

APPENDIX A

LEED CERTIFICATION FORM

LEED CERTIFICATION FORM

		New House Residence Hall, Carnegie Mellon University LEED Project # 0246 LEED Version 2 Certification Level: Silver September 12, 2003																																																																																																																					
35 Points Achieved		Possible Points: 69																																																																																																																					
Certified 26 to 32 points Silver 33 to 38 points Gold 39 to 51 points Platinum 52 or more points																																																																																																																							
5 Sustainable Sites Possible Points: 14		7 Materials & Resources Possible Points: 13																																																																																																																					
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APPENDIX B

ESTIMATED BUILDING ENERGY EMISSIONS

Estimating Emissions Associated with On-Site Electricity Use U.S. Power Generation Mix

Fuel	kWh(1999)	% Total	Short Tons				lbm Pollutant _j /kWh US			
			SO ₂	NO ₂	CO ₂		Particulates	SO ₂ /kWh	NO ₂ /kWh	CO ₂ /kWh
Coal	1.77E+12	55.7	1.13E+07	6.55E+06	1.90E+09		1.10E-03	1.28E-02	7.41E-03	2.15E+00
Oil	8.69E+10	2.7	6.70E+05	1.23E+05	9.18E+07		1.10E-03	1.54E-02	2.83E-03	2.11E+00
Nat. Gas	2.96E+11	9.3	2.00E+03	3.76E+05	1.99E+08		0.00E+00	1.35E-05	2.54E-03	1.34E+00
Nuclear	7.25E+11	22.8	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hydro/Wind	3.00E+11	9.4	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
Totals	3.18E+12	100.0	1.20E+07	7.05E+06	2.19E+09		6.42E-04	7.54E-03	4.44E-03	1.38E+00

Source: Electric Power Annual 1999, Vol.II, October 2000, DOE/EIA-0348(99)/2, Energy Information Administration, US DOE, Washington, D.C. 20585-065 <http://www.eia.doe.gov/eneaf/electricity/epav2/epav2.pdf>

First Energy Solutions Power Generation

First Energy Solutions		lbm Pollutant _j /kWh U.S.			
Fuel	% Mix U.S.	Particulates	SO ₂ /kWh	NO _x /kWh	CO ₂ /kWh
Coal	56.0	6.16E-04	7.16E-03	4.15E-03	1.20E+00
Oil	3.0	3.30E-05	4.62E-04	8.49E-05	6.33E-02
Nat. Gas	8.0	0.00E+00	1.08E-06	2.03E-04	1.07E-01
Nuclear	28.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Hydro/Wind	5.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Totals	100.0	6.49E-04	7.62E-03	4.44E-03	1.37E+00

New House Energy Consumption By Fuel Type

		lbm Pollutant _j /kWh U.S.			
Fuel	kWh	Particulates	SO ₂ /kWh	NO _x /kWh	CO ₂ /kWh
Coal		6.16E-04	7.16E-03	4.15E-03	1.20E+00
Oil		3.30E-05	4.62E-04	8.49E-05	6.33E-02
Totals	158,084	6.49E-04	7.62E-03	4.23E-03	1.27E+00
lbm Pollutant		1.03E+02	1.20E+03	6.69E+02	2.00E+05

		lbm Pollutant _j /kWh U.S.			
Fuel	kWh	Particulates	SO ₂ /kWh	NO _x /kWh	CO ₂ /kWh
Nat. Gas		0.00E+00	1.08E-06	2.03E-04	1.07E-01
Totals	439,496	0.00E+00	1.08E-06	2.03E-04	1.07E-01
lbm Pollutant		0.00E+00	4.75E-01	8.92E+01	4.71E+04

		lbm Pollutant _j /kWh U.S.			
Fuel	kWh	Particulates	SO ₂ /kWh	NO _x /kWh	CO ₂ /kWh
Electricity		6.49E-04	7.62E-03	4.44E-03	1.37E+00
Totals	361,202.5	6.49E-04	7.62E-03	4.44E-03	1.37E+00
lbm Pollutant		2.34E+02	2.75E+03	1.60E+03	4.97E+05

- Note:
1. lbm Pollutants; equal total of each fuel source used.
 2. Half of electricity produced by New Wind Energy. Actual total 722,405 kWh

APPENDIX C

THERMAL STORAGE MEDIA TYPES

THERMAL STORAGE MEDIUM EVALUATION

Operating Mode	Storage Type	Chiller Size	Storage Size	On-Peak	Peak Month Demand Savings	Annual Demand Savings	Annual Demand Savings
		tons	ton-hr	kW	kW	kW	\$
Nonstorage	-	120	0	84	-	-	-
Daily Full Storage	Chilled Water	172	1,071	0	84	546	3,630.99
Daily Full Storage	Glycol Ice	246	1,071	0	84	546	3,630.99
Daily Load Leveling	Chilled Water	93	44	65	19	149	990.92
Daily Demand Limiting	Glycol Ice	120	411	42	42	336	2,234.45

APPENDIX D

CARRIER HOURLY ANALYSIS DESIGN OUTPUT

COOLING PLANT SIZING SUMMARY

Plant Information:

Plant Name C Plant
Plant Type Chiller Plant
Design Weather Pittsburgh IAP, Pennsylvania

Cooling Plant Sizing Data:

Maximum Plant Load 102.6 Tons
Load occurs at July 1500
ft²/Ton 544.8 ft²/Ton
Floor area served by plant 55893.0 ft²

Coincident Air System Cooling Loads for July 1500

Air System Name	Mult.	System Cooling Coil Load (Tons)
AHU-1	1	5.6
AHU-2	1	10.2
AHU-3	1	3.2
AHU-4	1	21.7
AHU-5	1	61.8

AIR SYSTEM DESIGN LOAD SUMMARY – AHU-1

	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Jul 1500			HEATING DATA AT DES HTG		
	COOLING OA DB / WB 86.0 °F / 70.0 °F			HEATING OA DB / WB 2.0 °F / 0.3 °F		
ZONE LOADS	Details	Sensible (BTU/hr)	Latent (BTU/hr)	Details	Sensible (BTU/hr)	Latent (BTU/hr)
Window & Skylight Solar Loads	37 ft²	2480	-	37 ft²	-	-
Wall Transmission	323 ft²	962	-	323 ft²	2327	-
Roof Transmission	0 ft²	0	-	0 ft²	0	-
Window Transmission	37 ft²	191	-	37 ft²	1506	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	0 ft²	0	-	0 ft²	0	-
Floor Transmission	0 ft²	0	-	0 ft²	0	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	2000 W	5702	-	0	0	-
Task Lighting	2425 W	7518	-	0	0	-
Electric Equipment	1634 W	5166	-	0	0	-
People	32	6120	6560	0	0	0
Infiltration	-	0	0	-	0	0
Miscellaneous	-	0	0	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	-	28139	6560	-	3833	0
Zone Conditioning	-	28181	6560	-	3831	0
Plenum Wall Load	0%	0	-	0	0	-
Plenum Roof Load	0%	0	-	0	0	-
Plenum Lighting Load	0%	0	-	0	0	-
Return Fan Load	1499 CFM	3000	-	1499 CFM	-3000	-
Ventilation Load	915 CFM	10510	14412	915 CFM	70439	21191
Supply Fan Load	1499 CFM	4260	-	1499 CFM	-4260	-
Space Fan Coil Fans	-	0	-	-	0	-
Duct Heat Gain / Loss	5%	1407	-	5%	192	-
>> Total System Loads	-	47358	20972	-	67201	21191
Central Cooling Coil	-	5741	3233	-	0	0
Central Heating Coil	-	0	-	-	29355	-
Precool Coil	-	46769	17739	-	-46769	0
Preheat Coil	-	-5152	-	-	84416	-
Humidification Load	-	-	0	-	-	21191
Zone Heating Unit Coils	-	0	-	-	199	-
>> Total Conditioning	-	47358	20972	-	67201	21191
Key:	Positive values are clg loads Negative values are htg loads			Positive values are htg loads Negative values are clg loads		

