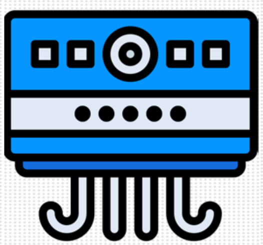
Planet to People: Low Lift Decoupled Systems

November 3, 2023

Low Lift Decoupled Systems

Agenda

- HVAC Energy Code & Local Law Trends
- Low Lift Systems
- Decoupled Systems
  - Introduction
  - Design Considerations
  - Applications
- Discussion



HVAC Systems

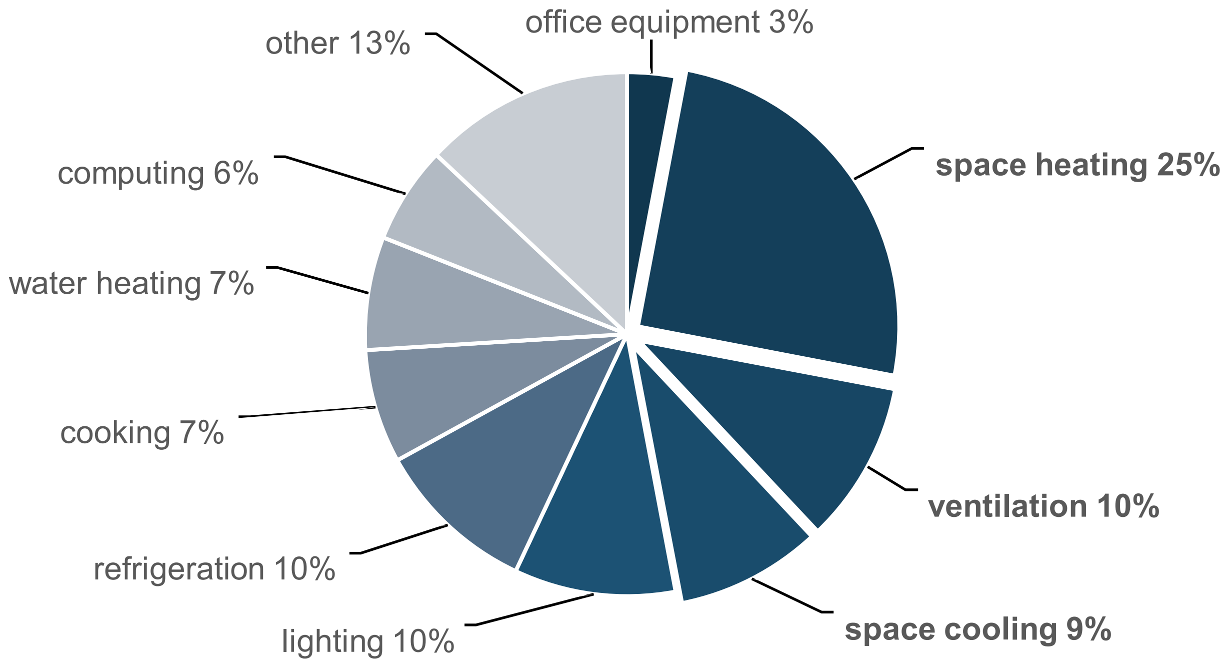
Codes and Local Law Trends

HVAC Systems – Codes and Local Law Trends

Building Energy Consumption

- 40 - 50% of the building energy consumption can be attributed to HVAC systems.

