



CareFirst Cumberland

Cumberland, Maryland

Chan Mi Hwang, BAE

Mechanical Option

Advisor: Dr. William P. Bahnfleth

CareFirst  





INTRODUCTION

- **Introduction**
 - **Building Statistics**
 - **Location & Weather Condition**
- **Existing Condition**
- **Thesis Proposal**
- **Mechanical Depth**
 - **Direct-Fired Chiller-Heater**
 - **Radiant Heating/Cooling Ceiling Panel**
- **Acoustical Breadth**
 - **Partition Replacement**
- **Conclusion**

BUILDING STATISTICS

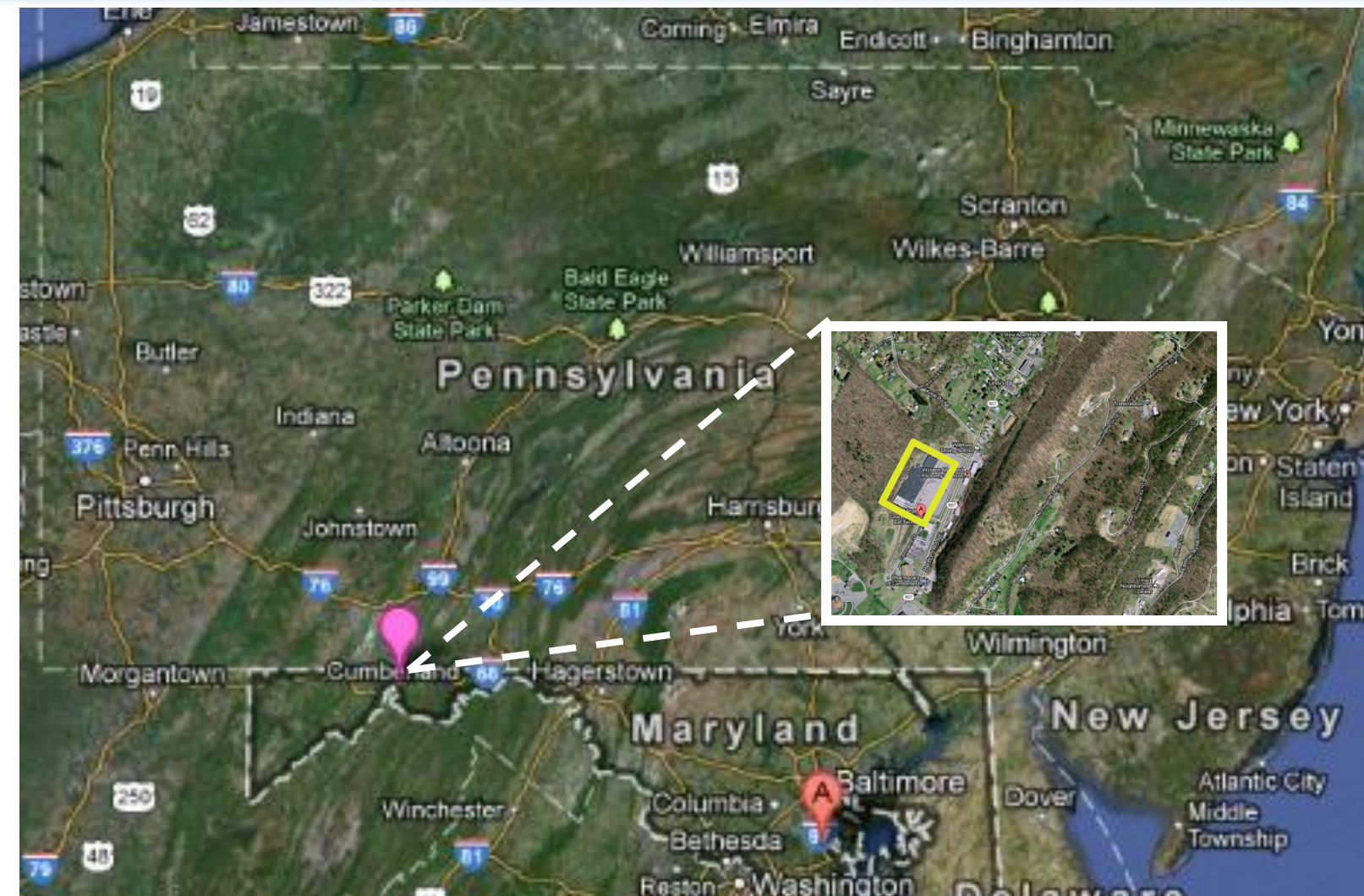
- **Occupancy Type: Office**
- **Size: 46,793 SF**
- **Number of Stories: 2 Floor above grade**
- **Overall Project Cost: \$13 million**
- **Construction Timeline: March 2010-May 2011**

- **Owner: CFBC Properties, LLC**
- **General Contractor: Carl Belt, Inc.**
- **Architects: VOA Associated, Inc.**
- **Civil Engineer: SPECS, Consulting Engineer & Surveyors**
- **MEP Engineer: R.G. Vanderweil Engineers, LLP**
- **Structural Engineer: Tadjer Cher Edelson Associates, Inc.**

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LOCATION

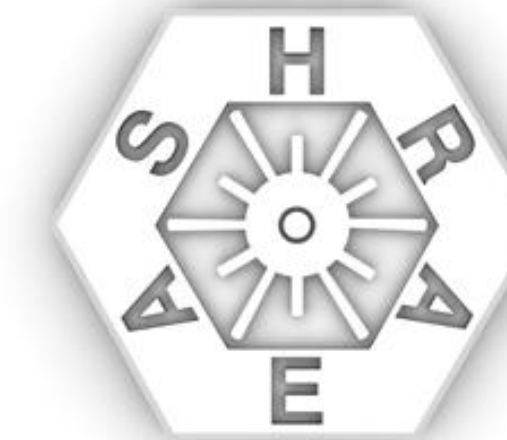


WEATHER CONDITION

Baltimore, MD

Design Condition (0.4%)

- Summer
 - 93.9 °F DB
 - 74.9 °F MCWB
- Winter
 - 12.9 °F DB



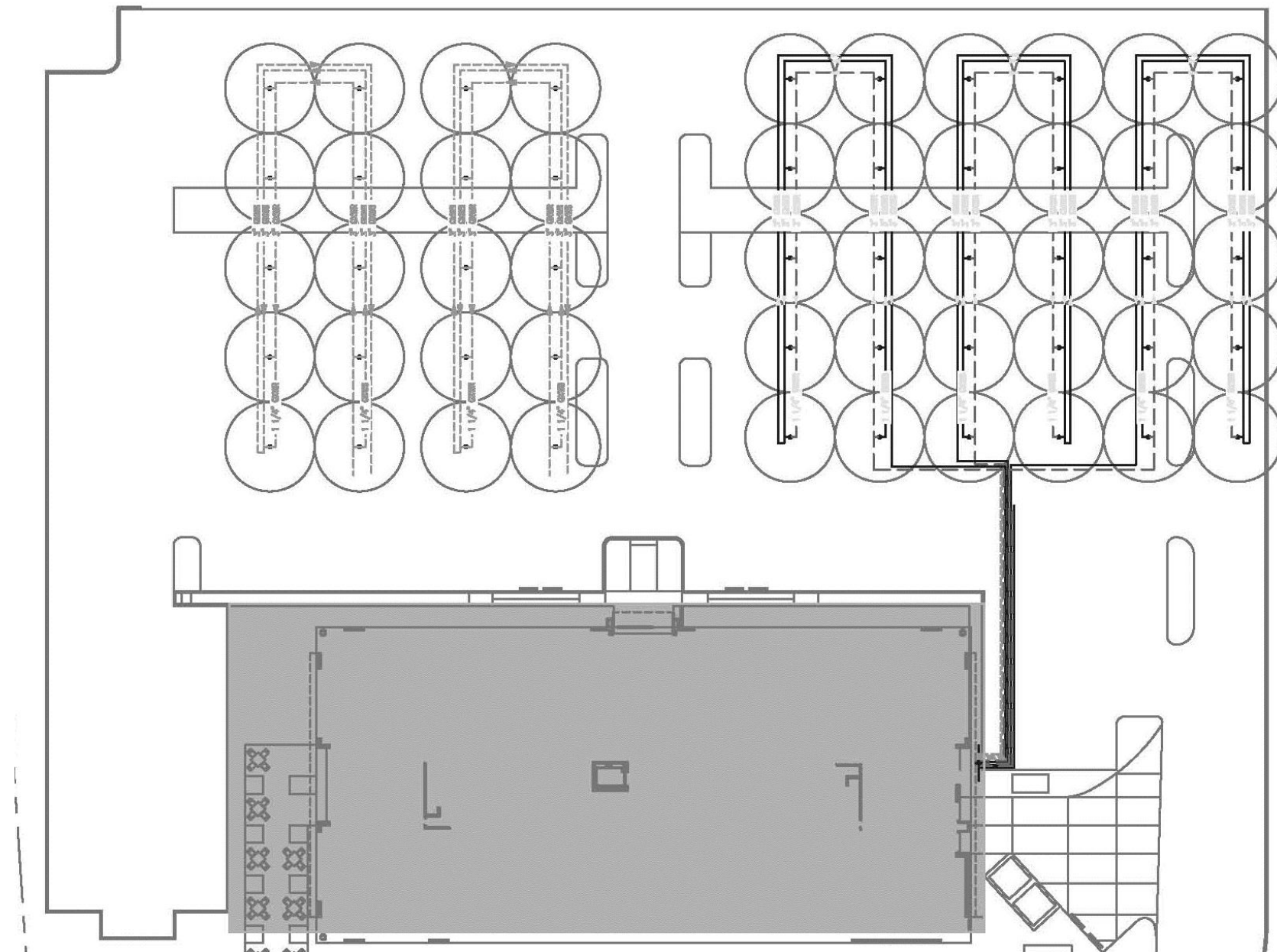


EXISTING CONDITION

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MECHANICAL DESIGN

- Ground-Coupled System
 - ❑ 35-90 °F EWT
 - ❑ 230 GPM Circulating pumps
 - ❑ 1500 MBH Auxiliary Boiler
 - ❑ 50 Tons Auxiliary Cooling Tower
 - ❑ 55-85 °F GXWS
- Dedicated Outdoor Air System
 - ❑ 9000 CFM RTU
 - ❑ Enthalpy Recovery Wheel