AIR SYSTEM SIZING SUMMARY – AHU-1

Air System Information

Air System Name **AHU-1**
Equipment Class **CW AHU**
Air System Type **SZCAV**

Number of zones **1**
Floor Area **1317.0** ft²
Location **Pittsburgh IAP, Pennsylvania**

Central Cooling Coil Sizing Data

Total coil load **0.7** Tons
Total coil load **9.0** MBH
Sensible coil load **5.7** MBH
Coil CFM at Jul 1500 **1499** CFM
Max block CFM **1499** CFM
Sum of peak zone CFM **1499** CFM
Sensible heat ratio **0.640**
ft²/Ton **1761.0**
BTU/(hr-ft²) **6.8**
Water flow @ 10.0 °F rise **1.80** gpm

Load occurs at **Jul 1500**
OA DB / WB **86.0 / 70.0** °F
Entering DB / WB **55.0 / 53.6** °F
Leaving DB / WB **51.3 / 51.2** °F
Coil ADP **50.9** °F
Bypass Factor **0.100**
Resulting RH **50** %
Design supply temp. **55.0** °F
Zone T-stat Check **1 of 1** OK
Max zone temperature deviation **0.0** °F

Precool Coil Sizing Data

Total coil load **6.1** Tons
Total coil load **72.8** MBH
Sensible coil load **46.8** MBH
Coil CFM at Aug 0000 **1499** CFM
Max coil CFM **1499** CFM
Sensible heat ratio **0.643**
Water flow @ 10.0 °F rise **14.57** gpm

Load occurs at **Aug 0000**
OA DB / WB **72.9 / 66.1** °F
Entering DB / WB **85.0 / 69.7** °F
Leaving DB / WB **55.0 / 53.8** °F
Bypass Factor **0.100**

Preheat Coil Sizing Data

Max coil load **84.4** MBH
Coil CFM at Des Htg **1499** CFM
Max coil CFM **1499** CFM
Water flow @ 20.0 °F drop **8.45** gpm

Load occurs at **Des Htg**
Ent. DB / Lvg DB **30.9 / 85.0** °F

Humidifier Sizing Data

Max steam flow at Des Htg **20.09** lb/hr
Airflow Rate **1499** CFM

Air mass flow **6495.72** lb/hr
Moisture gain **.00309** lb/lb

Supply Fan Sizing Data

Actual max CFM **1499** CFM
Standard CFM **1443** CFM
Actual max CFM/ft² **1.14** CFM/ft²

Fan motor BHP **1.67** BHP
Fan motor kW **1.25** kW
Fan static **3.55** in wg

Return Fan Sizing Data

Actual max CFM **1499** CFM
Standard CFM **1443** CFM
Actual max CFM/ft² **1.14** CFM/ft²

Fan motor BHP **1.18** BHP
Fan motor kW **0.88** kW
Fan static **1.50** in wg

Outdoor Ventilation Air Data

Design airflow CFM **915** CFM
CFM/ft² **0.69** CFM/ft²

CFM/person **28.59** CFM/person

AIR SYSTEM DESIGN LOAD SUMMARY – AHU-2

	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Jul 1500 COOLING OA DB / WB 86.0 °F / 70.0 °F			HEATING DATA AT DES HTG HEATING OA DB / WB 2.0 °F / 0.3 °F		
ZONE LOADS	Details	Sensible (BTU/hr)	Latent (BTU/hr)	Details	Sensible (BTU/hr)	Latent (BTU/hr)
Window & Skylight Solar Loads	128 ft²	7780	-	128 ft²	-	-
Wall Transmission	680 ft²	2329	-	680 ft²	4891	-
Roof Transmission	0 ft²	0	-	0 ft²	0	-
Window Transmission	128 ft²	669	-	128 ft²	5272	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	96 ft²	5554	-	96 ft²	3606	-
Floor Transmission	0 ft²	0	-	0 ft²	0	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	3411 W	9725	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	3030 W	9580	-	0	0	-
People	95	18295	19475	0	0	0
Infiltration	-	0	0	-	0	0
Miscellaneous	-	0	0	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	-	53931	19475	-	13769	0
Zone Conditioning	-	52182	19475	-	13029	0
Plenum Wall Load	0%	0	-	0	0	-
Plenum Roof Load	0%	0	-	0	0	-
Plenum Lighting Load	0%	0	-	0	0	-
Return Fan Load	2873 CFM	3174	-	2873 CFM	-3174	-
Ventilation Load	1297 CFM	16193	15461	1297 CFM	94237	27432
Supply Fan Load	2873 CFM	5175	-	2873 CFM	-5175	-
Space Fan Coil Fans	-	0	-	-	0	-
Duct Heat Gain / Loss	5%	2697	-	5%	688	-
>> Total System Loads	-	79421	34936	-	99605	27432
Central Cooling Coil	-	8014	1970	-	0	0
Central Heating Coil	-	0	-	-	0	-
Precool Coil	-	89637	32966	-	-89637	0
Preheat Coil	-	-16685	-	-	133505	-
Humidification Load	-	-	0	-	-	27432
Zone Heating Unit Coils	-	-1544	-	-	55736	-
>> Total Conditioning	-	79421	34936	-	99605	27432
Key:	Positive values are clg loads Negative values are htg loads			Positive values are htg loads Negative values are clg loads		

AIR SYSTEM SIZING SUMMARY – AHU-2

Air System Information

Air System Name **AHU-2**
Equipment Class **CW AHU**
Air System Type **CAV/RH**

Number of zones **5**
Floor Area **2535.0** ft²
Location **Pittsburgh IAP, Pennsylvania**

Central Cooling Coil Sizing Data

Total coil load **0.8** Tons
Total coil load **10.0** MBH
Sensible coil load **8.0** MBH
Coil CFM at Jul 1500 **2873** CFM
Max block CFM **2873** CFM
Sum of peak zone CFM **2873** CFM
Sensible heat ratio **0.803**
ft²/Ton **3047.0**
BTU/(hr-ft²) **3.9**
Water flow @ 10.0 °F rise **2.00** gpm

Load occurs at **Jul 1500**
OA DB / WB **86.0 / 70.0** °F
Entering DB / WB **55.0 / 53.6** °F
Leaving DB / WB **52.3 / 52.2** °F
Coil ADP **52.0** °F
Bypass Factor **0.100**
Resulting RH **55** %
Design supply temp. **55.0** °F
Zone T-stat Check **5 of 5** OK
Max zone temperature deviation **0.0** °F

Precool Coil Sizing Data

Total coil load **11.6** Tons
Total coil load **139.5** MBH
Sensible coil load **89.6** MBH
Coil CFM at Jul 0000 **2873** CFM
Max coil CFM **2873** CFM
Sensible heat ratio **0.643**
Water flow @ 10.0 °F rise **27.92** gpm