CBECS 2012 Breakdown of Energy Use

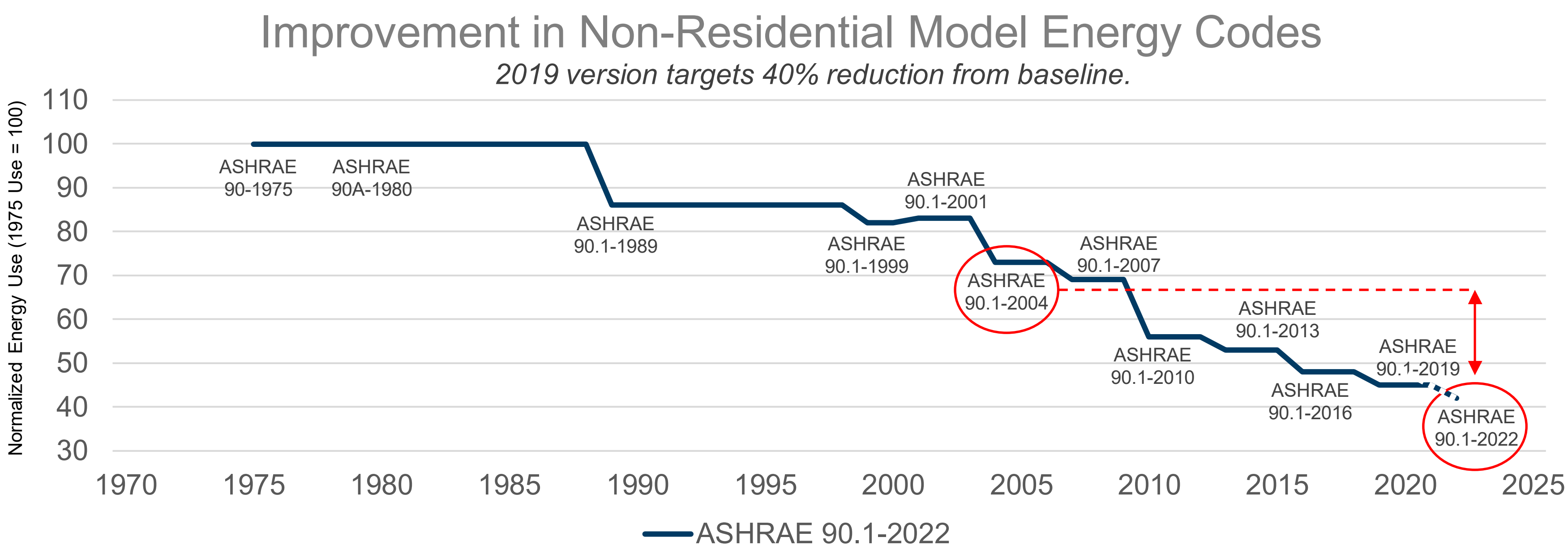


total energy use
6,963 trillion Btu

(Source: U.S. Energy Information Administration, 2012 Commercial Buildings Energy Consumption Survey)

HVAC Systems – Codes and Local Law Trends

90.1 Development



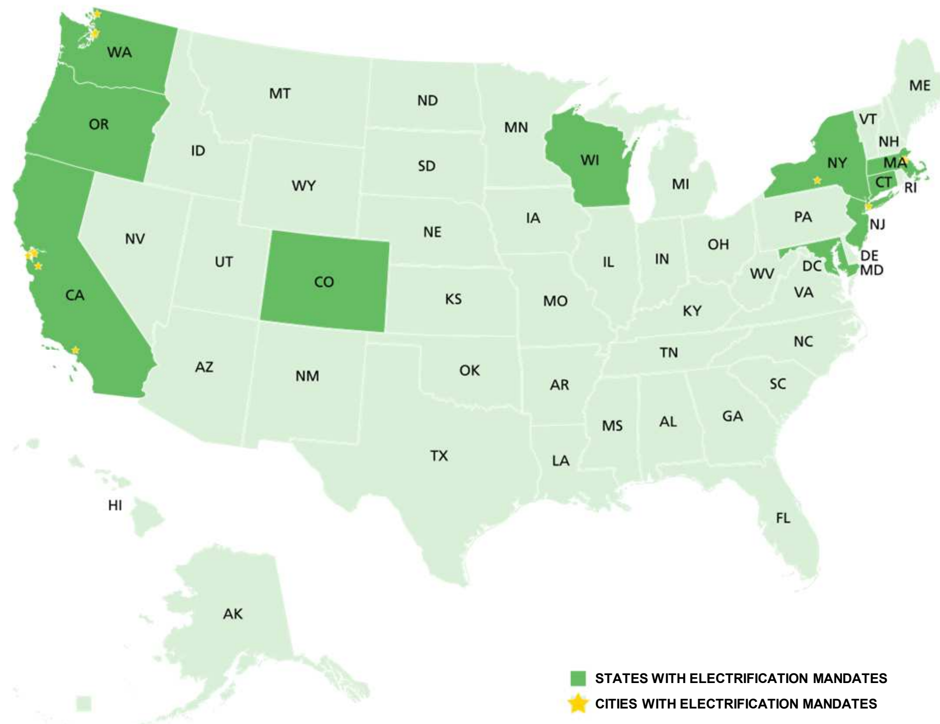
Source: Pacific Northwest National Laboratory

