	32250	54.13
FL-3 T	27200	55	2800	45	30000	54.07
FLOOR 5						
FL-5 E	20700	55	2500	45	23200	53.92
FL-5 W	20700	55	2500	45	23200	53.92

Table E1. DOAS/VAV Summer Mixed Air Conditions.

Space	VAV Supply Air Quantity CFM	VAV Supply Air Dry Bulb T F	DOAS Supply Air Quantity CFM	DOAS Supply Air Dry Bulb Te F	Mixed Supply Air Quantity CFM	Mixed Supply Air Dry Bulb F
FLOOR 1						
FL-1 NE	25200	55	1950	58.2	27150	55.23
FL-1 NW	25200	55	1950	58.2	27150	55.23
FL-1 SE	23750	55	1890	58.2	25640	55.24
FL-1 SW	23750	55	1890	58.2	25640	55.24
FL-1 T	27300	55	2150	58.2	29450	55.23
FLOOR 2						
FL-2 NE	28500	55	2080	58.2	30580	55.22
FL-2 NW	28500	55	2075	58.2	30575	55.22
FL-2 SE	29000	55	2080	58.2	31080	55.21
FL-2 SW	29000	55	2075	58.2	31075	55.21
FLOOR 3						
FL-3 NE	30000	55	2190	58.2	32190	55.22
FL-3 NW	30000	55	2190	58.2	32190	55.22
FL-3 SE	29450	55	2190	58.2	31640	55.22
FL-3 SW	29450	55	2190	58.2	31640	55.22
FL-3 T	27200	55	2080	58.2	29280	55.23
FLOOR 5						
FL-5 E	20700	55	1605	58.2	22305	55.23
FL-5 W	20700	55	1605	58.2	22305	55.23

Table E2. DOAS/VAV Winter Mixed Air Conditions.

4. McQuay Air Handling Unit Example Selection Procedure.

This example is for the FL-1 NE VAV air handling unit in the DOAS/VAV system.

1. Find Maximum Face Area

Supply Air Quantity = 25200CFM

Maximum Face Area = Supply Air Quantity/Maximum Face Velocity

= 25200CFM/500FPM = 50.4SF

*Check SWP080 with Face Area of 51.1SF

2. Find CFM Correction Factor

CFM Correction Factor = Supply Air Quantity/Nominal CFM

= 25200CFM/30660CFM = 0.82

3A. DX Coil Selection

DX Cooling Capacity Correction Factors

Total Heat = 0.968+((0.82-0.8)*100)*0.0006 = 0.969

Sensible Heat = 0.9+((0.82-0.8)*100)*0.005 = 0.911

Capacity Required by Space = 562.370MBH [Thousand Btu/h]

Total Capacity Required by Coil = 562.370/0.969 = 580.36MBH

Total Sensible Capacity Required by Coil =562.370/0.911 =617.31MBH

Total Capacity Available from SWP080F = 907MBH

Sensible Capacity Available from SWP080F = 708MBH

*Both are capacities are greater than what is required, SWP080F is ok!

SWP080F: 80F EDB, 67F EWB, 85F EWT, 56.8 LDB, 56.7 LWB, 214GPM

3B. Cooling Coil Selection

For the chilled water application, the chilled water coils were selected using Carrier's Air Handling Unit Builder. A typical coil was sized for each unit based on the average supply air quantity (32750CFM), total and sensible cooling capacity (668Mbh/648Mbh). A 4 row, 8 fin per inch coil was chosen with 45F EWT, 55F LWT, 782 SMbh, 691 TMbh, 5.6' P.D., and 156GPM.

4. Find Condenser Flow Rate

Condenser Flow Rate = 214GPM*Total Heat Correction Factor

= 214GPM*0.969 = 207GPM

5. Economizer Coil Selection

Economizer Cooling Capacity Correction Factors

Total Heat = 0.92+((0.82-0.8)*100)*0.004 = 0.929

Sensible Heat = 0.87+((0.82-0.8)*100)*0.006 = 0.883

Capacity Required by Space = 562.370MBH

Total Capacity Required by Coil = 562.370*0.929 = 494MBH

Total Sensible Capacity Required by Coil = 562.370*0.883 = 469MBH

Economizer Flow Rate = Condenser Flow Rate = 207GPM

Total Capacity Available from SWP080F = 592MBH

Sensible Capacity Available from SWP080F = 558MBH

*Both are capacities are greater than what is required, SWP080F is ok!

SWP080F: 55F EWT, 80F EDB, 67F EWB, 61.8F LDB, 60.5F LWB, 61.0F LWT

6A. Electric Heating Coil Capacity

68KW, 232MBH

6B. Hot Water Coil Capacity

1058MBH, 155.8F LWT, 100.0F LDB, 90GPM

7A. Fan/Motor Selection with Electric Heating Coil

Internal Static Pressure [ISP]

Filter:	0.251625 inches water gage [in wg]
Economizer:	0.413250 in wg
DX coil:	0.778750 in wg
Discharge Plenum:	0.461000 in wg

ISP = 0.251625 + 0.413250 + 0.778750 + 0.461000 = 1.904625 in wg

External Static Pressure [ESP]

Supply Duct:	1.00 in wg

EXP = 1.00 in wg

Total Static Pressure = ISP + ESP = 2.904625 in wg

*A 25HP airfoil fan is chosen

7B. Fan/Motor Selection with Hot Water Coil

Internal Static Pressure [ISP]

Filter:	0.251625 inches water gage [in wg]
Economizer:	0.413250 in wg
Cooling Coil:	0.778750 in wg
HW coil:	0.147750 in wg
Discharge Plenum:	0.461000 in wg

ISP = 0.251625 + 0.413250 + 0.778750 + 0.147750 + 0.461000

= 2.052375 in wg

External Static Pressure [ESP]

Supply Duct:	1.00 in wg

EXP = 1.00 in wg

Total Static Pressure = ISP + ESP = 3.052375 in wg

*A 25HP airfoil fan is chosen

8. Unit Size and Weight

Size: 144L x 84W x 88H (in inches)

Weight:

Basic Unit:	4021 lbs
Filter:	96 lbs
Evaporator Coil:	755 lbs
Economizer Coil:	723 lbs
Economizer Water Weight:	203 lbs
Electric Heating Coil:	40 lbs
Supply Fan Motor:	366 lbs
Discharge Plenum:	1003 lbs
Compressor/Condenser:	1684 lbs
Variable Frequency Drive:	100 lbs
*Total	8991 lbs

5. Mixed Air Dry and Wet Bulb Temperatures.

When using Carrier's Air Handling Unit Builder, the entering air dry and wet bulb temperatures are required to size a cooling coil. This table shows the mixed air conditions entering the VAV unit for conditioning.

Summer										
	Dry Bulb					Wet Bulb				
	Outdoor Air		Return Air		Mixed Air	Outdoor Air		Return Air		Mixed Air
	Quantity	Temperature	Quantity	Temperature	Temperature	Quantity	Temperature	Quantity	Temperature	Temperature
Space	CFM	F	CFM	F	F	CFM	F	CFM	F	F
FLOOR 1										
FL-1 NE	2500	92	29076	75	76.35	2500	75	26755	62.4	63.48
FL-1 NW	2500	92	27343	75	76.42	2500	75	25021	62.4	63.54
FL-1 SE	2500	92	28581	75	76.37	2500	75	26259	62.4	63.50
FL-1 SW	2500	92	24810	75	76.56	2500	75	22489	62.4	63.66
FL-1 T	2700	92	30515	75	76.38	2700	75	28309	62.4	63.50
FLOOR 2										
FL-2 NE	2800	92	32469	75	76.35	2800	75	30019	62.4	63.47
FL-2 NW	2800	92	31443	75	76.39	2800	75	28986	62.4	63.51
FL-2 SE	2800	92	32676	75	76.34	2800	75	30226	62.4	63.47
FL-2 SW	2800	92	32370	75	76.35	2800	75	29914	62.4	63.48
FLOOR 3										
FL-3 NE	2800	92	32957	75	76.33	2800	75	30434	62.4	63.46
FL-3 NW	2800	92	34361	75	76.28	2800	75	31674	62.4	63.42
FL-3 SE	2800	92	32638	75	76.34	2800	75	30269	62.4	63.47
FL-3 SW	2800	92	33176	75	76.32	2800	75	30765	62.4	63.45
FL-3 T	2800	92	30875	75	76.41	2800	75	28226	62.4	63.54
FLOOR 4										
FL-4	3000	92	793423	75	75.06	3000	75	793423	62.4	62.45
FLOOR 5										
FL-5 E	2500	92	23015	75	76.67	2500	75	20524	62.4	63.77
FL-5 W	2500	92	23831	75	76.61	2500	75	21301	62.4	63.72
		Average Mixed Air Dry Bulb Temperature			76.3			Average Mixed Air Wet Bulb Temperature		63.5