Load occurs at **Jul 0000**
OA DB / WB **72.9 / 66.1** °F
Entering DB / WB **85.0 / 69.7** °F
Leaving DB / WB **55.0 / 53.8** °F
Bypass Factor **0.100**

Preheat Coil Sizing Data

Max coil load **133.5** MBH
Coil CFM at Des Htg **2873** CFM
Max coil CFM **2873** CFM
Water flow @ 20.0 °F drop **13.36** gpm

Load occurs at **Des Htg**
Ent. DB / Lvg DB **40.3 / 85.0** °F

Humidifier Sizing Data

Max steam flow at Des Htg **26.01** lb/hr
Airflow Rate **2873** CFM

Air mass flow **12449.54** lb/hr
Moisture gain **.00209** lb/lb

Supply Fan Sizing Data

Actual max CFM **2873** CFM
Standard CFM **2767** CFM
Actual max CFM/ft² **1.13** CFM/ft²

Fan motor BHP **2.03** BHP
Fan motor kW **1.52** kW
Fan static **2.25** in wg

Return Fan Sizing Data

Actual max CFM **2873** CFM
Standard CFM **2767** CFM
Actual max CFM/ft² **1.13** CFM/ft²

Fan motor BHP **1.25** BHP
Fan motor kW **0.93** kW
Fan static **1.38** in wg

Outdoor Ventilation Air Data

Design airflow CFM **1297** CFM
CFM/ft² **0.51** CFM/ft²

CFM/person **13.65** CFM/person

AIR SYSTEM DESIGN LOAD SUMMARY – AHU-3

	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Aug 1100			HEATING DATA AT DES HTG		
	COOLING OA DB / WB 79.8 °F / 68.2 °F			HEATING OA DB / WB 2.0 °F / 0.3 °F		
ZONE LOADS	Details	Sensible (BTU/hr)	Latent (BTU/hr)	Details	Sensible (BTU/hr)	Latent (BTU/hr)
Window & Skylight Solar Loads	0 ft²	0	-	0 ft²	-	-
Wall Transmission	444 ft²	1260	-	444 ft²	3196	-
Roof Transmission	0 ft²	0	-	0 ft²	0	-
Window Transmission	0 ft²	0	-	0 ft²	0	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	144 ft²	8582	-	144 ft²	5409	-
Floor Transmission	0 ft²	0	-	0 ft²	0	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	703 W	1880	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	1112 W	3429	-	0	0	-
People	17	2966	3485	0	0	0
Infiltration	-	0	0	-	0	0
Miscellaneous	-	0	0	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	-	18116	3485	-	8604	0
Zone Conditioning	-	17692	3485	-	8241	0
Plenum Wall Load	0%	0	-	0	0	-
Plenum Roof Load	0%	0	-	0	0	-
Plenum Lighting Load	0%	0	-	0	0	-
Return Fan Load	980 CFM	1083	-	980 CFM	-1083	-
Ventilation Load	255 CFM	1528	3862	255 CFM	18506	5376
Supply Fan Load	980 CFM	1766	-	980 CFM	-1766	-
Space Fan Coil Fans	-	0	-	-	0	-
Duct Heat Gain / Loss	5%	906	-	5%	430	-
>> Total System Loads	-	22975	7347	-	24328	5376
Central Cooling Coil	-	2719	237	-	0	0
Central Heating Coil	-	0	-	-	0	-
Precool Coil	-	30585	7110	-	-30585	0
Preheat Coil	-	-9688	-	-	31984	-
Humidification Load	-	-	0	-	-	5376
Zone Heating Unit Coils	-	-640	-	-	22928	-
>> Total Conditioning	-	22975	7347	-	24328	5376
Key:	Positive values are clg loads Negative values are htg loads			Positive values are htg loads Negative values are clg loads		

AIR SYSTEM SIZING SUMMARY – AHU-3

Air System Information

Air System Name **AHU-3**
Equipment Class **CW AHU**
Air System Type **CAV/RH**

Number of zones **1**
Floor Area **556.0** ft²
Location **Pittsburgh IAP, Pennsylvania**

Central Cooling Coil Sizing Data

Total coil load **0.2** Tons
Total coil load **3.0** MBH
Sensible coil load **2.7** MBH
Coil CFM at Aug 1100 **980** CFM
Max block CFM **980** CFM
Sum of peak zone CFM **980** CFM
Sensible heat ratio **0.920**
ft²/Ton **2256.7**
BTU/(hr-ft²) **5.3**
Water flow @ 10.0 °F rise **0.59** gpm

Load occurs at **Aug 1100**
OA DB / WB **79.8 / 68.2** °F
Entering DB / WB **55.0 / 53.4** °F
Leaving DB / WB **52.3 / 52.2** °F
Coil ADP **52.0** °F
Bypass Factor **0.100**
Resulting RH **51** %
Design supply temp. **55.0** °F
Zone T-stat Check **1 of 1** OK
Max zone temperature deviation **0.0** °F

Precool Coil Sizing Data

Total coil load **4.0** Tons
Total coil load **47.6** MBH
Sensible coil load **30.6** MBH
Coil CFM at Jul 0000 **980** CFM
Max coil CFM **980** CFM
Sensible heat ratio **0.643**
Water flow @ 10.0 °F rise **9.52** gpm

Load occurs at **Jul 0000**
OA DB / WB **72.9 / 66.1** °F
Entering DB / WB **85.0 / 69.7** °F
Leaving DB / WB **55.0 / 53.8** °F
Bypass Factor **0.100**

Preheat Coil Sizing Data

Max coil load **32.0** MBH
Coil CFM at Des Htg **980** CFM
Max coil CFM **980** CFM
Water flow @ 20.0 °F drop **3.20** gpm

Load occurs at **Des Htg**
Ent. DB / Lvg DB **53.6 / 85.0** °F

Humidifier Sizing Data

Max steam flow at Des Htg **5.10** lb/hr
Airflow Rate **980** CFM

Air mass flow **4247.85** lb/hr
Moisture gain **.00120** lb/lb

Supply Fan Sizing Data

Actual max CFM **980** CFM
Standard CFM **944** CFM
Actual max CFM/ft² **1.76** CFM/ft²

Fan motor BHP **0.69** BHP
Fan motor kW **0.52** kW
Fan static **2.25** in wg

Return Fan Sizing Data

Actual max CFM **980** CFM
Standard CFM **944** CFM
Actual max CFM/ft² **1.76** CFM/ft²