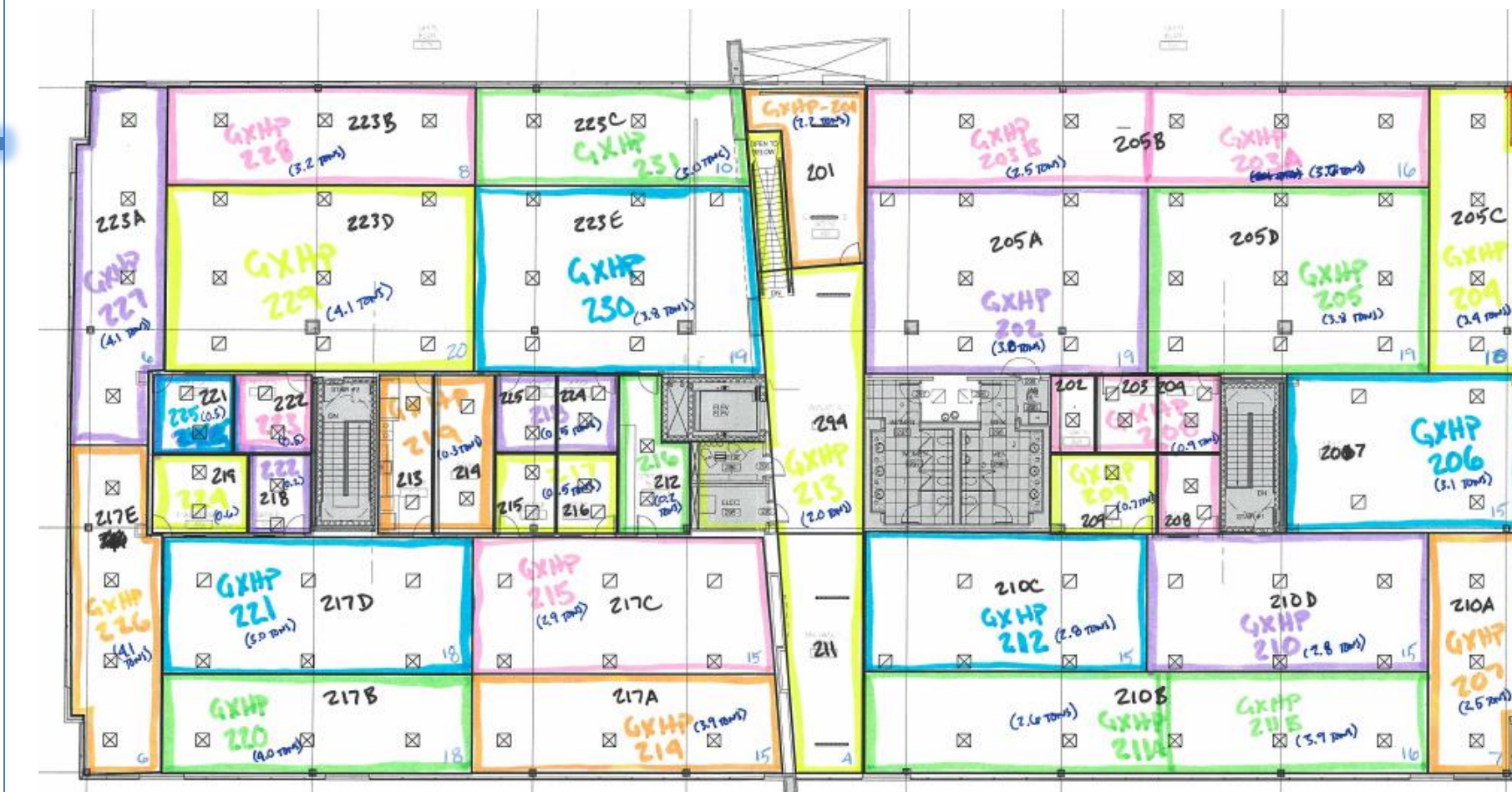


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MECHANICAL DESIGN

Designed Condition	
Cooling DB	75°F
Heating DB	70 °F
Relative Humidity	50 %



- 45 Geothermal Heat Pumps

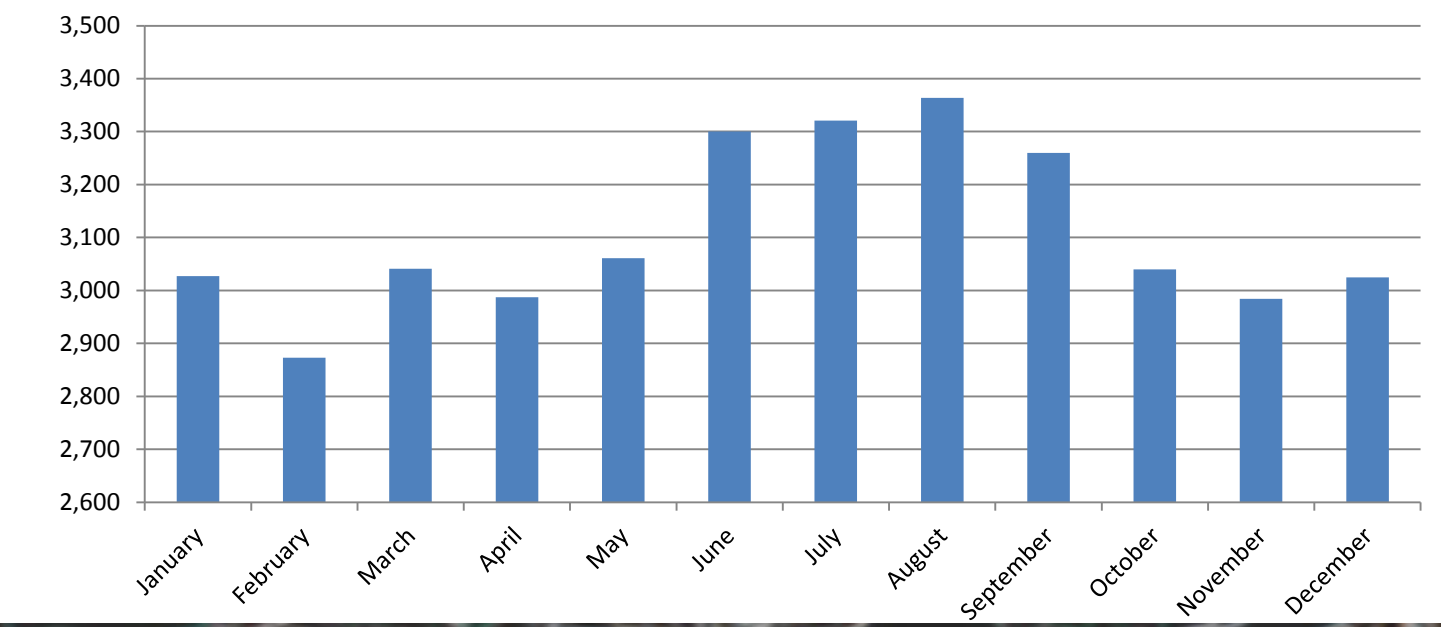


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ENERGY MODELING

- Total Loads
 - ❑ 153 Tons of Cooling
 - ❑ 1784 MBH of Heating
 - ❑ Annually 350,000 KWH Electricity
 - ❑ Annually \$37,283 Utility Cost



CONCLUSION

- High initial investment cost
- High electricity consumption
- Low operating cost
- Zone thermal comfort control
- Forced air system

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- Reduce Initial Investment
- Reduce Electrical Consumption
- Increase Maintainability



- Reduce Initial Investment by replacing Geothermal System to **Chiller/Heater**
- Reduce Electrical Consumption by replacing Heat pumps to **radiant panel system**