Winter										
	Dry Bulb					Wet Bulb				
	Outdoor Air		Return Air		Mixed Air	Outdoor Air		Return Air		Mixed Air
	Quantity	Temperature	Quantity	Temperature	Temperature	Quantity	Temperature	Quantity	Temperature	Temperature
Space	CFM	F	CFM	F	F	CFM	F	CFM	F	F
FLOOR 1										
FL-1 NE	2500	11	28067	70	65.17	2500	7.2	26755	58.6	54.21
FL-1 NW	2500	11	28921	70	65.31	2500	7.2	25021	58.6	53.93
FL-1 SE	2500	11	28539	70	65.25	2500	7.2	26259	58.6	54.13
FL-1 SW	2500	11	30282	70	65.50	2500	7.2	22489	58.6	53.46
FL-1 T	2700	11	28862	70	64.95	2700	7.2	28309	58.6	54.12
FLOOR 2										
FL-2 NE	2800	11	33313	70	65.43	2800	7.2	30019	58.6	54.21
FL-2 NW	2800	11	34016	70	65.51	2800	7.2	28986	58.6	54.07
FL-2 SE	2800	11	34949	70	65.62	2800	7.2	30226	58.6	54.24
FL-2 SW	2800	11	35302	70	65.66	2800	7.2	29914	58.6	54.20
FLOOR 3										
FL-3 NE	2800	11	23019	70	63.60	2800	7.2	30434	58.6	54.27
FL-3 NW	2800	11	23027	70	63.60	2800	7.2	31674	58.6	54.43
FL-3 SE	2800	11	32258	70	65.29	2800	7.2	30269	58.6	54.25
FL-3 SW	2800	11	32390	70	65.31	2800	7.2	30765	58.6	54.31
FL-3 T	2800	11	22948	70	63.58	2800	7.2	28226	58.6	53.96
FLOOR 4										
FL-4	3000	11	1037780	70	69.83	3000	7.2	793423	58.6	58.41
FLOOR 5										
FL-5 E	2500	11	13840	70	60.97	2500	7.2	20524	58.6	53.02
FL-5 W	2500	11	13932	70	61.02	2500	7.2	21301	58.6	53.20
		Average Mixed Air Dry Bulb Temperature			64.8			Average Mixed Air Wet Bulb Temperature		54.3

6. SEMCO Air Handling Unit Example Selection Procedure.

This example is for the North DOAS air handling unit.

1. Select Unit Based on Supply Air Quantity

   Supply Air Quantity = 14400CFM

   *Choose EP-24 with a minimum 11000CFM and maximum 18000CFM

2. Select Unit Configuration

   In addition to the cooling/dehumidification done by the enthalpy wheel in the summer, additional cooling will be needed to obtain the required supply temperature.

   In addition to the heating/humidification done by the enthalpy wheel in the winter, the outdoor air will need additional heating.

   *Choose EPCH-24 with a cooling and heating coil

3. Determine Total Static Pressure for Supply Side

   Internal Static Pressure [ISP]

OA Opening:	0.085 in wg
SA Opening:	0.085 in wg
Damper:	0.094 in wg
OA Filter:	0.434 in wg
Wheel:	0.569 in wg
CHW Coil:	0.564 in wg
HW Coil:	0.095 in wg
Casing:	0.300 in wg
Total:	2.226 in wg

   External Static Pressure [ESP]

Supply Duct:	1.000 in wg

   *Total Static Pressure = ISP + ESP = 3.226 in wg

4. Determine Total Static Pressure for Return Side

   Internal Static Pressure [ISP]

EA Opening:	0.254 in wg
RA Opening:	0.254 in wg

Damper: 0.094 in wg

RA Filter: 0.534 in wg

Wheel: 0.569 in wg

Casing: 0.300 in wg

Total: 2.005 in wg

External Static Pressure [ESP]

Supply Duct: 0.500 in wg

*Total Static Pressure = ISP + ESP = 2.505 in wg

5. Determine Total Supply Air Volume

Purge/Seal Air Volume = 1735CFM

*Total Supply Air Volume = 14400CFM + 1735CFM = 16135CFM

6. Determine Motor Horsepower

Supply Motor: 13.4HP

Return Motor: 10.8HP

*Choose 15HP motors for both the supply fan and return fan

7. Base Wheel Effectiveness: 80.6%

8. Unit Size and Weight

Size: 262L x 122W x 110H (in inches)

Weight: 8450 lbs

7. Radiant Panel Optimization.

The supply water temperature had to be supplied at a higher temperature than the room dew point temperature.

Supply Water Temperature Analysis	
RA DPT [F]	55
Inlet Water Temperature [F]	56
Assumed Temp Rise [F]	10
Mean Water Temperature [F]	61.0
RA DBT - MWT [F]	14.0

Table J1. Supply Water Temperature Analysis.

A flow rate of 1GPM can have 17 panels on one circuit, will have 6.8' pressure drop per circuit, will absorb 5000Btu/hr, and will require 841GPM total flow. These results are only for floors 1 and 2.

Max Pressure Drop per 2'x4'	Flow Rate	Absorption Capacity f. Flow Rate	# Panels	Pressure Drop per Circuit	# Circuits	Total Flow
5 pass	gpm	Btu/hr		ft. wg.		gpm
0.1	0.5	2500	8	0.8	1786	893
0.4	**1**	**5000**	**17**	**6.8**	**841**	**841**
1.4	2	10000	35	49.0	409	818
2	2.5	12500	44	88.0	325	813
2.8	3	15000	53	148.4	270	810

Table J2. Flow Optimization.

8. System Calculations.

Calculations were documented for each system. The VAV only case is in Appendix E.