Fan motor BHP **0.43** BHP
Fan motor kW **0.32** kW
Fan static **1.38** in wg

Outdoor Ventilation Air Data

Design airflow CFM **255** CFM
CFM/ft² **0.46** CFM/ft²

CFM/person **15.00** CFM/person

AIR SYSTEM DESIGN LOAD SUMMARY – AHU-4

	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Jul 1500			HEATING DATA AT DES HTG		
	COOLING OA DB / WB 86.0 °F / 70.0 °F			HEATING OA DB / WB 2.0 °F / 0.3 °F		
ZONE LOADS	Details	Sensible (BTU/hr)	Latent (BTU/hr)	Details	Sensible (BTU/hr)	Latent (BTU/hr)
Window & Skylight Solar Loads	0 ft²	0	-	0 ft²	-	-
Wall Transmission	3010 ft²	11198	-	3010 ft²	21666	-
Roof Transmission	0 ft²	0	-	0 ft²	0	-
Window Transmission	0 ft²	0	-	0 ft²	0	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	0 ft²	0	-	0 ft²	0	-
Floor Transmission	11411 ft²	0	-	11411 ft²	0	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	11542 W	32905	-	0	0	-
Task Lighting	1352 W	4191	-	0	0	-
Electric Equipment	22725 W	71850	-	0	0	-
People	2	439	240	0	0	0
Infiltration	-	0	0	-	0	0
Miscellaneous	-	0	0	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	-	120582	240	-	21666	0
Zone Conditioning	-	114697	240	-	19012	0
Plenum Wall Load	0%	0	-	0	0	-
Plenum Roof Load	0%	0	-	0	0	-
Plenum Lighting Load	0%	0	-	0	0	-
Return Fan Load	6530 CFM	7262	-	6530 CFM	-7262	-
Ventilation Load	3067 CFM	38497	58999	3067 CFM	223268	65137
Supply Fan Load	6530 CFM	14378	-	6530 CFM	-14378	-
Space Fan Coil Fans	-	0	-	-	0	-
Duct Heat Gain / Loss	5%	6029	-	5%	1083	-
>> Total System Loads	-	180863	59239	-	221724	65137
Central Cooling Coil	-	20724	5826	-	0	0
Central Heating Coil	-	0	-	-	0	-
Precool Coil	-	203753	53414	-	-203753	0
Preheat Coil	-	-36672	-	-	311647	-
Humidification Load	-	-	0	-	-	65137
Zone Heating Unit Coils	-	-6943	-	-	113830	-
>> Total Conditioning	-	180863	59240	-	221724	65137
Key:	Positive values are clg loads Negative values are htg loads			Positive values are htg loads Negative values are clg loads		

AIR SYSTEM SIZING SUMMARY – AHU-4

Air System Information

Air System Name **AHU-4**
Equipment Class **CW AHU**
Air System Type **CAV/RH**

Number of zones **16**
Floor Area **11491.0** ft²
Location **Pittsburgh IAP, Pennsylvania**

Central Cooling Coil Sizing Data

Total coil load **2.2** Tons
Total coil load **26.6** MBH
Sensible coil load **20.7** MBH
Coil CFM at Jul 1500 **6530** CFM
Max block CFM **6530** CFM
Sum of peak zone CFM **6530** CFM
Sensible heat ratio **0.781**
ft²/Ton **5193.7**
BTU/(hr-ft²) **2.3**
Water flow @ 10.0 °F rise **5.31** gpm

Load occurs at **Jul 1500**
OA DB / WB **86.0 / 70.0** °F
Entering DB / WB **55.0 / 53.4** °F
Leaving DB / WB **51.9 / 51.8** °F
Coil ADP **51.6** °F
Bypass Factor **0.100**
Resulting RH **46** %
Design supply temp. **55.0** °F
Zone T-stat Check **16 of 16** OK
Max zone temperature deviation **0.0** °F

Precool Coil Sizing Data

Total coil load **26.4** Tons
Total coil load **317.1** MBH
Sensible coil load **203.8** MBH
Coil CFM at Jul 0800 **6530** CFM
Max coil CFM **6530** CFM
Sensible heat ratio **0.643**
Water flow @ 10.0 °F rise **63.45** gpm

Load occurs at **Jul 0800**
OA DB / WB **72.6 / 65.9** °F
Entering DB / WB **85.0 / 69.7** °F
Leaving DB / WB **55.0 / 53.8** °F
Bypass Factor **0.100**

Preheat Coil Sizing Data

Max coil load **311.6** MBH
Coil CFM at Des Htg **6530** CFM
Max coil CFM **6530** CFM
Water flow @ 20.0 °F drop **31.18** gpm

Load occurs at **Des Htg**
Ent. DB / Lvg DB **39.1 / 85.0** °F

Humidifier Sizing Data

Max steam flow at Des Htg **61.75** lb/hr
Airflow Rate **6530** CFM

Air mass flow **28299.08** lb/hr
Moisture gain **.00218** lb/lb

Supply Fan Sizing Data

Actual max CFM **6530** CFM
Standard CFM **6289** CFM
Actual max CFM/ft² **0.57** CFM/ft²

Fan motor BHP **5.65** BHP
Fan motor kW **4.21** kW
Fan static **2.75** in wg

Return Fan Sizing Data

Actual max CFM **6530** CFM
Standard CFM **6289** CFM
Actual max CFM/ft² **0.57** CFM/ft²

Fan motor BHP **2.85** BHP
Fan motor kW **2.13** kW
Fan static **1.50** in wg

Outdoor Ventilation Air Data

Design airflow CFM **3067** CFM
CFM/ft² **0.27** CFM/ft²

CFM/person **1533.68** CFM/person

AIR SYSTEM DESIGN LOAD SUMMARY – AHU-5

	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT May 1500 COOLING OA DB / WB 77.2 °F / 65.2 °F			HEATING DATA AT DES HTG HEATING OA DB / WB 2.0 °F / 0.3 °F		
ZONE LOADS	Details	Sensible (BTU/hr)	Latent (BTU/hr)	Details	Sensible (BTU/hr)	Latent (BTU/hr)
Window & Skylight Solar Loads	2734 ft²	161103	-	2734 ft²	-	-
Wall Transmission	18720 ft²	34428	-	18720 ft²	134743	-
Roof Transmission	5273 ft²	189517	-	5273 ft²	15378	-
Window Transmission	2734 ft²	520	-	2734 ft²	112210	-
Skylight Transmission	0 ft²	0	-	0 ft²	0	-
Door Loads	528 ft²	23917	-	528 ft²	19832	-
Floor Transmission	0 ft²	0	-	0 ft²	0	-
Partitions	0 ft²	0	-	0 ft²	0	-
Ceiling	0 ft²	0	-	0 ft²	0	-
Overhead Lighting	25836 W	73657	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	54928 W	173668	-	0	0	-
People	465	100578	95243	0	0	0
Infiltration	-	0	0	-	0	0
Miscellaneous	-	0	0	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	-	757389	95243	-	282161	0
Zone Conditioning	-	468780	95243	-	34446	0
Plenum Wall Load	0%	0	-	0	0	-
Plenum Roof Load	0%	0	-	0	0	-
Plenum Lighting Load	0%	0	-	0	0	-
Return Fan Load	12100 CFM	13455	-	12100 CFM	-13455	-
Ventilation Load	12100 CFM	-139679	111032	12100 CFM	101430	18900
Supply Fan Load	12100 CFM	42607	-	12100 CFM	-42607	-
Space Fan Coil Fans	-	0	-	-	0	-
Duct Heat Gain / Loss	5%	37869	-	5%	14108	-
>> Total System Loads	-	423032	206275	-	93921	18900
Central Cooling Coil	-	120223	114464	-	0	0
Central Heating Coil	-	0	-	-	0	-
Precool Coil	-	377528	129854	-	-377528	0
Preheat Coil	-	-98157	-	-	469727	-
Humidification Load	-	-	-38042	-	-	18900
>> Total Conditioning	-	399594	206275	-	92199	18900
Key:	Positive values are clg loads Negative values are htg loads			Positive values are htg loads Negative values are clg loads		

AIR SYSTEM SIZING SUMMARY - AHU-5

Air System Information

Air System Name **AHU-5**
Equipment Class **CW AHU**
Air System Type **CAV/RH**

Number of zones **5**
Floor Area **39994.0** ft²
Location **Pittsburgh IAP, Pennsylvania**