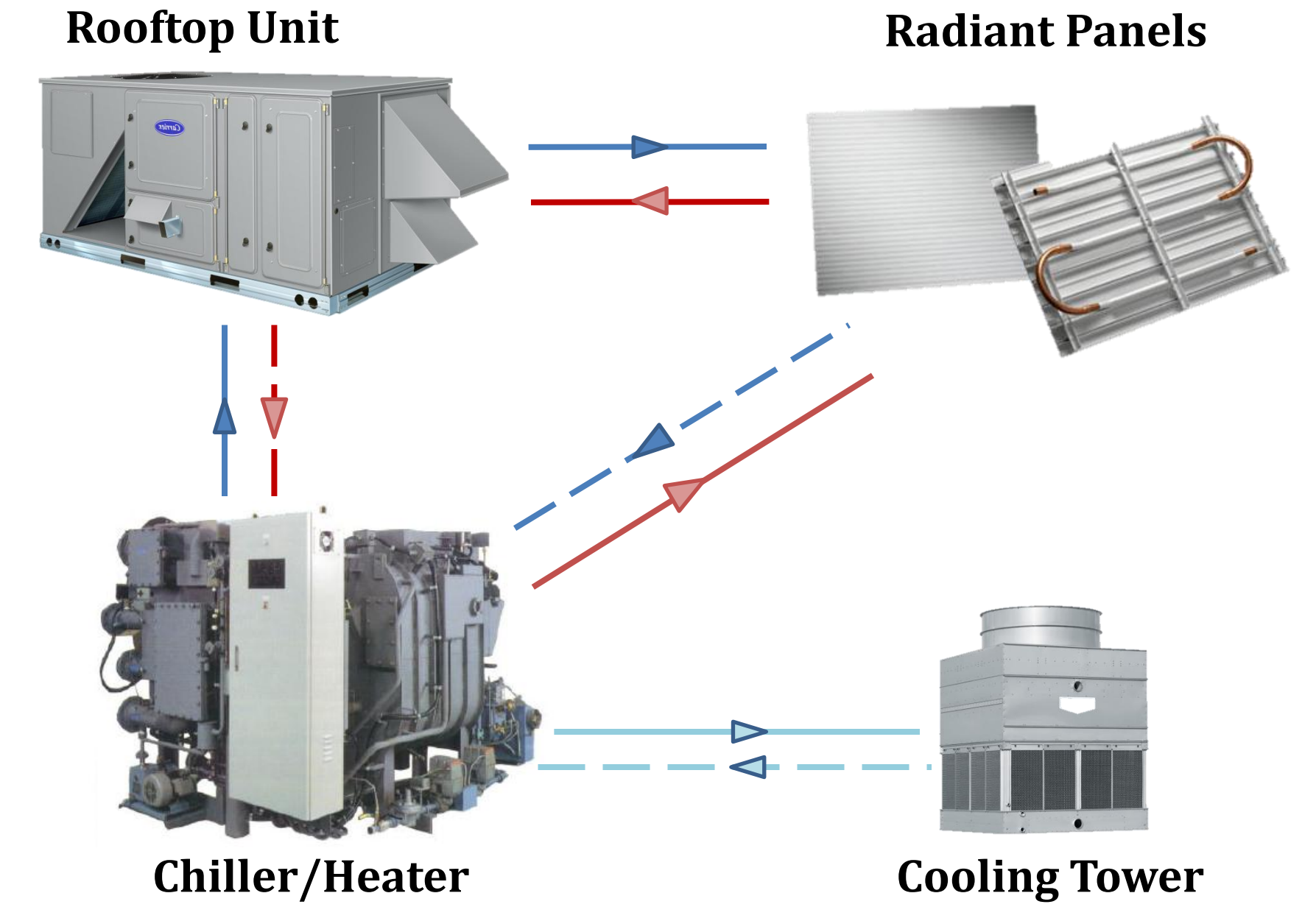


- Increase Maintainability by **Central Plant**

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PROPOSED ALTERNATIVE

- Chiller/Heater Central Plant
 - Absorption Chiller
 - Cooling Tower
 - Heater
- Rooftop Unit
 - Enthalpy Recovery Wheel
 - Latent Load-Cooling Coil
 - Precondition Heating Coil
- Radiant Cooling/Heating Panels



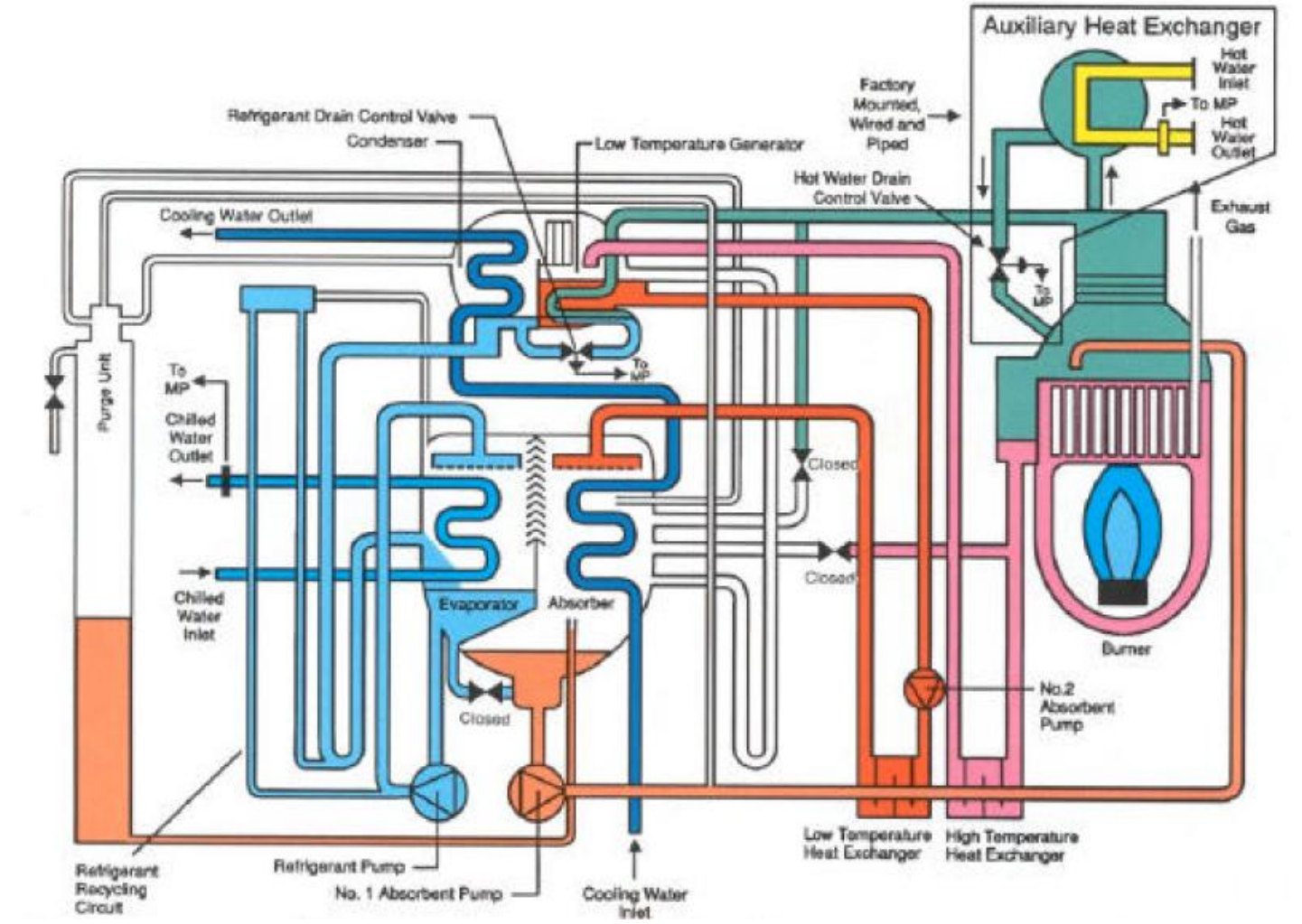
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OPERATION MODE

- Heating Only
- Cooling Only
- Simultaneous Mode

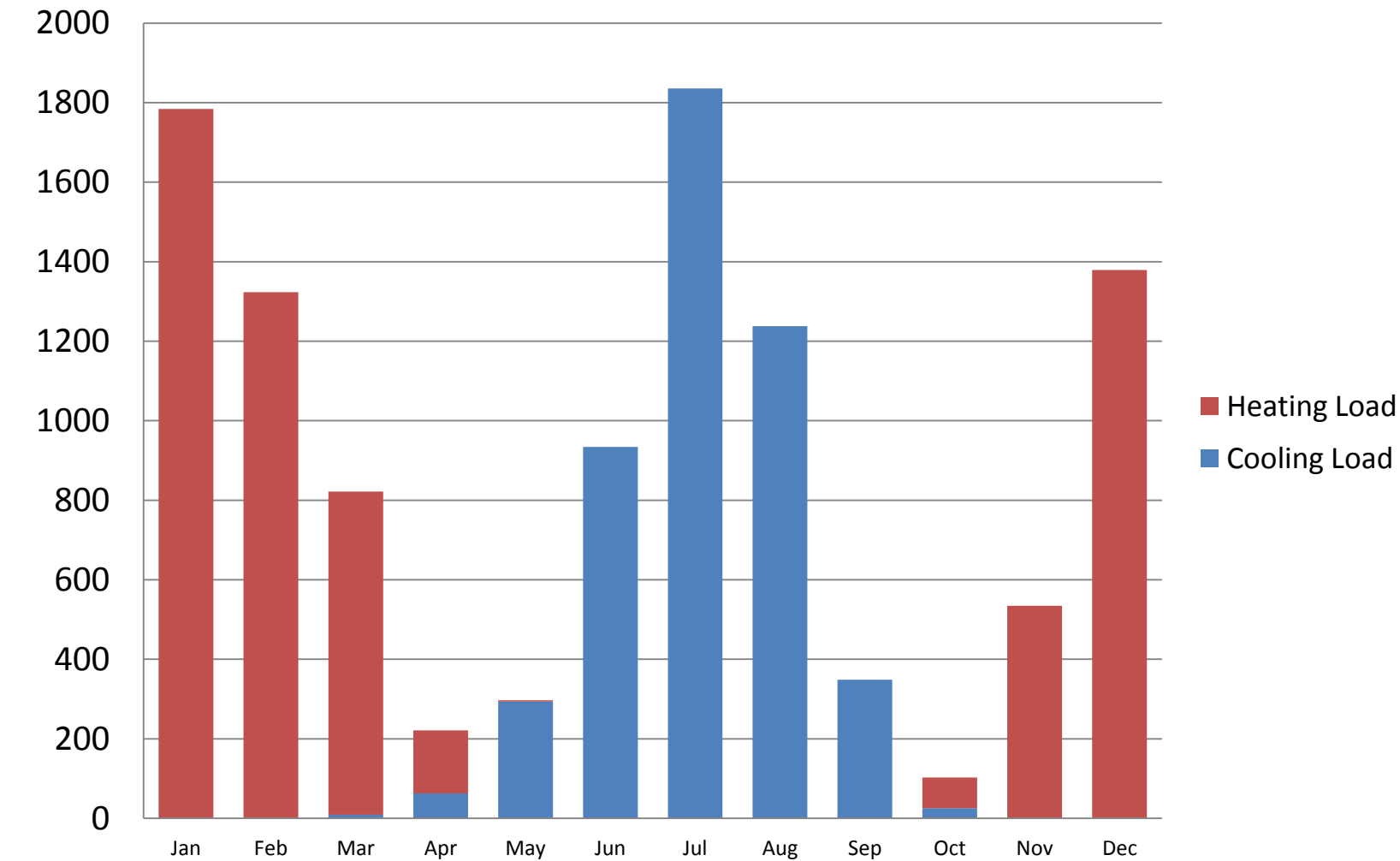
DIRECT-FIRED CHILLER/HEATER



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Monthly Loads of CareFirst, MBH