DOAS/VAV Summer Calcs—Floors 1 and 2

		FL-1 NE	FL-1 NW	FL-1 SE	FL-1 SW	FL-1 T	FL-2 NE	FL-2 NW	FL-2 SE	FL-2 SW
Room Properties	Area [SF]	25000	25000	24000	24000	27500	29000	29000	29000	29000
	Floor to Ceiling Height [FT]	12.5	12.5	12.5	12.5	29	13.5	13.5	13.5	13.5
	Plenum Depth [FT]	3	3	3	3	3	3	3	3	3
	Floor to Floor Height [FT]	15.5	15.5	15.5	15.5	32	16.5	16.5	16.5	16.5
	Volume [CF]	312500	312500	300000	300000	797500	391500	391500	391500	391500
	Occupancy	100	100	100	100	100	100	100	100	100
Ventilation Air Requirement to Satisfy Standard 62.1		2500	2500	2500	2500	2500	2800	2800	2800	2800
Latent Load Satisfied by Standard 62.1 Vent. Requirement		34000	34000	34000	34000	34000	38080	38080	38080	38080
Supply Air Required to Satisfy Latent Load at 44F/Saturated		1471	1471	1471	1471	1471	1471	1471	1471	1471
Room Loads	Q_SEN [btu/hr]	628050	590601	617350	535906	659122	701334	679160	705800	696202
	Q_LAT [btu/hr]	20000	20000	20000	20000	20000	20000	20000	20000	20000
Required Outdoor Air Quantity	[cfm]	2500	2500	2500	2500	2500	2800	2800	2800	2800
Enthalpy Wheel Charac.	ES	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
	EL	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
A - OA Outdoor Air entering enthalpy wheel	DBT [F]	92	92	92	92	92	92	92	92	92
	WBT [F]	75	75	75	75	75	75	75	75	75
	% RH	47	47	47	47	47	47	47	47	47
	W [g/lb]	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5
	h [Btu/lb]	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4
B - OA-EW Outdoor Air leaving enthalpy wheel entering cooling coil	DBT [F]	78.4	78.4	78.4	78.4	78.4	78.4	78.4	78.4	78.4
	% RH	52	52	52	52	52	52	52	52	52
	W [g/lb]	73.9	73.9	73.9	73.9	73.9	73.9	73.9	73.9	73.9
	h [Btu/lb]	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2
	rho [lb/cf]	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073
C - SA Supply Air leaving cooling coil entering room	DBT [F]	45	45	45	45	45	45	45	45	45
	% RH	100	100	100	100	100	100	100	100	100
	W_SA [g/lb]	44	44	44	44	44	44	44	44	44
	W_SA [lbm/lba]	0.00629	0.00629	0.00629	0.00629	0.00629	0.00629	0.00629	0.00629	0.00629
	DPT [F]	45	45	45	45	45	45	45	45	45
	h [Btu/lb]	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6
D - RA Exhaust Air leaving room entering enthalpy wheel	DBT [F]	75	75	75	75	75	75	75	75	75
	WBT [F]	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4
	DPT [F]	55	55	55	55	55	55	55	55	55
	% RH	50	50	50	50	50	50	50	50	50
	W [g/lb]	64	64	64	64	64	64	64	64	64
	ΔW = Wroom - Wsa	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
	h [Btu/lb]	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2
E - EA Exhaust Air leaving enthalpy wheel	DBT [F]	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0
	% RH	47.0	49.0	49.0	49.0	49.0	49.0	49.0	49.0	49.0
	W [g/lb]	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5
	h [Btu/lb]	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4
DOAS										
Cooling Coil Loads	Sensible Load [Btu/hr]	90180	90180	90180	90180	90180	101002	101002	101002	101002
	Latent Load [Btu/hr]	50830	50830	50830	50830	50830	56930	56930	56930	56930
	Total Load [Btu/hr]	141010	141010	141010	141010	141010	157931	157931	157931	157931
	Total Load [tons]	11.8	11.8	11.8	11.8	11.8	13.2	13.2	13.2	13.2
SA Cooling Capacity	[Btu/hr]	81000	81000	81000	81000	81000	90720	90720	90720	90720
North SA	[cfm]	2500	2500				2800	2800		
South SA	[cfm]			2500	2500	2500			2800	2800
Parallel System: VAV										
Parallel Cooling Capacity	[Btu/hr]	547050	509601	536350	454906	578122	610614	588440	615080	608482
Cooling Coil	Entering DBT	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0
	Sensible Load [Btu/hr]	547050	509601	536350	454906	578122	610614	588440	615080	608482
	Latent Load [Btu/hr]	0	0	0	0	0	0	0	0	0
	Total Load [Btu/hr]	547050	509601	536350	454906	578122	610614	588440	615080	608482
	Total Load [tons]	45.6	42.5	44.7	37.9	48.2	50.9	49.0	51.3	50.7
Supply Air	DBT [F]	55	55	55	55	55	55	55	55	55
	[cfm]	25326	23593	24831	21060	26765	28269	27243	28476	28170
Mixed Air After Conditioning	DBT [F]	54.10	54.04	54.09	53.94	54.15	54.10	54.07	54.10	54.10

DOAS/VAV Winter Calcs—Floors 1 and 2

		FL-1 NE	FL-1 NW	FL-1 SE	FL-1 SW	FL-1 T	FL-2 NE	FL-2 NW	FL-2 SE	FL-2 SW
Room Properties	Area [SF]	25000	25000	24000	24000	27500	29000	29000	29000	29000
	Floor to Ceiling Height [FT]	12.5	12.5	12.5	12.5	29	13.5	13.5	13.5	13.5
	Plenum Depth [FT]	3	3	3	3	3	3	3	3	3
	Floor to Floor Height [FT]	15.5	15.5	15.5	15.5	32	16.5	16.5	16.5	16.5
	Volume [CF]	312500	312500	300000	300000	797500	391500	391500	391500	391500
	Occupancy	100	100	100	100	100	100	100	100	100
Ventilation Air Requirement to Satisfy Standard 62.1		2500	2500	2500	2500	2500	2800	2800	2800	2800
Latent Load Satisfied by Standard 62.1 Vent. Requirement		17850	17850	17850	17850	17850	19992	19992	19992	19992
Supply Air Required to Satisfy Latent Load at 44F/Saturated		0	0	0	0	0	0	0	0	0
Room Loads	Q_SEN [btu/hr]	454693	468519	462339	490562	467564	539666	551052	566174	571899
	Q_LAT [btu/hr]	0	0	0	0	0	0	0	0	0
Required Outdoor Air Quantity	[cfm]	2500	2500	2500	2500	2500	2800	2800	2800	2800
Enthalpy Wheel Charac.	ES	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
	EL	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
A - OA Outdoor Air entering enthalpy wheel	DBT [F]	11	11	11	11	11	11	11	11	11
	WBT [F]	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
	% RH	30	30	30	30	30	30	30	30	30
	W [g/lb]	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
	h [Btu/lb]	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11	3.11
B - OA-EW Outdoor Air leaving enthalpy wheel entering cooling coil	DBT [F]	58.2	58.2	58.2	58.2	58.2	58.2	58.2	58.2	58.2
	% RH	52	52	52	52	52	52	52	52	52
	W [g/lb]	44.2	44.2	44.2	44.2	44.2	44.2	44.2	44.2	44.2
	h [Btu/lb]	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2
	rho [lb/cf]	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073
C - SA Supply Air leaving cooling coil entering room	DBT [F]	45	45	45	45	45	45	45	45	45
	% RH	100	100	100	100	100	100	100	100	100
	W_SA [g/lb]	44	44	44	44	44	44	44	44	44
	W_ SA [lbm/lba]	0.00629	0.00629	0.00629	0.00629	0.00629	0.00629	0.00629	0.00629	0.00629
	DPT [F]	45	45	45	45	45	45	45	45	45
	h [Btu/lb]	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6
D - RA Exhaust Air leaving room entering enthalpy wheel	DBT [F]	70	70	70	70	70	70	70	70	70
	WBT [F]	58.6	58.6	58.6	58.6	58.6	58.6	58.6	58.6	58.6
	DPT [F]	50	50	50	50	50	50	50	50	50
	% RH	50	50	50	50	50	50	50	50	50
	W [g/lb]	54.5	54.5	54.5	54.5	54.5	54.5	54.5	54.5	54.5
	ΔW = Wroom - Wsa	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5
	h [Btu/lb]	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3
E - EA Exhaust Air leaving enthalpy wheel	DBT [F]	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
	% RH	49.0	49.0	49.0	49.0	49.0	49.0	49.0	49.0	49.0
	W [g/lb]	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
	h [Btu/lb]	37.1	37.1	37.1	37.1	37.1	37.1	37.1	37.1	37.1
DOAS										
Cooling Coil Loads	Sensible Load [Btu/hr]	35640	35640	35640	35640	35640	39917	39917	39917	39917
	Latent Load [Btu/hr]	272	272	272	272	272	305	305	305	305
	Total Load [Btu/hr]	35912	35912	35912	35912	35912	40221	40221	40221	40221
	Total Load [tons]	2.99	2.99	2.99	2.99	2.99	3.35	3.35	3.35	3.35
SA Cooling Capacity	[Btu/hr]	67500	67500	67500	67500	67500	75600	75600	75600	75600
North SA	[cfm]	2500	2500				2800	2800		
South SA	[cfm]			2500	2500	2500			2800	2800
Parallel System: VAV										
Space Sensible Load	[Btu/hr]	387193	401019	394839	423062	400064	464066	475452	490574	496299
Cooling Coil	Entering DBT	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0
	Sensible Load [Btu/hr]	387193	401019	394839	423062	400064	464066	475452	490574	496299
	Latent Load [Btu/hr]	0	0	0	0	0	0	0	0	0
	Total Load [Btu/hr]	387193	401019	394839	423062	400064	464066	475452	490574	496299
	Total Load [tons]	32.3	33.4	32.9	35.3	33.3	38.7	39.6	40.9	41.4
Supply Air	DBT [F]	55	55	55	55	55	55	55	55	55
	[cfm]	23901	24754	24373	26115	24695	28646	29349	30282	30636
Mixed Air After Conditioning	DBT [F]	54.05	54.08	54.07	54.13	54.08	54.11	54.13	54.15	54.16