Central Cooling Coil Sizing Data

Total coil load **19.6** Tons
Total coil load **234.7** MBH
Sensible coil load **120.2** MBH
Coil CFM at May 1500 **12100** CFM
Max block CFM **12100** CFM
Sum of peak zone CFM **12737** CFM
Sensible heat ratio **0.512**
ft²/Ton **2045.0**
BTU/(hr-ft²) **5.9**
Water flow @ 10.0 °F rise **46.96** gpm

Load occurs at **May 1500**
OA DB / WB **77.2 / 65.2** °F
Entering DB / WB **55.0 / 53.5** °F
Leaving DB / WB **45.4 / 45.4** °F
Coil ADP **44.4** °F
Bypass Factor **0.100**
Resulting RH **30** %
Design supply temp. **52.0** °F
Zone T-stat Check **0 of 5** OK
Max zone temperature deviation **28.1** °F

Precool Coil Sizing Data

Total coil load **45.4** Tons
Total coil load **544.4** MBH
Sensible coil load **377.5** MBH
Coil CFM at Jun 0900 **12100** CFM
Max coil CFM **12100** CFM
Sensible heat ratio **0.694**
Water flow @ 10.0 °F rise **108.93** gpm

Load occurs at **Jun 0900**
OA DB / WB **71.6 / 64.5** °F
Entering DB / WB **85.0 / 68.6** °F
Leaving DB / WB **55.0 / 53.6** °F
Bypass Factor **0.100**

Preheat Coil Sizing Data

Max coil load **469.7** MBH
Coil CFM at Des Htg **12100** CFM
Max coil CFM **12100** CFM
Water flow @ 20.0 °F drop **47.00** gpm

Load occurs at **Des Htg**
Ent. DB / Lvg DB **47.7 / 85.0** °F

Humidifier Sizing Data

Max steam flow at Jun 1400 **43.64** lb/hr
Airflow Rate **12100** CFM

Air mass flow **52434.50** lb/hr
Moisture gain **.00083** lb/lb

Supply Fan Sizing Data

Actual max CFM **12100** CFM
Standard CFM **11652** CFM
Actual max CFM/ft² **0.30** CFM/ft²

Fan motor BHP **16.75** BHP
Fan motor kW **12.49** kW
Fan static **4.75** in wg

Return Fan Sizing Data

Actual max CFM **12100** CFM
Standard CFM **11652** CFM
Actual max CFM/ft² **0.30** CFM/ft²

Fan motor BHP **5.29** BHP
Fan motor kW **3.94** kW
Fan static **1.50** in wg

Outdoor Ventilation Air Data

Design airflow CFM **12100** CFM
CFM/ft² **0.30** CFM/ft²

CFM/person **26.04** CFM/person

APPENDIX E

THERMAL STORAGE CALCULATIONS

DESIGN DAY LOAD PROFILE

Hour	Load		Hour	Load		Hour	Load	
	Tons	kW		Tons	kW		Tons	kW
1	88.7	311.96	9	93.1	327.43	17	98.4	346.07
2	88.4	310.90	10	93.5	328.84	18	96.8	340.45
3	88.8	312.31	11	95.1	334.47	19	95.1	334.47
4	89.3	314.07	12	96.8	340.45	20	93.1	327.43
5	89.4	314.42	13	98.4	346.07	21	91.0	320.05
6	90.7	318.99	14	100.7	354.16	22	89.1	313.36
7	92.0	323.56	15	102.6	360.84	23	88.6	311.61
8	92.7	326.03	16	100.7	354.16	24	88.4	310.90

			Ton-hr	kWh
# of on-peak hours	11	On-peak	1,071.20	3,767.41
# of off-peak hours	13	Off-Peak	1,170.20	4,115.59
		Total Load	2,241.40	7,883.00

THERMAL STORAGE CALCULATIONS

Peak Design Load: 103 tons
Off-Peak Design Load: 94 tons
Original Chiller Size: 120 tons

Off-Peak Ice Storage Available:

$$120 - 94 = 26 \text{ tons}$$

Total Non-Storage On-Peak Ton-hrs

$$1,071.2 - 338 = 733.2 \text{ ton-hrs}$$

Total Ice Storage Charged:

$$(26 \text{ tons})(13 \text{ hrs}) = 338 \text{ ton-hrs}$$

On-Peak Chiller Load per hour

$$733.2 \text{ ton-hrs} / 11 \text{ hrs} = 66.6 \text{ tons}$$

Chiller #1: 26 tons
Chiller #2: 94 tons
Ice Storage Tanks: 338 ton-hrs

APPENDIX F

AIR COOLED SCROLL CHILLER CUT SHEETS

YORK - AIR-COOLED SCROLL CHILLER



YCAL0030EC

IPLV=14.1

LCWT (°F)	AIR TEMPERATURE ON CONDENSER (°F)														
	105°F			110°F			115°F			120°F			125°F		
	TONS	KW	EER	TONS	KW	EER	TONS	KW	EER	TONS	KW	EER	TONS	KW	EER
40.0	25.0	33.6	8.2	24.2	35.5	7.6	23.5	37.5	7.0	22.7	39.6	6.4	11.7	18.7	6.5
42.0	25.9	33.9	8.5	25.1	35.8	7.8	24.3	37.8	7.2	23.6	39.9	6.6	12.1	18.7	6.8
44.0	26.8	34.1	8.7	26.0	36.0	8.0	25.2	38.1	7.4	12.9	17.8	7.5	12.5	18.8	6.9
45.0	27.3	34.2	8.8	26.5	36.2	8.1	25.6	38.2	7.5	13.1	17.8	7.6	12.7	18.8	7.0
46.0	27.7	34.4	9.0	26.9	36.3	8.3	26.1	38.3	7.6	13.4	17.9	7.8	12.9	18.9	7.2
48.0	28.7	34.6	9.2	27.8	36.6	8.5	27.0	38.6	7.8	13.9	17.9	8.0	13.4	19.0	7.4
50.0	29.7	34.9	9.4	28.8	36.8	8.7	27.9	38.9	8.0	14.4	18.0	8.3	13.9	19.1	7.6

YCAL0104EC

IPLV=14.0

LCWT (°F)	AIR TEMPERATURE ON CONDENSER (°F)																	
	75°F			80°F			85°F			90°F			95°F			100°F		
	TONS	KW	EER	TONS	KW	EER	TONS	KW	EER	TONS	KW	EER	TONS	KW	EER	TONS	KW	EER
40.0	102.6	88.5	12.4	100.3	93.1	11.6	97.9	97.9	10.8	95.5	103.1	10.1	93.0	108.7	9.3	90.4	114.6	8.7
42.0	106.2	89.6	12.7	103.8	94.1	11.9	101.3	99.0	11.1	98.8	104.2	10.3	96.3	109.8	9.6	93.6	115.7	8.9
44.0	109.9	90.7	13.0	107.4	95.2	12.2	104.9	100.1	11.3	102.2	105.3	10.6	99.6	110.9	9.8	96.9	116.9	9.1
45.0	111.8	91.3	13.1	109.2	95.8	12.3	106.7	100.7	11.5	104.0	105.9	10.7	101.4	111.5	9.9	98.6	117.5	9.2
46.0	113.7	91.8	13.3	111.1	96.4	12.4	108.5	101.2	11.6	105.8	106.4	10.8	103.1	112.1	10.1	100.3	118.1	9.3
48.0	117.5	93.0	13.6	114.9	97.5	12.7	112.2	102.4	11.9	109.4	107.6	11.1	106.6	113.3	10.3	103.8	119.4	9.6
50.0	121.4	94.2	13.9	118.7	98.7	13.0	115.9	103.6	12.2	113.1	108.9	11.3	110.2	114.6	10.6	107.3	120.6	9.8