MECHANICAL DEPTH

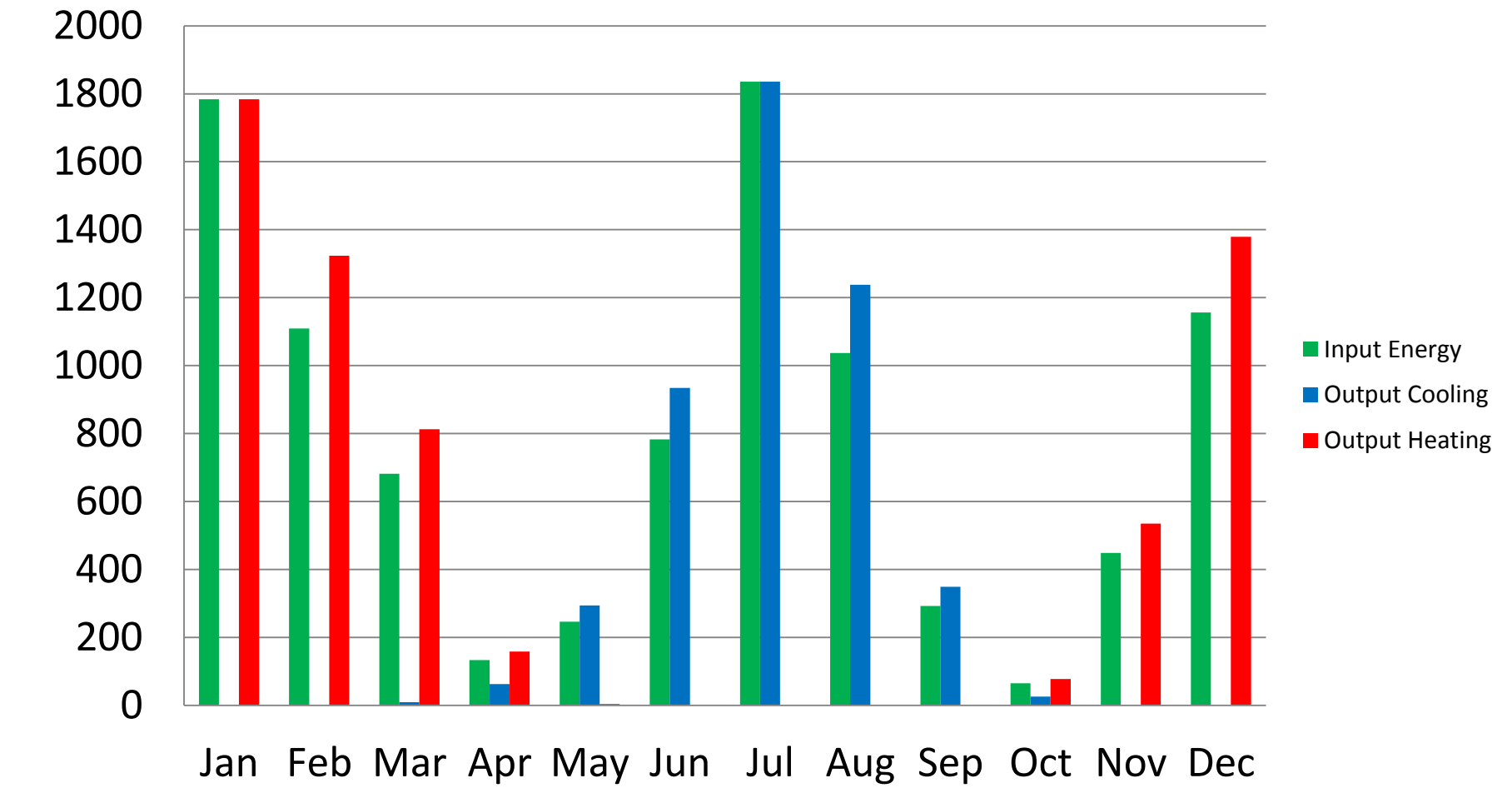
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INTEGRATED PART LOAD VALUE (IPLV)

ARI #560-2000 Performance	
% Load	TSA-DC C.O.P.
100	1
75	1.154
50	1.25
25	1.136

• Partial load (IPLV)=1.193

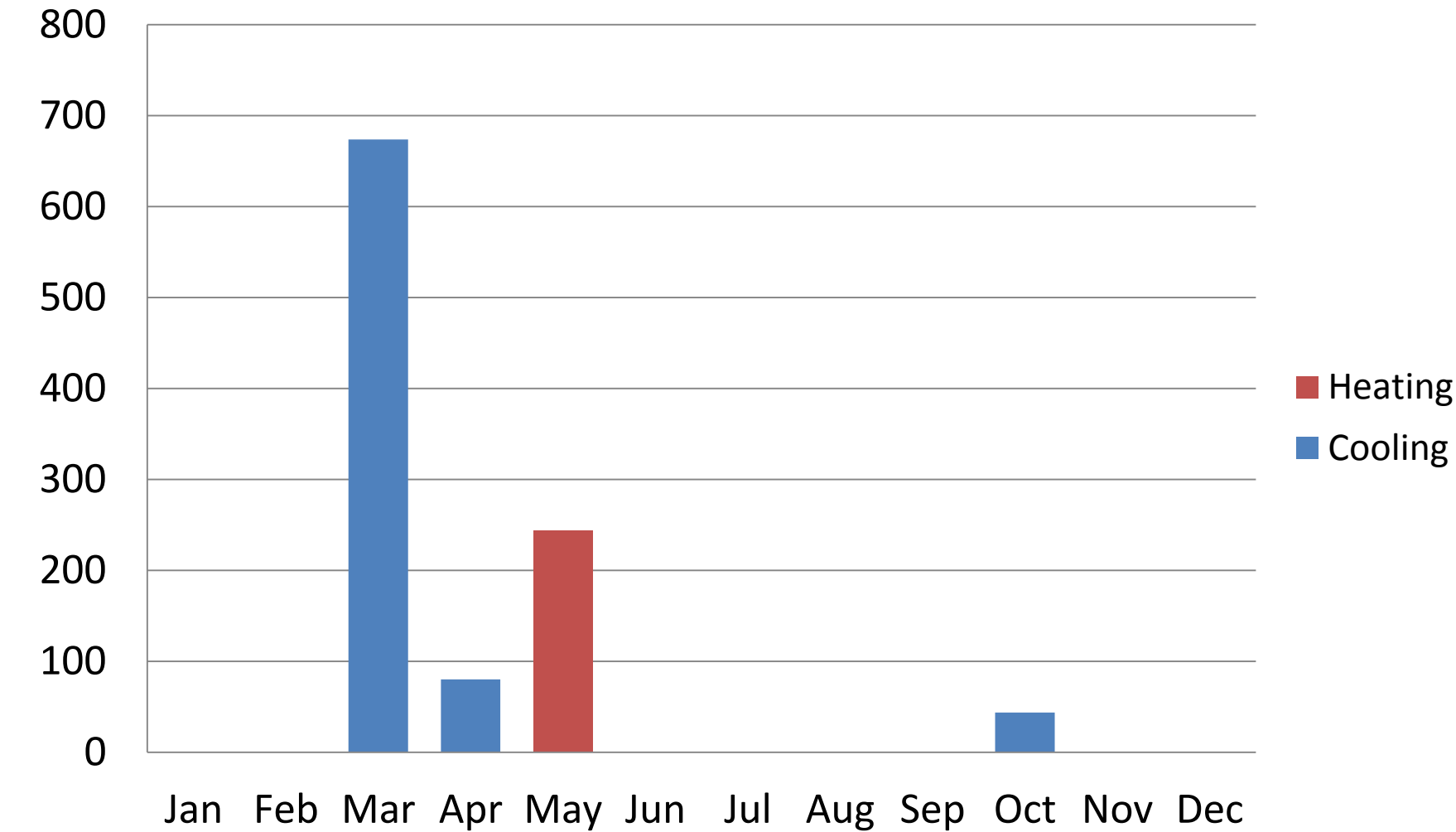
Input & Output Energy Comparison of Chiller/Heater, MBH



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WASTE ENERGY IN SIMULTANEOUS MODE



- **Annually 65 Tons of Cooling Loads**
- **Annually 243 MBH of Heating Loads**

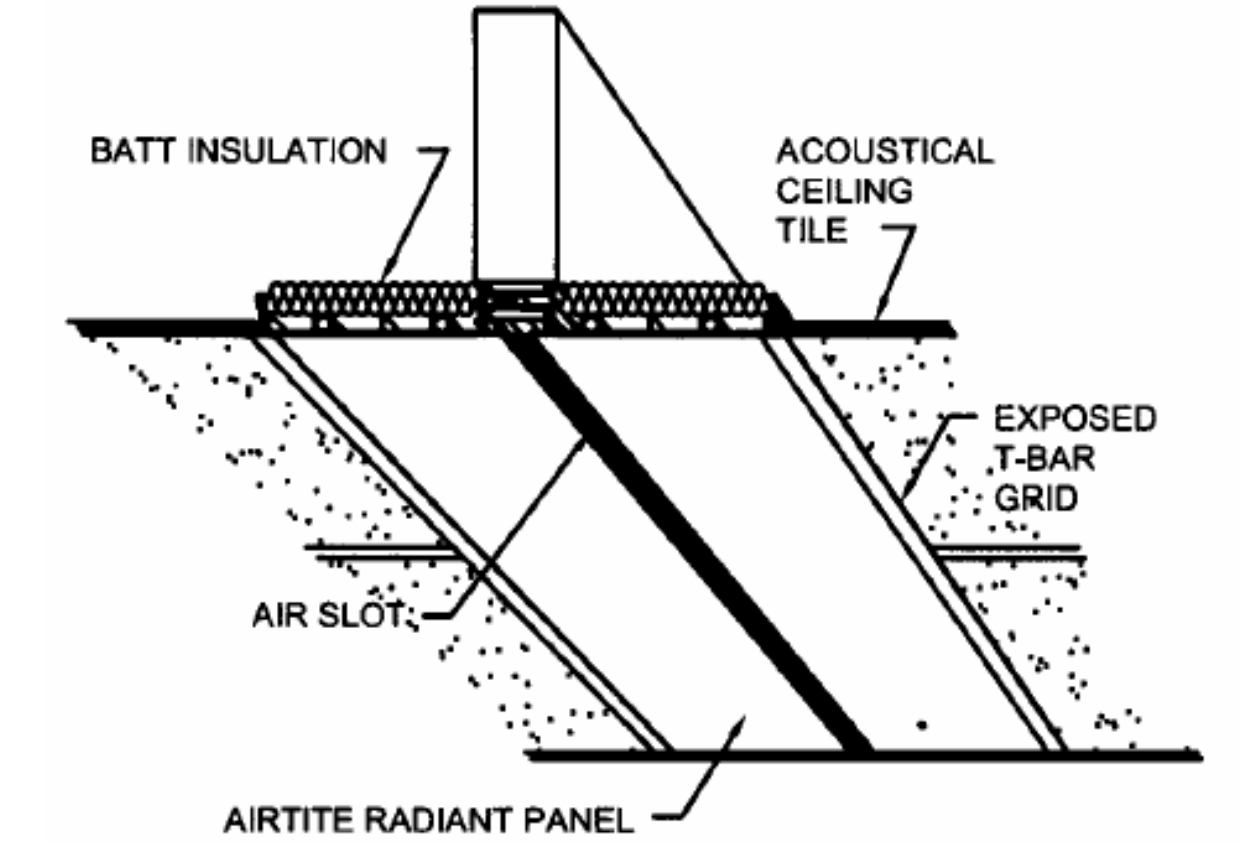
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RADIANT CEILING PANEL