DOAS/Radiant Summer Calcs—Floors 1 and 2

		FL-1 NE	FL-1 NW	FL-1 SE	FL-1 SW	FL-1 T	FL-2 NE	FL-2 NW	FL-2 SE	FL-2 SW
Room Properties	Area [SF]	25000	25000	24000	24000	27500	29000	29000	29000	29000
	Floor to Ceiling Height [FT]	12.5	12.5	12.5	12.5	29	13.5	13.5	13.5	13.5
	Plenum Depth [FT]	3	3	3	3	3	3	3	3	3
	Floor to Floor Height [FT]	15.5	15.5	15.5	15.5	32	16.5	16.5	16.5	16.5
	Volume [CF]	312500	312500	300000	300000	797500	391500	391500	391500	391500
	Occupancy	100	100	100	100	100	100	100	100	100
Ventilation Air Requirement to Satisfy Standard 62.1		2500	2500	2500	2500	2500	2800	2800	2800	2800
Latent Load Satisfied by Standard 62.1 Vent. Requirement		34000	34000	34000	34000	34000	38080	38080	38080	38080
Supply Air Required to Satisfy Latent Load at 44F/Saturated		1471	1471	1471	1471	1471	1471	1471	1471	1471
Room Loads	Q_SEN [btu/hr]	517725	480276	510438	428994	540264	577357	555183	581823	575225
	Q_LAT [btu/hr]	20000	20000	20000	20000	20000	20000	20000	20000	20000
Required Outdoor Air Quantity	[cfm]	2500	2500	2500	2500	2500	2800	2800	2800	2800
Enthalpy Wheel Charac.	ES	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
	EL	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
A - OA Outdoor Air entering enthalpy wheel	DBT [F]	92	92	92	92	92	92	92	92	92
	WBT [F]	75	75	75	75	75	75	75	75	75
	% RH	47	47	47	47	47	47	47	47	47
	W [g/lb]	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5
	h [Btu/lb]	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4
B - OA-EW Outdoor Air leaving enthalpy wheel entering cooling coil	DBT [F]	78.4	78.4	78.4	78.4	78.4	78.4	78.4	78.4	78.4
	% RH	52	52	52	52	52	52	52	52	52
	W [g/lb]	73.9	73.9	73.9	73.9	73.9	73.9	73.9	73.9	73.9
	h [Btu/lb]	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2
	rho [lb/cf]	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073
C - SA Supply Air leaving cooling coil entering room	DBT [F]	45	45	45	45	45	45	45	45	45
	% RH	100	100	100	100	100	100	100	100	100
	W_SA [g/lb]	44	44	44	44	44	44	44	44	44
	W_SA [lbm/lba]	0.00629	0.00629	0.00629	0.00629	0.00629	0.00629	0.00629	0.00629	0.00629
	DPT [F]	45	45	45	45	45	45	45	45	45
	h [Btu/lb]	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6
D - RA Exhaust Air leaving room entering enthalpy wheel	DBT [F]	75	75	75	75	75	75	75	75	75
	WBT [F]	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4
	DPT [F]	55	55	55	55	55	55	55	55	55
	% RH	50	50	50	50	50	50	50	50	50
	W [g/lb]	64	64	64	64	64	64	64	64	64
	ΔW = Wroom - Wsa	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
	h [Btu/lb]	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2	28.2
E - EA Exhaust Air leaving enthalpy wheel	DBT [F]	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0
	% RH	47.0	49.0	49.0	49.0	49.0	49.0	49.0	49.0	49.0
	W [g/lb]	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5	113.5
	h [Btu/lb]	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4
DOAS										
Cooling Coil Loads	Sensible Load [Btu/hr]	90180	90180	90180	90180	90180	101002	101002	101002	101002
	Latent Load [Btu/hr]	50830	50830	50830	50830	50830	56930	56930	56930	56930
	Total Load [Btu/hr]	141010	141010	141010	141010	141010	157931	157931	157931	157931
	Total Load [tons]	11.8	11.8	11.8	11.8	11.8	13.2	13.2	13.2	13.2
SA Cooling Capacity	[Btu/hr]	81000	81000	81000	81000	81000	90720	90720	90720	90720
North SA	[cfm]	2500	2500				2800	2800		
South SA	[cfm]			2500	2500	2500			2800	2800
Parallel System: Radiant Panels										
Total Load	[Btu/hr]	436725	399276	429438	347994	459264	486637	464463	491103	484505
	[tons]	36.39	33.27	35.79	29.00	38.27	40.55	38.71	40.93	40.38
Total Chiller Size	[tons]	48.14	45.02	47.54	40.75	50.02	53.71	51.87	54.09	53.54
Radiant Panels - Sterling Type C										
Total Absorbed Energy	[Btu/hr]	436725	399276	429438	347994	459264	486637	464463	491103	484505
Absorbed Energy per Panel	[Btu/hr]	280	280	280	280	280	280	280	280	280
Number of Panels		1560	1426	1534	1243	1640	1738	1659	1754	1730
Total Ceiling Area	[SF]	25000	25000	24000	24000	27500	29000	29000	29000	29000
Panel Area	[SF]	12478	11408	12270	9943	13122	13904	13270	14032	13843
Panel Coverage Area Fraction		0.50	0.46	0.51	0.41	0.48	0.48	0.46	0.48	0.48
Number of Panels per Circuit	17	1 GPM through circuit					Pressure drop per circuit		6.8	
Number of Circuits		92	84	90	73	96	102	98	103	102
Total Flow Rate - 1 Circuit	[GPM]	92	84	90	73	96	102	98	103	102

9. Energy Consumption per System.

Values were taken from TRACE based on the energy consumption of each modeled system.

System 1

	Electric Consumption (kWh)	Gas Consumption (therms)	Water Consumption (1000 gallons)	Percent of Total Energy %	**Total Source Energy (kBtu/yr)**
Primary Heating					
Primary Heating	1209479.5	0.0		3.7	**123851.0**
Primary Cooling					
Cooling Compressor	5206464.0			16.1	**533143.2**
Tower/Cond Fans	420212.0		25396.4	1.3	**43029.8**
Condenser Pump	1205839.1			3.7	**123478.2**
Other CLG Accessories	876.0				**89.7**
Cooling Subtotal	6833391.1		25396.4	21.1	**699740.9**
Auxiliary					
Supply Fans	2062867.0			6.4	**211238.1**
Circ Pumps					
Base Utilities					
Aux Subtotal	2062867.0			6.4	**211238.1**
Lighting/Equipment					
Lighting/Equipment	22285440.0			68.8	**2282034.3**
Totals	32391177.6	0.0	25396.4	100.0	**3316864.3**

System 2

	Electric Consumption (kWh)	Gas Consumption (therms)	Water Consumption (1000 gallons)	Percent of Total Energy %	**Total Source Energy (kBtu/yr)**
Primary Heating					
Primary Heating	22539.0	49555.3		5.0	**54471.5**
Primary Cooling					
Cooling Compressor	2110947.8			7.2	**216161.6**
Tower/Cond Fans	672199.4		23481.1	2.3	**68833.4**
Condenser Pump	489990.5			1.7	**50175.1**
Other CLG Accessories	0.0			0.0	**0.0**
Cooling Subtotal	3273137.7		23481.1	11.2	**335170.1**
Auxiliary					
Supply Fans	2062866.7			7.0	**211238.0**
Circ Pumps	335646.8			1.1	**34370.3**
Base Utilities	0.0			0.0	**0.0**
Aux Subtotal	2398513.5			8.1	**245608.3**
Lighting/Equipment					
Lighting/Equipment	22285440.0			75.7	**2282034.3**
Totals	27979630.2		23481.1	100.0	**2917284.2**