APPENDIX G

CALMAC STORAGE TANKS

CALMAC ICEBANK MODEL 1098C

TANK MODELS	1098C
Total Storage Capacity, Ton-Hr	115
With Mix Air	108
Latent Capacity Ton-Hr	98
With Mix Air	92
Sensible Capacity Ton-Hr	17
With Mix Air	16
Max. Operating Temp., °F	100
Factory Tested Pres., PSI	250
Max. Operating Pres., PSI	90
Dimensions (WxLxH), in.	89x93x69.5(4F)
Shipping Weight, lb*	1,275
Weight, Filled, lb	10,235
Floor Loading, lb/Sq Ft	237
Volume Of Water/Ice, Gal	980
Vol. Solution in HX, Gal	99
With Mix Air	85
Type of connection	4" Flange

Table 5.4: Tank Specifications

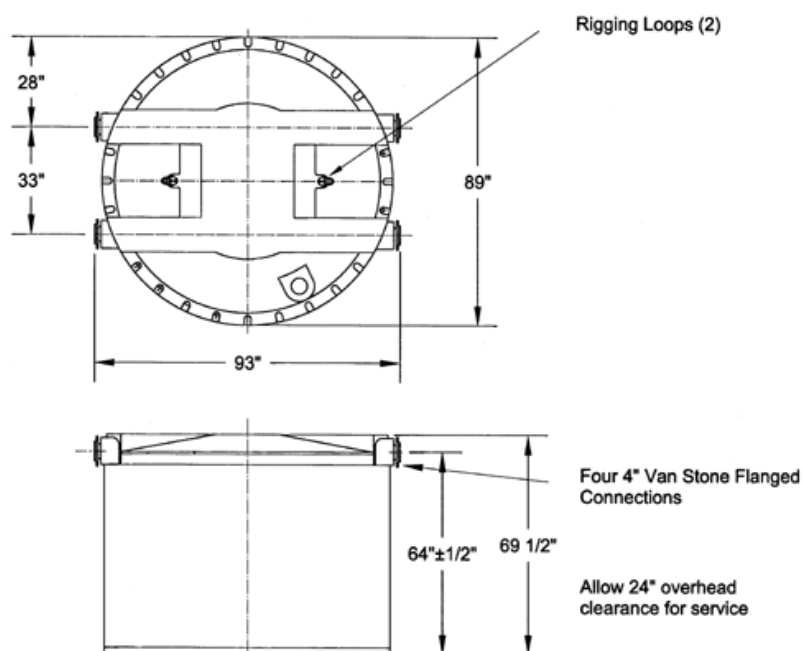


Figure 5.5: Tank Specification Drawings

APPENDIX H

ADDITIONAL PUMP CALCULATIONS

CHILLER CHARGE LOOP DESIGN

ρ (Glycol)	ρ (Water)	Fraction of Glycol	Fraction of Water	ρ (Total)	ρ (Total)
Kg/m ³	Kg/m ³			Kg/m ³	Lb/ft ³
1,096.78	1,000	0.25	0.75	1,024.195	63.94

Charge	Specific Heat	Density	Ice Bank Temp Drop	Conversion	Flow Rate
Btu/Hr	Btu/(lb °F)	Lb/ft ³	°F	Gpm/ft ³ /hr	Gpm
312,000	0.913	63.94	6.00	0.12	107

Pump Flow Rate:

$$312,000 / (.913 * 63.94) = 5,344.55 \text{ °F- ft}^3/\text{hr}$$
$$(5,344.55 / 6) * .12 = \mathbf{107 \text{ gpm}}$$

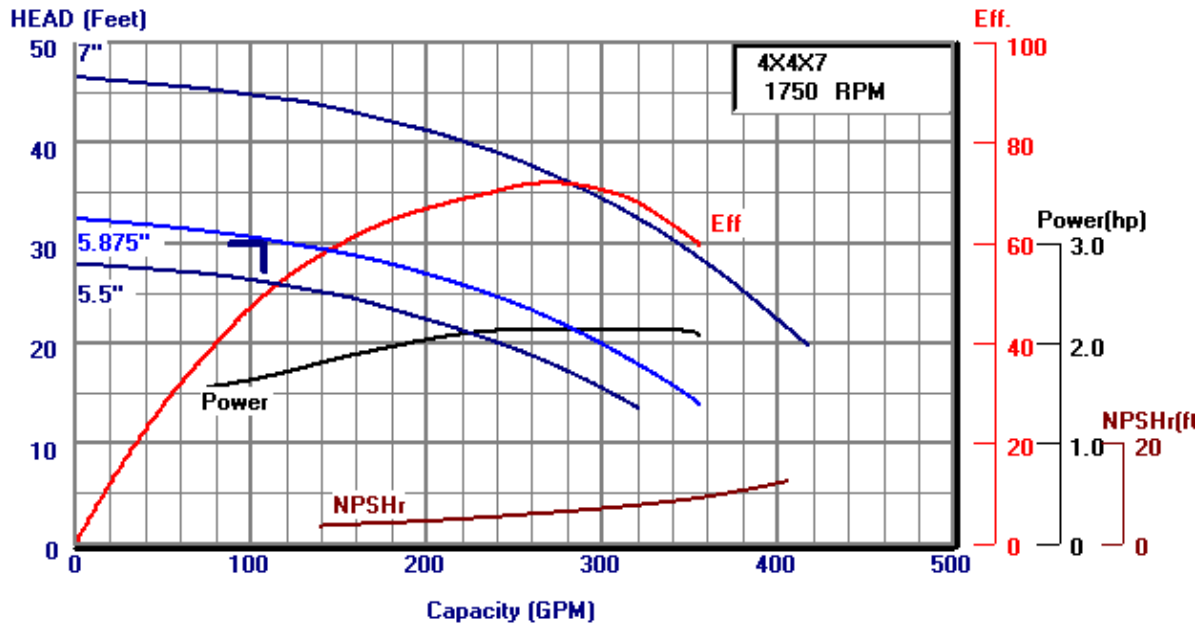
BELL & GOSSETT SERIES 80

PUMP 80 4X4X7

Flow Rate (GPM)	107	Pump Head (Feet)	30
Speed (RPM)	1750	NPSHr (Feet)	3.6
Weight (lbs)	**	Cost Index	**
Suction Size (in.)	4	Suction Velocity (fps)	2.7
Discharge Size (in.)	4	Discharge Velocity (fps)	2.7
Impeller Size (in.)	5.875	Pump Efficiency (%)	48.38
Max. Flow (GPM)	353	Duty Flow/Max Flow (%)	30.3
Flow @ BEP (GPM)	269	Min. Rec. Flow (GPM)	67.1
Selected Motor Size (HP)	2	Selected Motor Size (kw)	1.49
Duty-Point Power (BHP)	1.68	Duty-Point Power (kw)	1.25
Maximum Power (BHP)	2.17	Maximum Power (kw)	1.61
Est. Full Load Amps	**	Est. Full Load Efficiency (%)	**
Frame Size	**	Est. Full Load Power	