- Superior Comfort
- Quiet Operation
- Lower Initial Investment Cost
- Flexible Installation

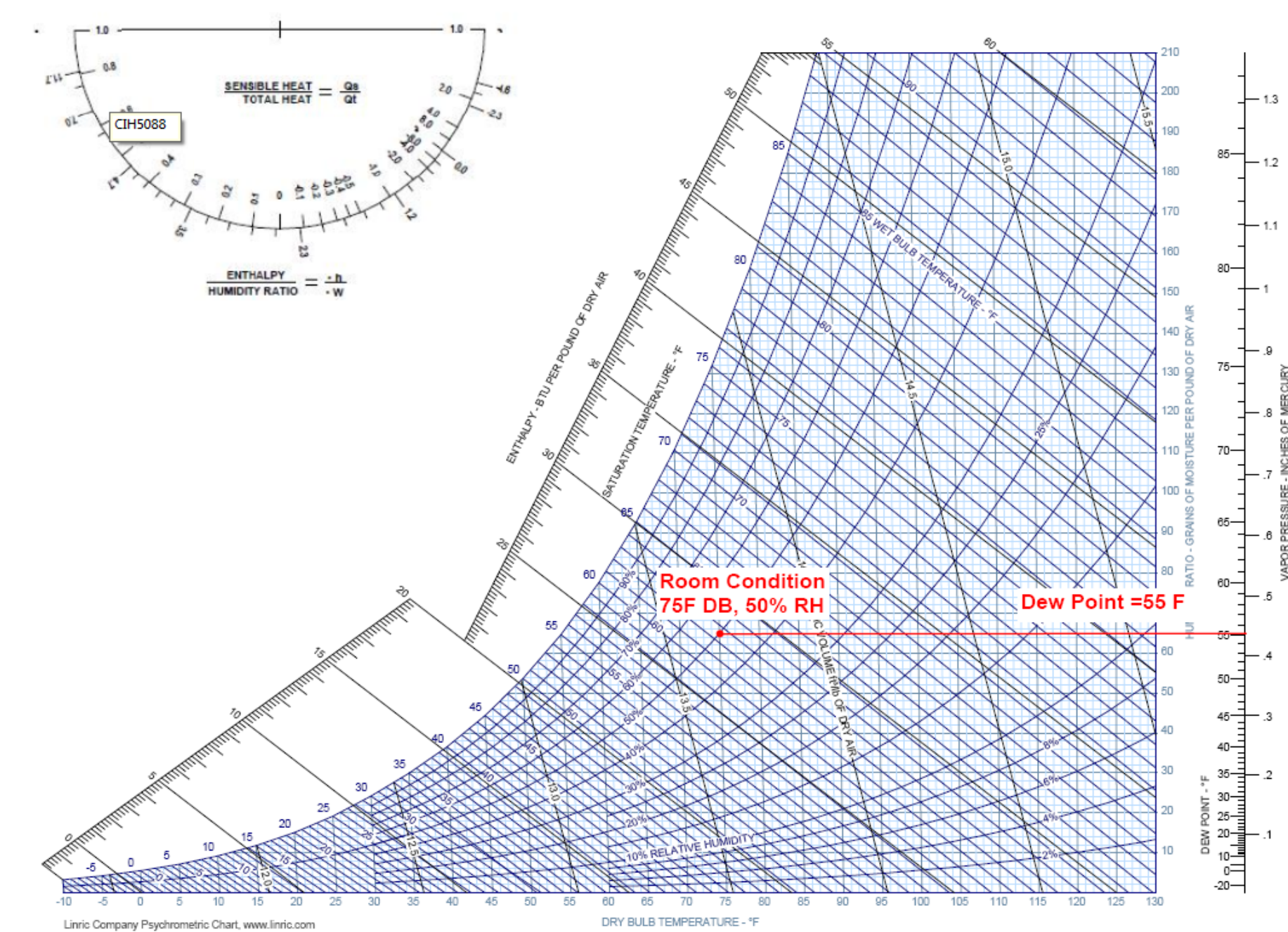


INTEGRAL DIFFUSER PANEL



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- Ventilation
- Latent load
- Condensation issue
- Water Design Approach
- Dew Point Temperature



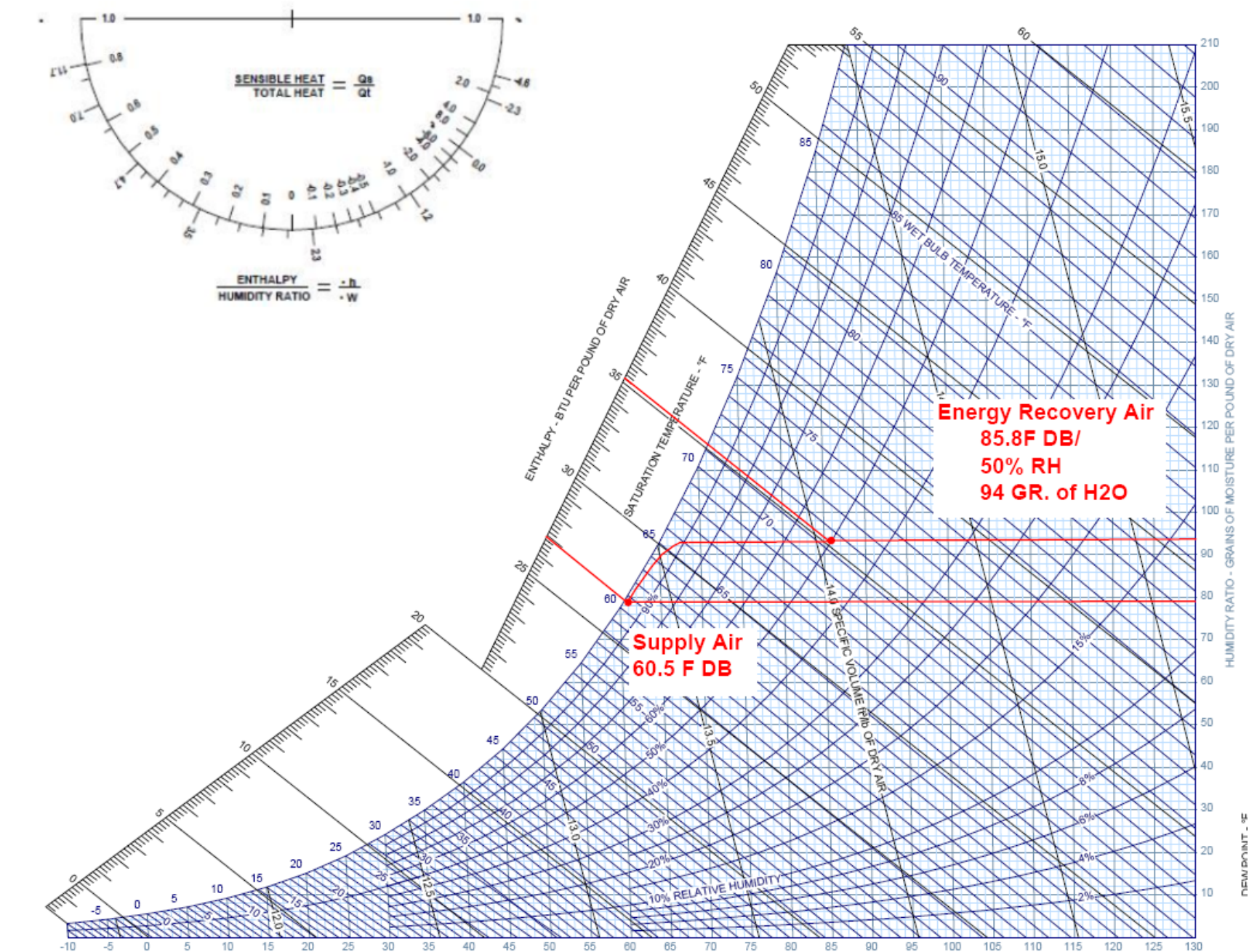
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LATENT LOAD RECOVERY

Occupant Latent Load (Btu/h-person)	Number of Occupancy	Total Latent Load (Btu/h)
205	445	91225

Required Latent Load			
q_lat	0.69	CFM	delta W
91225	0.69	9000	14.7





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SENSIBLE LOAD RECOVERY

Sensible Load_Cooling coil			
q_sen	1.08	CFM	delta_T
245916	1.08	9000	25.3

Required CL on cooling panel=
 (Total required CL) - (CL on Cooling coil)