System 3

	Electric Consumption (kWh)	Gas Consumption (therms)	Water Consumption (1000 gallons)	Percent of Total Energy %	**Total Source Energy (kBtu/yr)**
Primary Heating					
Primary Heating	1119320.9	0.0		3.3	**114618.7**
Primary Cooling					
Cooling Compressor	6815661.0			19.9	**697925.3**
Tower/Cond Fans	439288.9		28450.5	1.3	**44983.3**
Condenser Pump	1238664.8			3.6	**126839.6**
Other CLG Accessories	876.0			0.0	**89.7**
Cooling Subtotal	8494490.7		28450.5	24.8	**869837.9**
Auxiliary					
Supply Fans	2300449.5			6.7	**235566.6**
Circ Pumps	0.0			0.0	**0.0**
Base Utilities	0.0			0.0	**0.0**
Aux Subtotal	2300449.5			6.7	**235566.6**
Lighting/Equipment					
Lighting/Equipment	22285440.0			65.2	**2282034.3**
Totals	34199701.1		28450.5	100.0	**3502057.5**

System 4

	Electric Consumption (kWh)	Gas Consumption (therms)	Water Consumption (1000 gallons)	Percent of Total Energy %	**Total Source Energy (kBtu/yr)**
Primary Heating					
Primary Heating	22539.8	45861.2		4.6	**50583.0**
Primary Cooling					
Cooling Compressor	2238820.0			7.5	**229255.7**
Tower/Cond Fans	669206.8		24287.1	2.2	**68526.9**
Condenser Pump	478854.3			1.6	**49034.8**
Other CLG Accessories	0.0			0.0	**0.0**
Cooling Subtotal	3386881.1		24287.1	11.3	**346817.4**
Auxiliary					
Supply Fans	2300449.5			7.7	**235566.6**
Circ Pumps	526663.6			1.8	**53930.5**
Base Utilities	0.0			0.0	**0.0**
Aux Subtotal	2827113.1			9.5	**289497.1**
Lighting/Equipment					
Lighting/Equipment	22285440.0			74.6	**2282034.3**
Totals	28521974.0		24287.1	100.0	**2968931.8**

System 5

	Electric Consumption (kWh)	Gas Consumption (therms)	Water Consumption (1000 gallons)	Percent of Total Energy %	**Total Source Energy (kBtu/yr)**
Primary Heating					
Primary Heating	25561.1	54378.8		6.7	**59858.3**
Primary Cooling					
Cooling Compressor	1573273.4			6.6	**161103.6**
Tower/Cond Fans	552840.5		17975.1	2.3	**56611.0**
Condenser Pump	400901.3			1.7	**41052.4**
Other CLG Accessories	0.0			0.0	**0.0**
Cooling Subtotal	2527015.2		17975.1	10.6	**258767.0**
Auxiliary					
Supply Fans	341908.0			1.4	**35011.5**
Circ Pumps	950483.1			4.0	**97329.7**
Base Utilities	0.0			0.0	**0.0**
Aux Subtotal	1292391.1			5.4	**132341.2**
Lighting/Equipment					
Lighting/Equipment	18571200.0			77.3	**1901695.3**
Totals	22416167.4		17975.1	100.0	**2352661.8**

10. Energy Rates.

The energy rates were based on PECO rates from 03/31/06.

PECO Unbundled Rates [03/31/06]			
Fixed Distribution Service Charge		$291.43	per month
Variable Distribution Service Charge			
Demand		$1.68	per kW
1st 150 hours of billed demand		$0.0091	per kWh
2nd 150 hours of billed demand		$0.0054	per kWh
All other KWH		$0.0018	per kWh
Competitive Transition Charge			
Demand		$4.74	per kW
1st 150 hours of billed demand		$0.0262	per kWh
2nd 150 hours of billed demand		$0.0158	per kWh
All other KWH		$0.0056	per kWh
Energy and Capacity Charge			
Demand		$6.45	per kW
1st 150 hours of billed demand		$0.0494	per kWh
2nd 150 hours of billed demand		$0.0353	per kWh
All other KWH		$0.0213	per kWh
Transmission Charge			
Demand		$0.80	per kW
1st 150 hours of billed demand		$0.0043	per kWh
2nd 150 hours of billed demand		$0.0025	per kWh
All other KWH		$0.0008	per kWh
Time of Use Adjustment	Summer	Winter	
	June-Sept	Oct-May	
Off-Peak Credit	($0.0021)	($0.0021)	per kWh
On-Peak Charge	$0.0058	$0.0022	per kWh

11. Yearly Operating Cost.

The yearly operating cost for each system was based on the PECO energy rates as of 03/31/06 in the previous Appendix.

System 1						
	Electric On-Peak			Gas On-Peak	Water On-Peak	
	Consumption	Demand	Total	Consumption	Consumption	Monthly Total
	$	$	$	$	$	$
January	$86,748	$51,369	$138,117	$0	$9,732	**$147,849**
February	$78,598	$51,281	$129,879	$0	$8,753	**$138,632**
March	$86,343	$51,085	$137,428	$0	$11,049	**$148,477**
April	$83,678	$51,077	$134,755	$0	$11,942	**$146,697**
May	$85,556	$53,245	$138,801	$0	$14,156	**$152,957**
June	$96,157	$55,333	$151,490	$0	$15,524	**$167,014**
July	$102,654	$56,647	$159,301	$0	$17,629	**$176,930**
August	$99,425	$55,178	$154,603	$0	$16,066	**$170,669**
September	$92,724	$53,102	$145,826	$0	$13,939	**$159,765**
October	$85,818	$50,677	$136,495	$0	$12,245	**$148,740**
November	$82,858	$50,670	$133,528	$0	$11,063	**$144,591**
December	$86,267	$50,943	$137,210	$0	$10,281	**$147,491**
Totals	**$1,066,826**	**$630,607**	**$1,697,433**	**$0**	**$152,379**	**$1,849,812**

System 2						
	Electric On-Peak			Gas On-Peak	Water On-Peak	
	Consumption	Demand	Total	Consumption	Consumption	Monthly Total
	$	$	$	$	$	$
January	$70,434	$44,034	$114,468	$7,370	$9,124	**$130,962**
February	$63,106	$43,827	$106,933	$6,835	$8,178	**$121,946**
March	$73,480	$44,899	$118,379	$5,416	$10,522	**$134,317**
April	$73,288	$45,408	$118,696	$3,724	$11,190	**$133,610**
May	$76,817	$46,882	$123,699	$0	$12,987	**$136,686**
June	$74,919	$48,302	$123,221	$0	$14,070	**$137,291**
July	$89,712	$49,188	$138,900	$0	$15,839	**$154,739**
August	$87,629	$48,166	$135,795	$0	$14,534	**$150,329**
September	$82,904	$46,747	$129,651	$0	$12,738	**$142,389**
October	$75,501	$44,941	$120,442	$3,447	$11,465	**$135,354**
November	$72,288	$44,469	$116,757	$4,260	$10,499	**$131,516**
December	$72,232	$44,070	$116,302	$6,403	$9,741	**$132,446**
Totals	**$912,310**	**$550,933**	**$1,463,243**	**$37,455**	**$140,887**	**$1,641,585**