Table 5.6: Pump Series 80 Characteristics



Pump Series: 80
Suction Size = 4 "
Discharge Size = 4 "

Min Imp Dia = 5.5 "
Max Imp Dia = 7 "
Cut Dia = 5.875 "

Design Capacity = 107.0
Design Head = 30.0
Motor Size = 2 HP

ITT Bell & Gossett
8200 N. Austin
Morton Grove, IL 60053

Figure 5.7 Series 80 Performance Curve

APPENDIX I

THERMAL STORAGE MONTHLY SAVINGS

HOURLY CHILLER LOAD PROFILES PER MONTH

(NON-STORAGE)

	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
	TOTAL COOLING	TOTAL COOLING	TOTAL COOLING	TOTAL COOLING	TOTAL COOLING	TOTAL COOLING	TOTAL COOLING	TOTAL COOLING	TOTAL COOLING	TOTAL COOLING	TOTAL COOLING	TOTAL COOLING
Hour	(Tons)	(Tons)	(Tons)	(Tons)	(Tons)	(Tons)	(Tons)	(Tons)	(Tons)	(Tons)	(Tons)	(Tons)
0	62.4	62.4	62.4	67.5	83.3	87.5	88.4	88.5	88.3	76.8	62.4	62.4
100	62.4	62.4	62.4	65.5	83.8	86.7	88.7	88.7	88.1	74.7	62.4	62.4
200	62.4	62.4	62.4	63.5	83.8	86.9	88.4	87.5	87.7	72.3	62.4	62.4
300	62.4	62.4	62.4	62.4	83.8	87.3	88.8	88.3	87.7	70.4	62.4	62.4
400	62.4	62.4	62.4	62.4	83.3	89.2	89.3	89.3	87.7	68.9	62.4	62.4
500	62.4	62.4	62.4	62.4	83.3	89.9	89.4	89.3	88.2	68.4	62.4	62.4
600	62.4	62.4	62.4	62.4	83.5	89.9	90.7	89.9	88.2	69.4	62.4	62.4
700	62.4	62.4	62.4	63.5	83.6	90.7	92	92.8	87.8	71.7	62.4	62.4
800	62.4	62.4	62.4	66.9	83.8	93.7	92.7	93.7	89.4	76.1	62.4	62.4
900	62.4	62.4	62.4	72.7	83.8	94	93.1	94	91.1	79.9	62.4	62.4
1000	62.4	62.4	62.4	74	86.1	95.6	93.5	94.2	91.2	79.9	64.3	62.4
1100	62.4	62.4	62.4	73.9	94	93.2	95.1	94.4	91	79.9	66.1	62.4
1200	62.4	62.4	67.3	73.9	99	94.8	96.8	94.8	91.2	80.3	66.1	62.4
1300	62.4	62.4	71.7	74	101.2	96.4	98.4	95.9	91.7	83.4	66.1	62.4
1400	62.4	62.4	71.7	75.1	102.1	98.7	100.7	98.2	91.7	87.4	66.1	62.4
1500	62.4	62.4	71.7	75.9	102.6	100.3	102.6	99.7	93.1	89	66.1	62.4
1600	62.4	62.4	71.7	74.9	100.7	96.9	100.7	96.3	91.4	86.4	66.1	62.4
1700	62.4	62.4	71.7	73.8	99.5	94.2	98.4	93.7	89.8	82	66.2	62.4
1800	62.4	62.4	68.1	73.9	98.1	91.6	96.8	92.7	89.2	79.6	66.1	62.4
1900	62.4	62.4	63.2	73.8	94.1	90.2	95.1	92.4	89.3	79.6	66.2	62.4
2000	62.4	62.4	62.4	73.8	87.8	89.6	93.1	91.8	89.1	79.8	66.2	62.4
2100	62.4	62.4	62.4	73.9	84.7	88.7	91	91.6	88.8	79.8	63.6	62.4
2200	62.4	62.4	62.4	73.7	83.3	89.3	89.1	89.1	88.6	79.5	62.4	62.4
2300	62.4	62.4	62.4	70.2	83.7	88.6	88.6	88.5	88.4	79.5	62.4	62.4
Total ton-hrs	1497.6	1497.6	1555.5	1684.0	2152.9	2203.9	2241.4	2215.3	2148.7	1874.7	1538.0	1497.6

# of on-peak hours	11
# of off-peak hours	13

HOURLY CHILLER LOAD PROFILES PER MONTH

(PARTIAL ICE-STORAGE)

	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
	TOTAL COOLING	TOTAL COOLING	TOTAL COOLING	TOTAL COOLING	TOTAL COOLING	TOTAL COOLING	TOTAL COOLING	TOTAL COOLING	TOTAL COOLING	TOTAL COOLING	TOTAL COOLING	TOTAL COOLING
Hour	(Tons)	(Tons)	(Tons)	(Tons)	(Tons)	(Tons)	(Tons)	(Tons)	(Tons)	(Tons)	(Tons)	(Tons)
0	88.4	88.4	88.4	93.5	109.3	113.5	114.4	114.5	114.3	102.8	88.4	88.4
100	88.4	88.4	88.4	91.5	109.8	112.7	114.7	114.7	114.1	100.7	88.4	88.4
200	88.4	88.4	88.4	89.5	109.8	112.9	114.4	113.5	113.7	98.3	88.4	88.4
300	88.4	88.4	88.4	88.4	109.8	113.3	114.8	114.3	113.7	96.4	88.4	88.4
400	88.4	88.4	88.4	88.4	109.3	115.2	115.3	115.3	113.7	94.9	88.4	88.4
500	88.4	88.4	88.4	88.4	109.3	115.9	115.4	115.3	114.2	94.4	88.4	88.4
600	88.4	88.4	88.4	88.4	109.5	115.9	116.7	115.9	114.2	95.4	88.4	88.4
700	88.4	88.4	88.4	89.5	109.6	116.7	118.0	118.8	113.8	97.7	88.4	88.4
800	88.4	88.4	88.4	92.9	109.8	119.7	118.7	119.7	115.4	102.1	88.4	88.4
900	88.4	88.4	88.4	98.7	109.8	120.0	119.1	120.0	117.1	105.9	88.4	88.4
1000	31.7	31.7	31.7	43.3	55.4	64.9	62.8	63.5	60.5	49.2	33.6	31.7
1100	31.7	31.7	31.7	43.2	63.3	62.5	64.4	63.7	60.3	49.2	35.4	31.7
1200	31.7	31.7	36.6	43.2	68.3	64.1	66.1	64.1	60.5	49.6	35.4	31.7
1300	31.7	31.7	41.0	43.3	70.5	65.7	67.7	65.2	61.0	52.7	35.4	31.7
1400	31.7	31.7	41.0	44.4	71.4	68.0	70.0	67.5	61.0	56.7	35.4	31.7
1500	31.7	31.7	41.0	45.2	71.9	69.6	71.9	69.0	62.4	58.3	35.4	31.7
1600	31.7	31.7	41.0	44.2	70.0	66.2	70.0	65.6	60.7	55.7	35.4	31.7
1700	31.7	31.7	41.0	43.1	68.8	63.5	67.7	63.0	59.1	51.3	35.5	31.7
1800	31.7	31.7	37.4	43.2	67.4	60.9	66.1	62.0	58.5	48.9	35.4	31.7
1900	31.7	31.7	32.5	43.1	63.4	59.5	64.4	61.7	58.6	48.9	35.5	31.7
2000	31.7	31.7	31.7	43.1	57.1	58.9	62.4	61.1	58.4	49.1	35.5	31.7
2100	88.4	88.4	88.4	99.9	110.7	114.7	117.0	117.6	114.8	105.8	89.6	88.4
2200	88.4	88.4	88.4	99.7	109.3	115.3	115.1	115.1	114.6	105.5	88.4	88.4
2300	88.4	88.4	88.4	96.2	109.7	114.6	114.6	114.5	114.4	105.5	88.4	88.4
Total ton-hrs	1497.6	1497.6	1555.5	1684.0	2152.9	2203.9	2241.4	2215.3	2148.7	1874.7	1538.0	1497.6