153 Tons (1836 MBH) - 246 MBH = **1590 MBH**

DESIGN CONCLUSION

Grand Load_Cooling Coil			
q_tot	4.5	CFM	delta_h
307800	4.5	9000	7.6

Water-Side Design									
Chiller				Cooling Coil			Cooling Panel		
EWT	LWT	ΔT	GPM	EWT	LWT	ΔT	EWT	LWT	ΔT
68.5	53	15.5	237	53	55.6	2.6	55.6	69.1	13.5

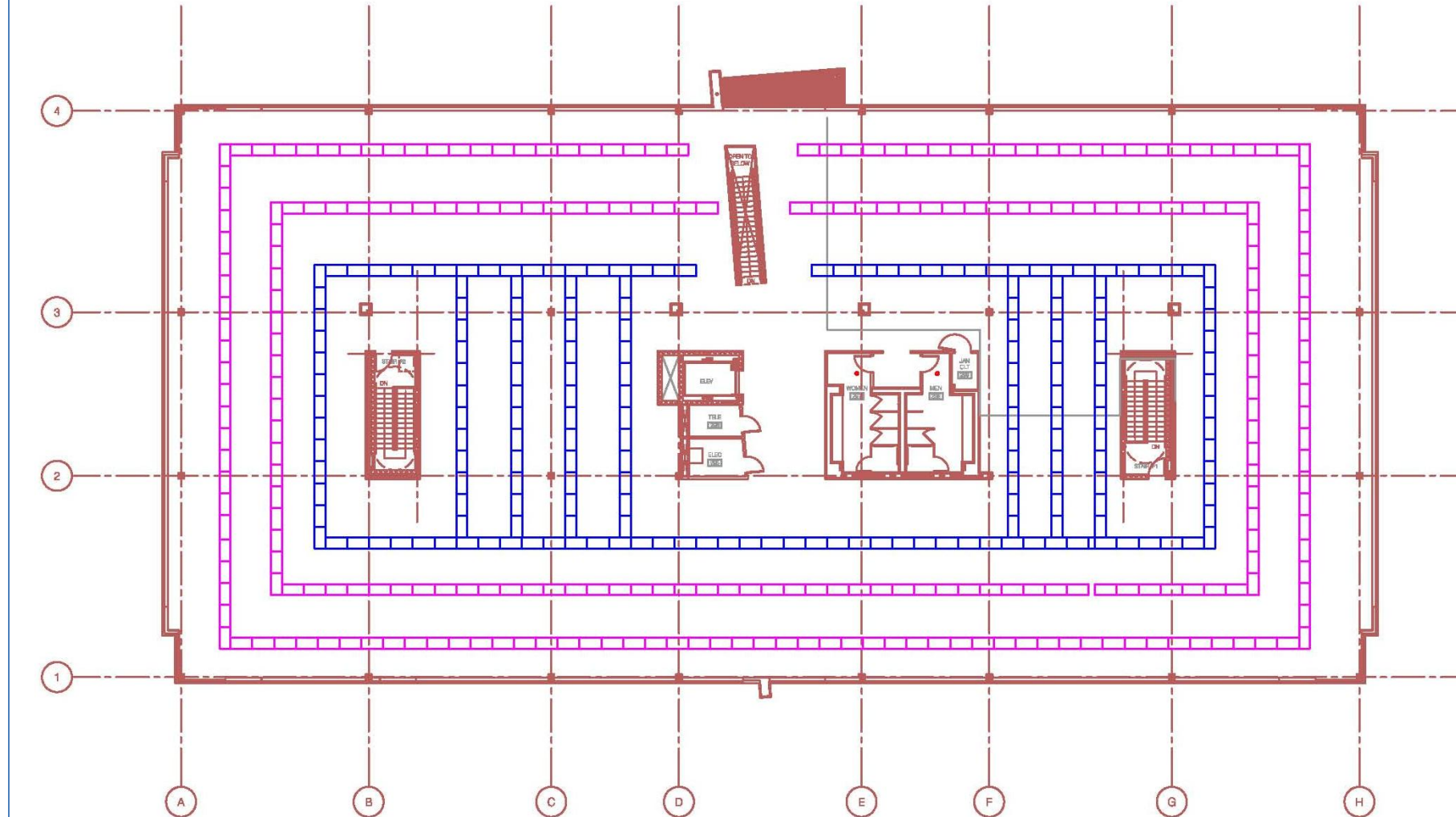
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COOLING PANEL SELECTION

Airtite Radiant Panel w/ Center Slotted Air Diffuser

- Total Required Cooling Load= 1590 MBH
- Selected Cooling Panel Capacity = 72 BTUH/SF
- Total Cooling Panel Area= **22,000 SF**