System 3						
	Electric On-Peak			Gas On-Peak	Water On-Peak	
	Consumption	Demand	Total	Consumption	Consumption	Monthly Total
	$	$	$	$	$	$
January	$93,530	$55,620	$149,150	$0	$13,604	**$162,754**
February	$84,803	$55,443	$140,246	$0	$12,349	**$152,595**
March	$92,406	$54,953	$147,359	$0	$13,943	**$161,302**
April	$88,657	$54,074	$142,731	$0	$13,744	**$156,475**
May	$89,231	$54,625	$143,856	$0	$14,392	**$158,248**
June	$100,015	$57,870	$157,885	$0	$15,382	**$173,267**
July	$106,010	$58,478	$164,488	$0	$16,861	**$181,349**
August	$102,984	$57,604	$160,588	$0	$15,656	**$176,244**
September	$96,515	$55,628	$152,143	$0	$14,003	**$166,146**
October	$90,754	$53,967	$144,721	$0	$13,927	**$158,648**
November	$88,173	$54,362	$142,535	$0	$13,284	**$155,819**
December	$92,564	$54,864	$147,428	$0	$13,559	**$160,987**
Totals	**$1,125,642**	**$667,488**	**$1,793,130**	**$0**	**$170,704**	**$1,963,834**

System 4						
	Electric On-Peak			Gas On-Peak	Water On-Peak	
	Consumption	Demand	Total	Consumption	Consumption	Monthly Total
	$	$	$	$	$	$
January	$73,309	$45,078	$118,387	$6,820	$11,164	**$136,371**
February	$65,663	$45,486	$111,149	$6,325	$10,025	**$127,499**
March	$76,189	$45,706	$121,895	$5,012	$11,932	**$138,839**
April	$74,867	$46,006	$120,873	$3,447	$11,920	**$136,240**
May	$77,522	$46,553	$124,075	$0	$12,461	**$136,536**
June	$85,105	$48,031	$133,136	$0	$13,215	**$146,351**
July	$89,110	$48,754	$137,864	$0	$14,395	**$152,259**
August	$87,687	$47,876	$135,563	$0	$13,438	**$149,001**
September	$83,567	$46,869	$130,436	$0	$12,104	**$142,540**
October	$77,090	$45,536	$122,626	$3,190	$12,085	**$137,901**
November	$74,226	$45,274	$119,500	$3,942	$11,501	**$134,943**
December	$75,197	$45,146	$120,343	$5,925	$11,483	**$137,751**
Totals	**$939,532**	**$556,315**	**$1,495,847**	**$34,661**	**$145,723**	**$1,676,231**

System 5						
	Electric On-Peak			Gas On-Peak	Water On-Peak	
	Consumption	Demand	Total	Consumption	Consumption	Monthly Total
	$	$	$	$	$	$
January	$55,989	$34,508	$90,497	$7,311	$7,259	**$105,067**
February	$50,195	$34,931	$85,126	$8,133	$6,529	**$99,788**
March	$58,837	$35,940	$94,777	$5,944	$8,278	**$108,999**
April	$58,690	$36,353	$95,043	$3,587	$8,731	**$107,361**
May	$62,114	$37,777	$99,891	$680	$10,059	**$110,630**
June	$68,219	$38,763	$106,982	$77	$10,489	**$117,548**
July	$71,862	$39,692	$111,554	$0	$11,548	**$123,102**
August	$70,235	$38,586	$108,821	$52	$10,641	**$119,514**
September	$66,870	$37,627	$104,497	$518	$9,621	**$114,636**
October	$60,517	$36,141	$96,658	$3,132	$8,863	**$108,653**
November	$57,863	$35,755	$93,618	$4,338	$8,169	**$106,125**
December	$57,626	$35,289	$92,915	$7,328	$7,664	**$107,907**
Totals	**$739,017**	**$441,362**	**$1,180,379**	**$41,100**	**$107,851**	**$1,329,330**

12. Emissions Generated per System.

These emission rates were calculated based on Exelon's 2004 generation fuel mix.

2004 Exelon/PECO Generation Mix						
System 1						
			lbm Pollutant			
Fuel	% Total	kWh	lbm Particulates	lbm SO2	lbm Nox	lbm CO2
Coal	6.0	1943470.7	35630.3	413942.1	239936.1	69642830.4
Oil	4.0	1295647.1	35630.3	499306.1	91663.7	68377359.0
Nat. Gas	1.0	323911.8	0.0	437.2	82185.3	43421605.2
Nuclear	88.0	28504236.3	0.0	0.0	0.0	0.0
Hydro/Wind	1.0	323911.8	0.0	0.0	0.0	0.0
Totals	100.0	32391177.6	20808.1	244101.2	143723.3	44685834.0

2004 Exelon/PECO Generation Mix						
System 2						
			lbm Pollutant			
Fuel	% Total	kWh	lbm Particulates	lbm SO2	lbm Nox	lbm CO2
Coal	6.0	1678777.8	30777.6	357564.8	207257.8	60157758.5
Oil	4.0	1119185.2	30777.6	431302.6	79179.4	59064639.2
Nat. Gas	1.0	279796.3	0.0	377.6	70992.0	37507758.2
Nuclear	88.0	24622074.6	0.0	0.0	0.0	0.0
Hydro/Wind	1.0	279796.3	0.0	0.0	0.0	0.0
Totals	100.0	27979630.2	17974.1	210855.6	124148.8	38599804.1

System 3						
			lbm Pollutant			
Fuel	% Total	kWh	lbm Particulates	lbm SO2	lbm Nox	lbm CO2
Coal	6.0	2051982.1	37619.7	437054.0	253332.7	73531256.3
Oil	4.0	1367988.0	37619.7	527184.2	96781.6	72195128.8
Nat. Gas	1.0	341997.0	0.0	461.6	86774.0	45845999.7
Nuclear	88.0	30095737.0	0.0	0.0	0.0	0.0
Hydro/Wind	1.0	341997.0	0.0	0.0	0.0	0.0
Totals	100.0	34199701.1	21969.9	257730.3	151747.9	47180815.2

2004 Exelon/PECO Generation Mix						
System 4						
			lbm Pollutant			
Fuel	% Total	kWh	lbm Particulates	lbm SO2	lbm Nox	lbm CO2
Coal	6.0	1711318.4	31374.2	364495.7	211275.2	61323827.8
Oil	4.0	1140879.0	31374.2	439662.8	80714.2	60209520.0
Nat. Gas	1.0	285219.7	0.0	384.9	72368.1	38234790.7
Nuclear	88.0	25099337.1	0.0	0.0	0.0	0.0
Hydro/Wind	1.0	285219.7	0.0	0.0	0.0	0.0
Totals	100.0	28521974.0	18322.5	214942.7	126555.2	39348004.3

2004 Exelon/PECO Generation Mix						
System 5						
			lbm Pollutant			
Fuel	% Total	kWh	lbm Particulates	lbm SO2	lbm Nox	lbm CO2
Coal	6.0	1344970.0	24657.8	286466.7	166046.7	48196004.6
Oil	4.0	896646.7	24657.8	345542.5	63435.4	47320240.8
Nat. Gas	1.0	224161.7	0.0	302.5	56876.0	30049724.7
Nuclear	88.0	19726227.3	0.0	0.0	0.0	0.0
Hydro/Wind	1.0	224161.7	0.0	0.0	0.0	0.0
Totals	100.0	22416167.4	14400.1	168929.1	99463.1	30924628.5