# of on-peak hours	11
# of off-peak hours	13

System	January	February	March	April	May	June	July	August	September	October	November	December	
Non-Storage													
	On-Peak Demand:	11233.32	11233.32	12278.15	13409.88	17571.48	17180.11	17656.53	17202.51	16399.93	15005.54	11878.14	11233.32
	Off-Peak Demand:	5353.92	5353.92	5353.92	5722.20	7178.82	7671.84	7723.32	7729.92	7590.00	6384.84	5361.84	5353.92
	Totals:	\$16,587.24	\$16,587.24	\$17,632.07	\$19,132.08	\$24,750.30	\$24,851.96	\$25,379.85	\$24,932.43	\$23,989.93	\$21,390.38	\$17,239.98	\$16,587.24
Ice-Storage													
	On-Peak Demand:	5701.76	5701.76	6746.59	7878.32	12039.92	11648.55	12124.97	11670.95	10868.37	9473.98	6346.58	5701.76
	Off-Peak Demand:	7584.72	7584.72	7584.72	7953.00	9409.62	9902.64	9954.12	9960.72	9820.80	8615.64	7592.64	7584.72
	Totals:	\$13,286.48	\$13,286.48	\$14,331.31	\$15,831.32	\$21,449.55	\$21,551.20	\$22,079.09	\$21,631.67	\$20,689.17	\$18,089.63	\$13,939.22	\$13,286.48
Difference:	3,300.76	3,300.76	3,300.76	3,300.76	3,300.76	3,300.76	3,300.76	3,300.76	3,300.76	3,300.76	3,300.76	3,300.76	
Average Monthly Savings:		\$3,300.76											
Average Yearly Savings:		\$39,609.10											
Percent Savings:		16%											

APPENDIX J

ELECTRICAL SIZING – EQUIPMENT / PANEL SCHEDULE

PUMP (107 gpm): 1/2"C, 4-#12THW (Cu)

460 V, 3 Phase @ 2 hp: FLC = **3.4A**
PF = .9

$$(3.4 \text{ A})(2.5) = 8.5\text{A} \Rightarrow \mathbf{15\text{A Breaker}}$$

Conduit Size: 1/2"

PANEL SCHEDULE LOAD CHECK

PANEL SCHEDULE:

Symbol	Motor Hp	Phase	FLC	A	kVA
Panel RPPH	-	3	-	50	35.81
P-1	7.5	3	11	20	7.88
P-2	7.5	3	11	20	7.88
EF-6	3	3	4.8	15	3.44
PRV-1	0.5	3	1	15	0.72
ACC-1	11	3	21	30	15.04
Lighting	-	1	-	20	8.28
P-3	3	3	4.8	15	3.44
P-4	3	3	4.8	15	3.44
SF-5	30	3	40	50	28.65
ACCU-2	0.125	2	1	20	0.41
ACCU-3	0.125	2	1	20	0.41
AHU-5 Exhaust	20	3	27	30	19.34
AHU-5 Heat Wheel	10	3	14	15	10.03
CH-1	40.9	3	65	175	46.55
CH-2	148.66	3	180	450	128.92
AP-1	2	3	3.4	15	2.44

Total kVA = $\Sigma \text{kVA} + (.25)\text{kVA}_{\text{CH-2}} = 355 \text{ kVA}$

Min Ampacity = $\text{Total kVA} / [(.480)(1.73)] = 427\text{A}$

Max Ampacity = $[\Sigma \text{kVA} + (.75)\text{kVA}_{\text{CH-2}}] / [(.480)(1.73)] = 505\text{A}$

Actual Ampacity = 600A ✓ OK

APPENDIX K

ACOUSTICS - EQUATIONS

ACOUSTICAL ANALYSIS EQUATIONS

$$R_T = \Sigma S_i \alpha_i / [1 - \alpha_{sab}]$$

$$\alpha_{sab} = \Sigma S_i \alpha_i / \Sigma S_i$$

$$L_{pmech} = L_{Wmech} - 10 \log[R_{Tmech}] + 6$$

$$NR = TL_{sf} - 10 \log[S_w / R_{Treceiver}]$$

$$L_{preceiver} = L_{pmech} - NR$$

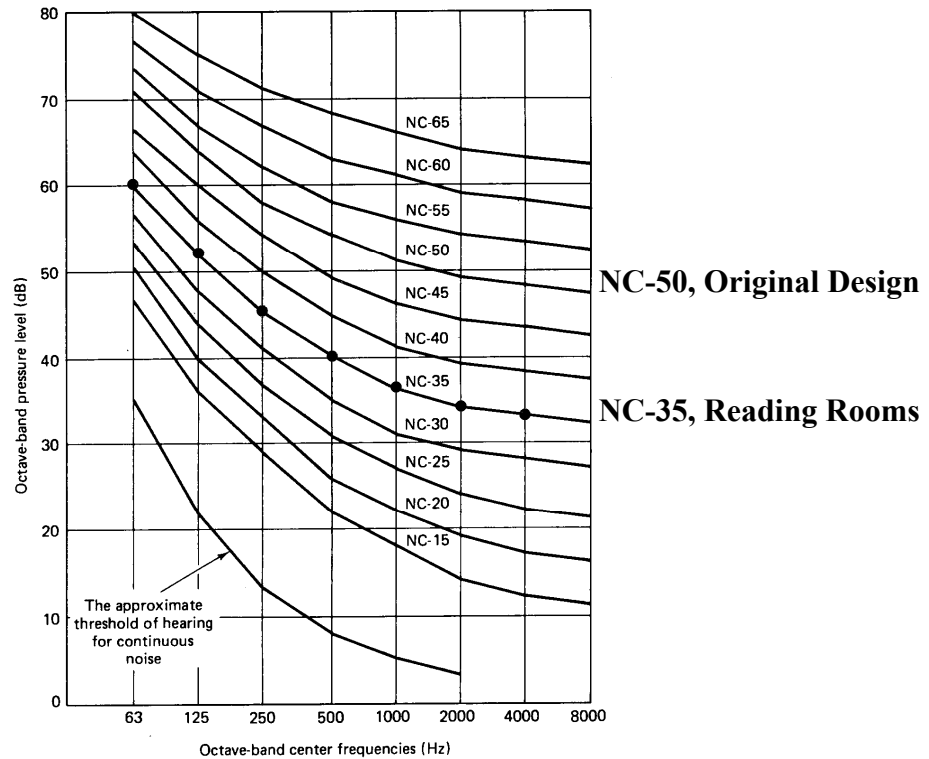


Table 8.4: Typical NC Curve, L_p Rating