COOLING PANEL LAYOUT

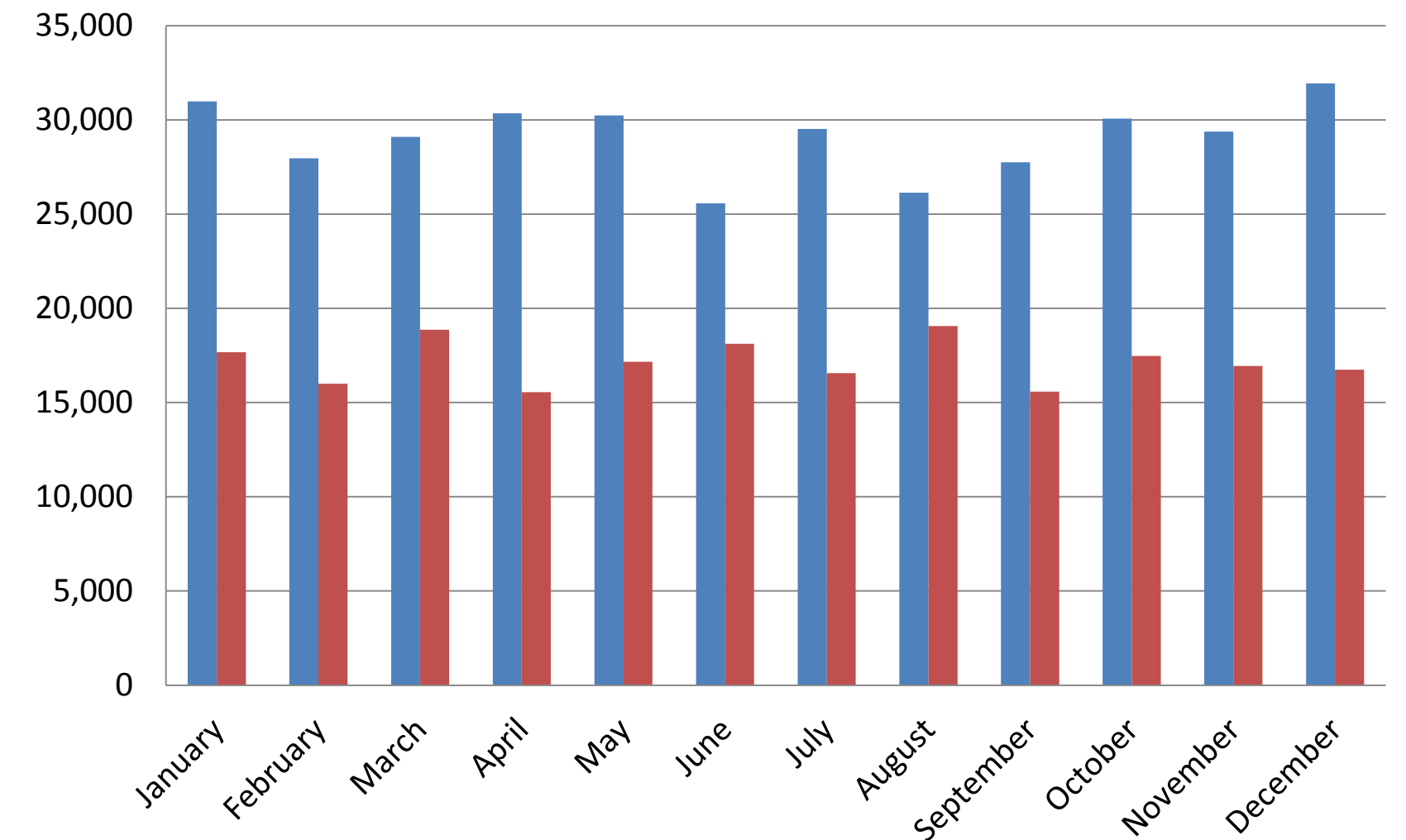




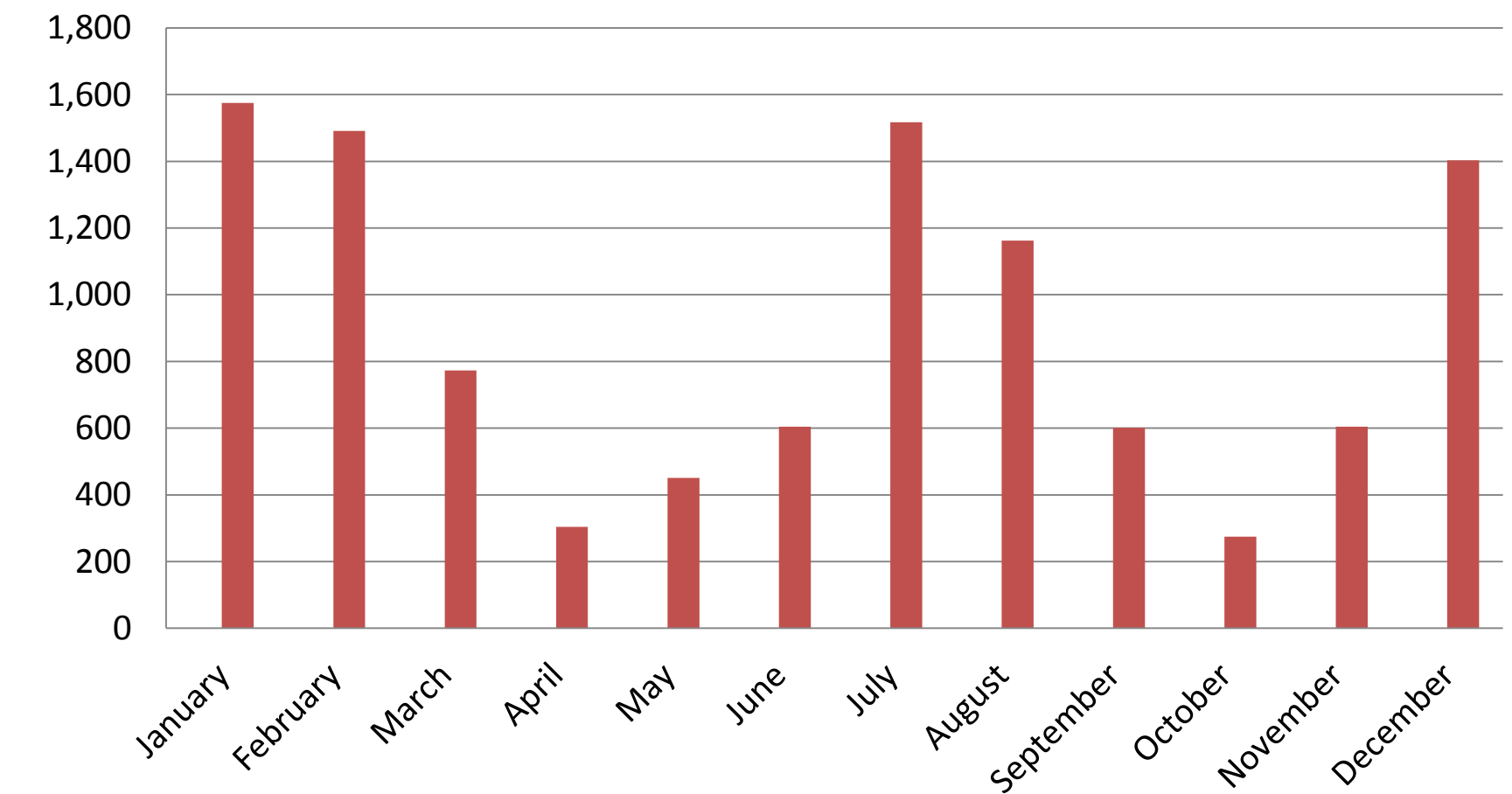
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ELECTRICAL CONSUMPTION



NATURAL GAS CONSUMPTION

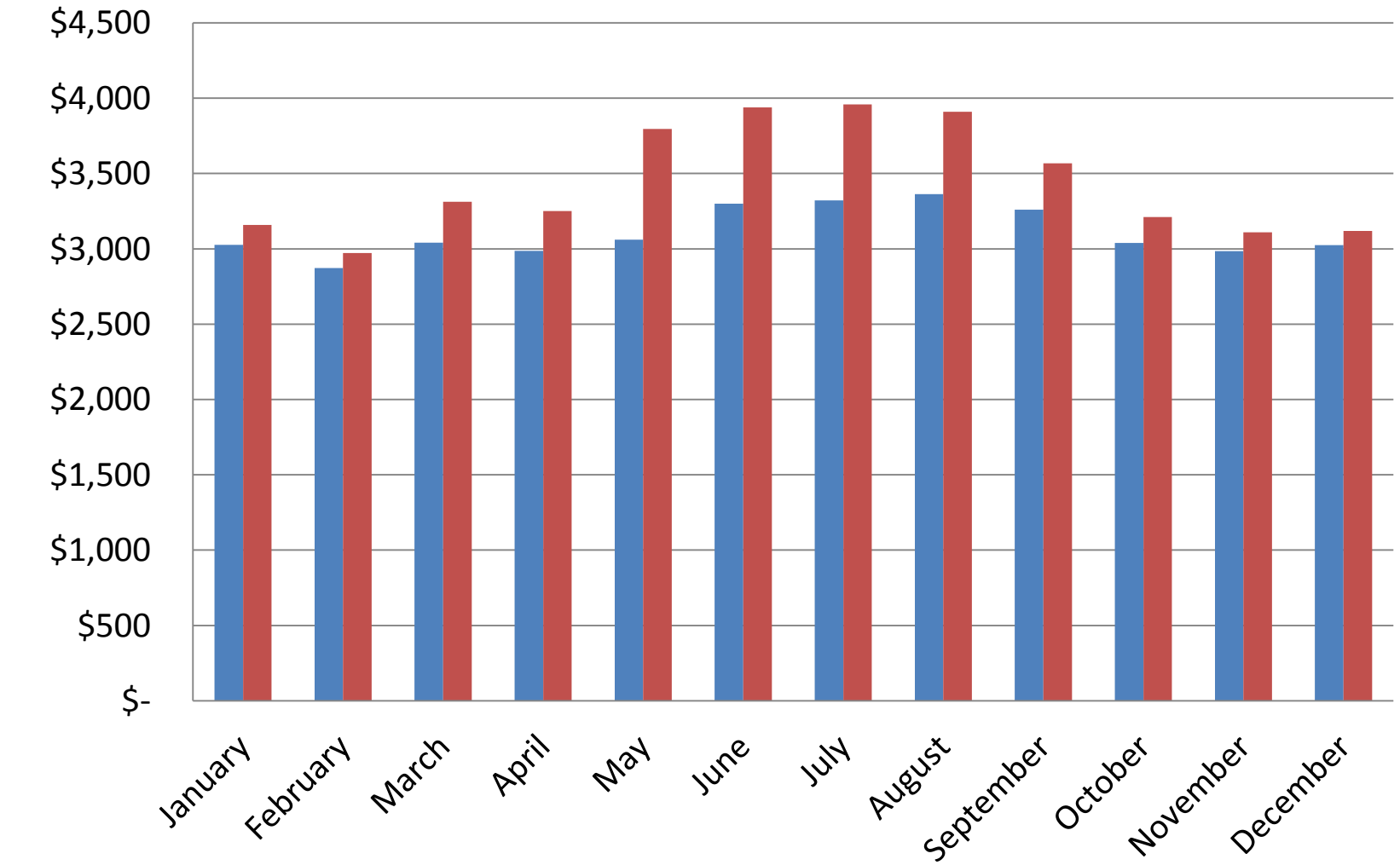




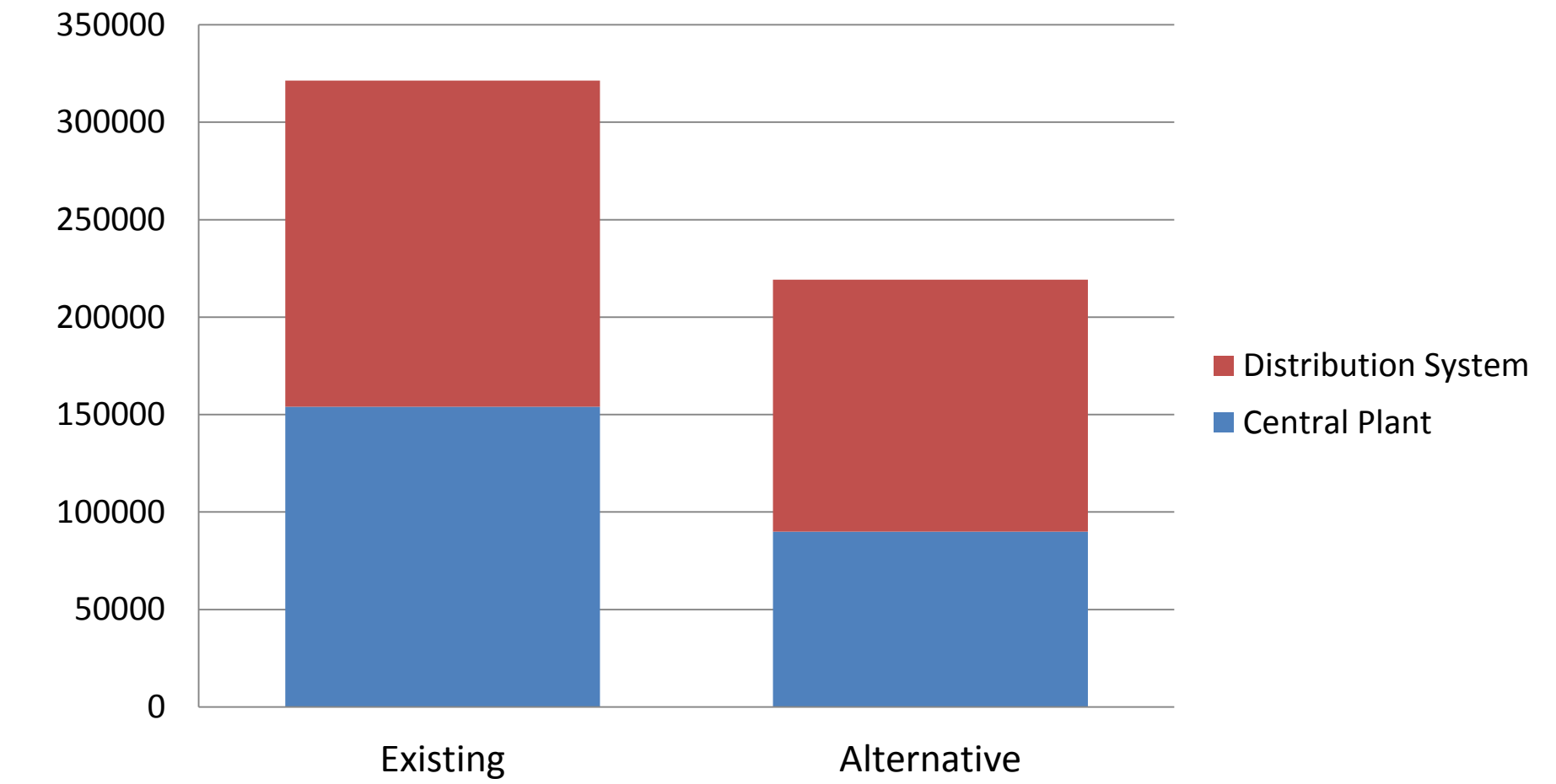
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ENERGY COST