13. Floor 4 Systems Analysis Energy Consumption Results.

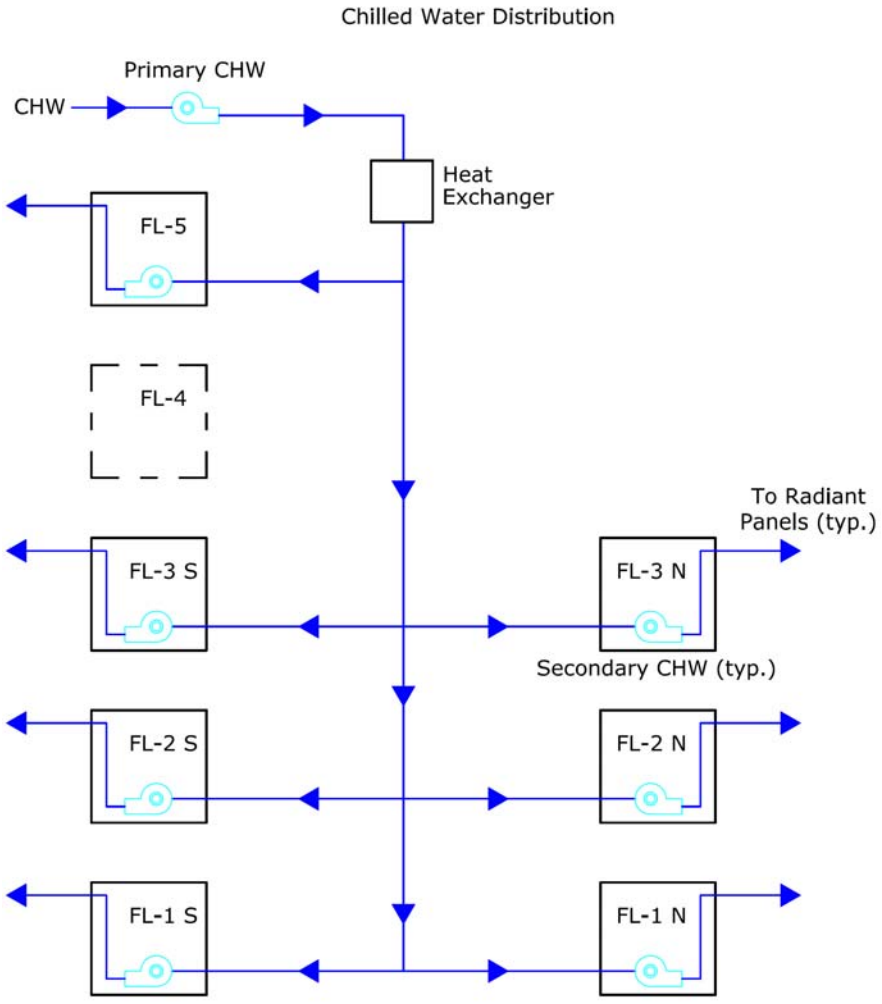
Floor 4's energy usage using combinations of a centrifugal chiller, an economizer, and a boiler.

Floor 4

	DX Coil / Electric Coil (kBtu/yr)	Centrifugal Chiller / Electric Boiler (kBtu/yr)	Centrifugal Chiller / Gas-Fired Boiler (kBtu/yr)	With Plate & Frame / Electric Boiler (kBtu/yr)	With Plate & Frame / Gas-Fired Boiler (kBtu/yr)
Primary Heating					
Primary Heating	11591.7	11906.7	5379.6	11906.7	**5379.6**
Primary Cooling					
Cooling Compressor	856360.9	504106.0	504106.0	492590.5	**492590.5**
Tower/Cond Fans	84298.5	88105.8	88105.8	93130.3	**93130.3**
Condenser Pump	154712.4	65683.8	65683.8	65683.8	**65683.8**
Other CLG Accessories	89.7	0.0	0.0	0.0	**0.0**
Cooling Subtotal	1095461.5	657895.6	657895.6	651404.6	**651404.6**
Auxiliary					
Supply Fans	482454.5	482454.5	482454.5	482454.5	**482454.5**
Circ Pumps	0.0	90710.5	90710.5	90710.5	**90710.5**
Base Utilities	0.0	0.0	0.0	0.0	**0.0**
Aux Subtotal	482454.5	573165.0	573165.0	573165.0	**573165.0**
Lighting/Equipment					
Lighting/Equipment	4485130.0	4485130.0	4485130.0	4485130.0	**4485130.0**
Totals	**6074637.7**	**5728097.3**	**5721570.2**	**5721606.3**	**5715079.2**

14. Chilled Water Distribution Schematic—DOAS/Radiant, System 5.

Chilled water is pumped through primary pumps directly from the chiller to secondary pumps that maintain the flow throughout the radiant panels.



Appendix C—Integration of Structural System and Constructability

1. Gravity Beam Design.
2. Gravity Column Design.
3. Primavera Ductwork Schedule.

1. Gravity Beam Design

Gravity Beam Design

RAM Steel v10.0
DataBase: Jayme Structural
Building Code: IBC

04/05/06 17:05:53
Steel Code: ASD 9th Ed.

Floor Type: Mechanical Equipmen **Beam Number = 16**

SPAN INFORMATION (ft): I-End (25.00,25.00) J-End (25.00,50.00)

Beam Size (User Selected) = HSS20X12X1/2 Fy = 50.0 ksi
Total Beam Length (ft) = 25.00

LINE LOADS (k/ft):

Load	Dist	DL	LL	Red%	Type
1	3.500	3.900	0.000	---	NonR
	21.500	3.900	0.000		
2	0.000	0.096	0.000	---	NonR
	25.000	0.096	0.000		

SHEAR: Max V (DL+LL) = 36.30 kips fv = 1.95 ksi Fv = 20.00 ksi

MOMENTS:

Span	Cond	Moment	@	Lb	Cb	Tension Flange		Compr Flange	
		kip-ft	ft	ft		fb	Fb	fb	Fb
Center	Max +	288.3	12.5	25.0	1.00	22.32	33.00	22.32	33.00
Controlling		288.3	12.5	25.0	1.00	22.32	33.00	---	---

REACTIONS (kips):

	Left	Right
DL reaction	36.30	36.30
Max +total reaction	36.30	36.30

DEFLECTIONS: (Camber = 1/2)

Dead load (in)	at	12.50 ft	=	-0.711	L/D = 422
Live load (in)	at	12.50 ft	=	0.000	
Net Total load (in)	at	12.50 ft	=	-0.211	L/D = 1425

2.0 Gravity Column Design

Gravity Column Design

RAM Steel v10.0
DataBase: Jayme Structural
Building Code: IBC

04/05/06 17
Steel Code: ASD

Story level Equipment, Column Line B - 2

Fy (ksi) = 50.00 Column Size = W12X40
Orientation (degrees) = 90.0

INPUT DESIGN PARAMETERS:

		X-Axis	Y-Axis
Lu (ft)		4.00	4.00
K		1	1
Braced Against Joint Translation		Yes	Yes
Column Eccentricity (in)	Top	8.45	6.51
	Bottom	8.45	6.51

CONTROLLING COLUMN LOADS - Load Case 2:

			Dead	Live	Roof
Axial (kips)			38.11	0.00	0.00
Moments	Top	Mx (kip-ft)	25.56	0.00	0.00
		My (kip-ft)	0.89	0.00	0.00
	Bot	Mx (kip-ft)	0.00	4.63	0.00
		My (kip-ft)	0.00	7.13	0.00

Reverse curvature about X-Axis
Reverse curvature about Y-Axis

CALCULATED PARAMETERS: (DL + LL + RF)

fa (ksi)	=	3.26	Fa (ksi)	=	27.78
fbx (ksi)	=	5.96	Fbx (ksi)	=	33.00
fby (ksi)	=	7.78	Fby (ksi)	=	37.50
Cb	=	1.95			
KL/Rx	=	9.37	KL/Ry	=	24.72

INTERACTION EQUATION

fa/Fa = 0.12
Eq H1-3: 0.117 + 0.181 + 0.207 = 0.505

Gravity Column Design

RAM Steel v10.0 — Page 2/6
DataBase: Jayme Structural — 04/05/06 17:05:53
Building Code: IBC — Steel Code: ASD 9th Ed.