INITIAL INVESTMENT COMPARISON



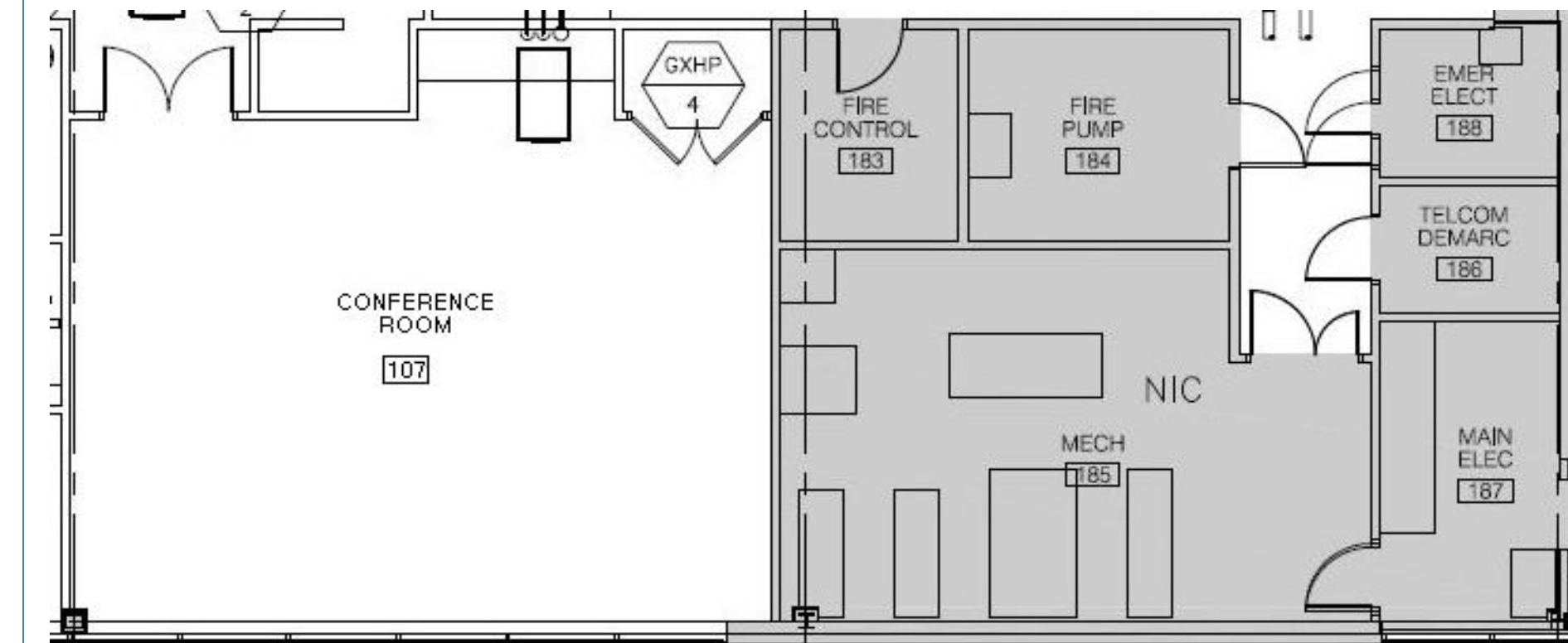
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	Capital Cost, \$	Operation, \$
Existing	321377	37283
Alternative 2	219200	41305
	Investment	Operation
Saving	102177	4022
Simple Payback Period, years	25.4	

- Existing
 - Higher Initial Investment
 - Lower Operation Cost
 - Zone Controllability
- Alternative
 - Lower Initial Investment
 - Higher Operation Cost
 - Radiant + Convection Heat Transfer

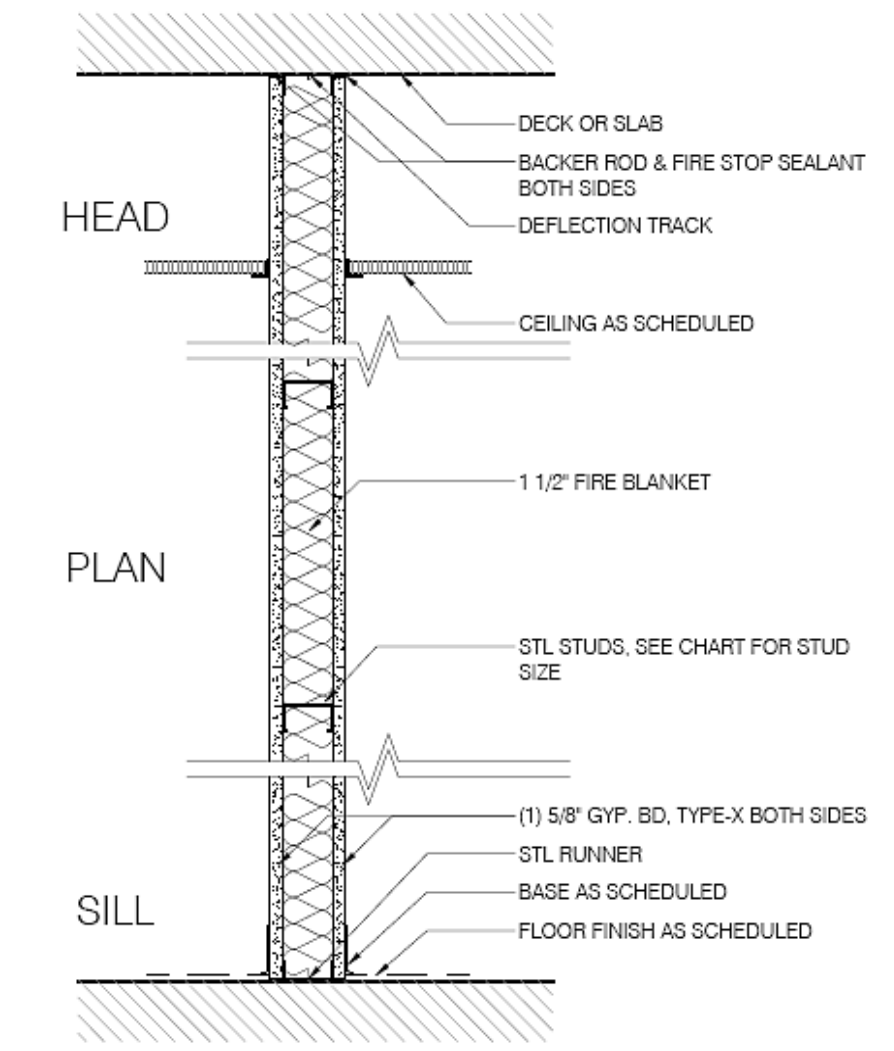
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- Alternative Noise Consideration
 - Hot water pumps
 - Condensed water pumps
 - Chilled water pumps
 - Chiller/Heater



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- **ASHRAE Ch. 48 Noise and Vibration Control**
 - Airborne path through partition
 - Receiver Consideration
 - Conference Room : NC-30



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	Converted to A-weighted (dBA)					
OctaveBand Frequencies (Hz)	125	250	500	1000	2000	4000
SPL of all source in each Octave Band (dB)	86	81	79	77	67	63

OctaveBand Frequencies (Hz)	125	250	500	1000	2000	4000
Noise in Mechanical Room (dB)	86	82	81	80	71	66
Background Noise Level in Conference (NC-35)	52	45	40	36	34	33
Required TL (dB)	34	37	41	44	37	33

- Assume all Noise Source Operating in Full Capacity

- Existing Partition Noise Reduction

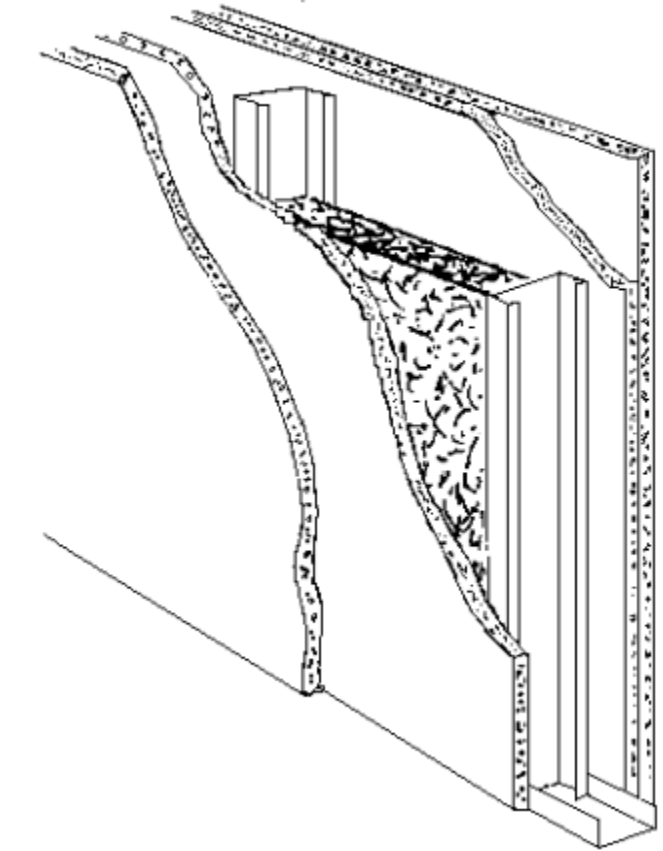
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PROPOSED PARTITION

	125	250	500	1000	2000	4000
Required TL (dB)	34	37	41	44	37	33
Proposed Partition	34	41	51	54	46	52
Remaining TL (dB)	0	-4	-10	-10	-9	-19

- 3-5/8" steel channel Studs with 2 layers of 5/8" gypsum boards both sides

CONCLUSION



- Required NR comply
- Partition wall section areas



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- Alternative
 - Lower Initial Investment
 - Lower electrical consumption
 - Easier maintainability

QUESTION?