Story level 5th, Column Line B - 2

Fy (ksi) = 50.00 — Column Size = W12X40
Orientation (degrees) = 90.0

INPUT DESIGN PARAMETERS:

		X-Axis	Y-Axis
Lu (ft)		15.00	15.00
K		1	1
Braced Against Joint Translation		Yes	Yes
Column Eccentricity (in)	Top	8.45	6.51
	Bottom	8.45	6.51

CONTROLLING COLUMN LOADS - Load Case 2:

			Dead	Live	Roof
Axial (kips)			88.93	27.50	0.00
Moments	Top	Mx (kip-ft)	0.00	0.00	0.00
		My (kip-ft)	0.00	0.00	0.00
	Bot	Mx (kip-ft)	0.00	1.61	0.00
		My (kip-ft)	0.00	2.48	0.00

Single curvature about X-Axis
Single curvature about Y-Axis

CALCULATED PARAMETERS: (DL + LL + RF)

fa (ksi)	=	9.95	Fa (ksi)	=	16.35
fbx (ksi)	=	0.38	Fbx (ksi)	=	30.00
Fbx (ksi)	=	23.11 (Eq H1-1)			
fby (ksi)	=	2.71	Fby (ksi)	=	37.50
Cb	=	1.75			
KL/Rx	=	35.14	KL/Ry	=	92.71
F'ex	=	120.94	F'ey	=	17.37
Cmx	=	0.60	Cmy	=	0.60

INTERACTION EQUATION

fa/Fa = 0.61
Eq H1-1: 0.609 + 0.011 + 0.102 = 0.721
Eq H1-2: 0.332 + 0.013 + 0.072 = 0.417

Gravity Column Design

RAM Steel v10.0 — Page 3/6
DataBase: Jayme Structural — 04/05/06 17:05:53
Building Code: IBC — Steel Code: ASD 9th Ed.

Story level 4th, Column Line B - 2

Fy (ksi) = 50.00 — Column Size = W12X50
Orientation (degrees) = 90.0

INPUT DESIGN PARAMETERS:

		X-Axis	Y-Axis
Lu (ft)		15.00	15.00
K		1	1
Braced Against Joint Translation		Yes	Yes
Column Eccentricity (in)	Top	8.60	6.54
	Bottom	8.60	6.54

CONTROLLING COLUMN LOADS - Load Case 6:

		Dead	Live	Roof
Axial (kips)		139.90	38.51	0.00
Moments	Top Mx (kip-ft)	0.00	0.00	0.00
	My (kip-ft)	0.00	2.10	0.00
	Bot Mx (kip-ft)	0.00	-1.38	0.00
	My (kip-ft)	0.00	-2.10	0.00

Single curvature about X-Axis
Single curvature about Y-Axis

CALCULATED PARAMETERS: (DL + LL + RF)

fa (ksi)	=	12.22	Fa (ksi)	=	16.58
fbx (ksi)	=	0.26	Fbx (ksi)	=	30.00
Fbx (ksi)	=	28.26 (Eq H1-1)			
fby (ksi)	=	1.81	Fby (ksi)	=	37.50
Cb	=	1.75			
KL/Rx	=	34.78	KL/Ry	=	91.66
F'ex	=	123.43	F'ey	=	17.77
Cmx	=	0.60	Cmy	=	1.00

INTERACTION EQUATION

fa/Fa = 0.74
Eq H1-1: 0.737 + 0.006 + 0.155 = 0.898
Eq H1-2: 0.407 + 0.009 + 0.048 = 0.464

Gravity Column Design

RAM Steel v10.0
DataBase: Jayme Structural
Building Code: IBC

Page 4/6
04/05/06 17:05:53
Steel Code: ASD 9th Ed.

Story level 3rd, Column Line B - 2

Fy (ksi) = 50.00 Column Size = W12X53
Orientation (degrees) = 90.0

INPUT DESIGN PARAMETERS:

		X-Axis	Y-Axis
Lu (ft)		15.00	15.00
K		1	1
Braced Against Joint Translation		Yes	Yes
Column Eccentricity (in)	Top	8.55	7.49
	Bottom	8.55	7.49

CONTROLLING COLUMN LOADS - Load Case 6:

			Dead	Live	Roof
Axial (kips)			190.91	56.43	0.00
Moments	Top	Mx (kip-ft)	0.00	0.00	0.00
		My (kip-ft)	0.00	2.20	0.00
	Bot	Mx (kip-ft)	0.00	-1.37	0.00
		My (kip-ft)	0.00	-2.40	0.00

Single curvature about X-Axis
Single curvature about Y-Axis

CALCULATED PARAMETERS: (DL + LL + RF)

fa (ksi)	=	15.85	Fa (ksi)	=	20.44
fbx (ksi)	=	0.23	Fbx (ksi)	=	30.00
fby (ksi)	=	1.50	Fby (ksi)	=	37.50
Cb	=	1.75			
KL/Rx	=	34.49	KL/Ry	=	72.64
F'ex	=	125.57	F'ey	=	28.30
Cmx	=	0.60	Cmy	=	0.97

INTERACTION EQUATION

fa/Fa = 0.78
Eq H1-1: 0.776 + 0.005 + 0.088 = 0.869
Eq H1-2: 0.528 + 0.008 + 0.040 = 0.576

Gravity Column Design

RAM Steel v10.0 — Page 5/6
DataBase: Jayme Structural — 04/05/06 17:05:53
Building Code: IBC — Steel Code: ASD 9th Ed.

Story level 2nd, Column Line B - 2

Fy (ksi) = 50.00 — Column Size = W12X65
Orientation (degrees) = 90.0

INPUT DESIGN PARAMETERS:

		X-Axis	Y-Axis
Lu (ft)		18.00	18.00
K		1	1
Braced Against Joint Translation		Yes	Yes
Column Eccentricity (in)	Top	8.55	8.50
	Bottom	8.55	8.50

CONTROLLING COLUMN LOADS - Load Case 6:

		Dead	Live	Roof
Axial (kips)		242.30	73.33	0.00
Moments	Top Mx (kip-ft)	0.00	0.00	0.00
	My (kip-ft)	0.00	2.15	0.00
	Bot Mx (kip-ft)	0.00	-1.19	0.00
	My (kip-ft)	0.00	-2.36	0.00

Single curvature about X-Axis
Single curvature about Y-Axis

CALCULATED PARAMETERS: (DL + LL + RF)

fa (ksi)	=	16.53	Fa (ksi)	=	20.64
fbx (ksi)	=	0.16	Fbx (ksi)	=	30.00
fby (ksi)	=	0.97	Fby (ksi)	=	36.22
Cb	=	1.75			
KL/Rx	=	40.89	KL/Ry	=	71.56
F'ex	=	89.32	F'ey	=	29.16
Cmx	=	0.60	Cmy	=	0.96

INTERACTION EQUATION

fa/Fa = 0.80
Eq H1-1: 0.801 + 0.004 + 0.060 = 0.864
Eq H1-2: 0.551 + 0.005 + 0.027 = 0.583

Gravity Column Design

RAM Steel v10.0 — Page 6/6
DataBase: Jayme Structural — 04/05/06 17:05:53
Building Code: IBC — Steel Code: ASD 9th Ed.

Story level 1st, Column Line B - 2

Fy (ksi) = 50.00 Column Size = W12X72
Orientation (degrees) = 90.0

INPUT DESIGN PARAMETERS:

		X-Axis	Y-Axis
Lu (ft)		18.00	18.00
K		1	1
Braced Against Joint Translation		Yes	Yes
Column Eccentricity (in)	Top	8.65	8.50
	Bottom	0.00	0.00

CONTROLLING COLUMN LOADS - Load Case 6:

			Dead	Live	Roof
Axial (kips)			293.81	93.33	0.00
Moments	Top	Mx (kip-ft)	0.00	0.00	0.00
		My (kip-ft)	0.00	2.36	0.00
	Bot	Mx (kip-ft)	0.00	0.00	0.00
		My (kip-ft)	0.00	0.00	0.00

Single curvature about X-Axis
Single curvature about Y-Axis

CALCULATED PARAMETERS: (DL + LL + RF)

fa (ksi)	=	18.35	Fa (ksi)	=	20.74
fbx (ksi)	=	0.00	Fbx (ksi)	=	30.00
fby (ksi)	=	0.87	Fby (ksi)	=	37.50
Cb	=	1.00			
KL/Rx	=	40.61	KL/Ry	=	71.05
F'ex	=	90.56	F'ey	=	29.58
Cmx	=	0.00	Cmy	=	0.60

INTERACTION EQUATION

fa/Fa = 0.88
Eq H1-1: 0.885 + 0.000 + 0.037 = 0.922
Eq H1-2: 0.612 + 0.000 + 0.023 = 0.635

3. Primavera Ductwork Schedule.