HVAC Systems – Codes and Local Law Trends

Electrification

US Cities and States Moving to All-Electric Buildings

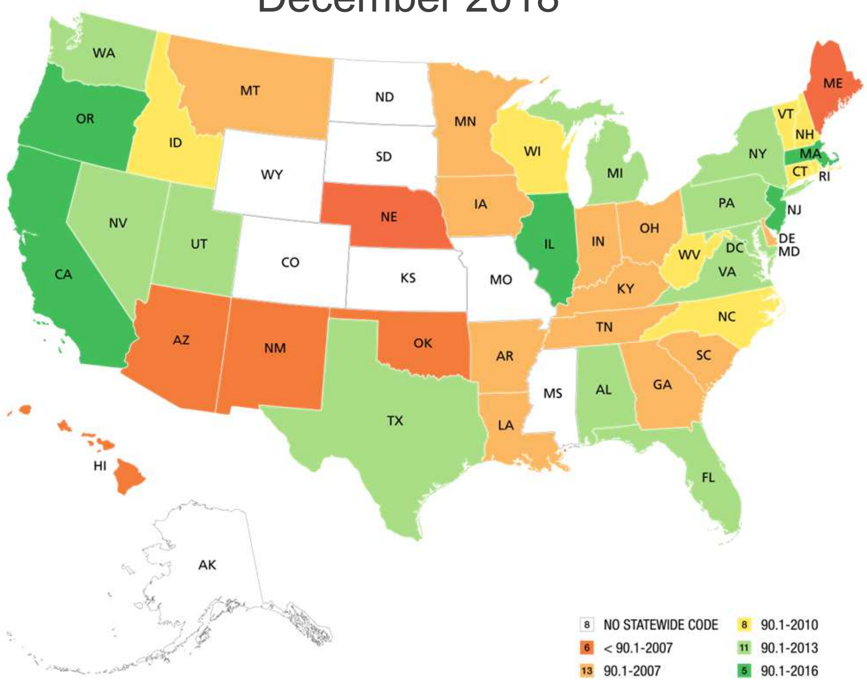
In the following slides are recent examples of cities and states transitioning away from gas in homes and buildings and moving to all-electric power.



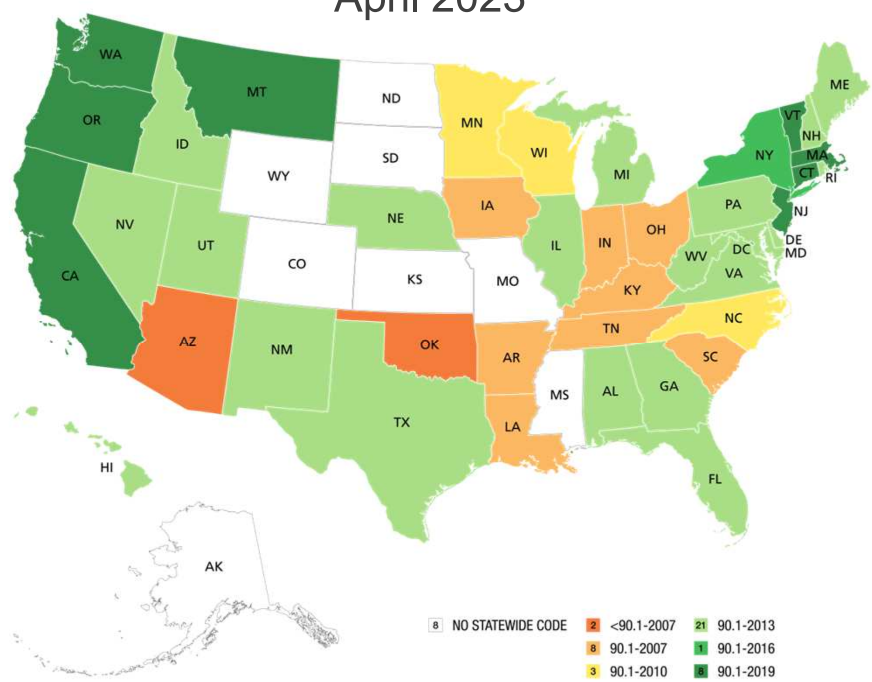
HVAC Systems – Codes and Local Law Trends

Energy Code Adoption

December 2018



April 2023



HVAC Systems – Codes and Local Law Trends

Inflation Reduction Act 2022

At $ 370B, this is the largest federal investment ever passed into law that will combat climate change through energy and other climate-related initiatives.

179D: ENERGY EFFICIENT COMMERCIAL BUILDING TAX DEDUCTION

Tier 1 has lower base deduction of $ 0.50/ sq. ft. if buildings outperform code baseline by 25% and up to $ 1/ sq. ft. if annual energy savings is reduced beyond 25%.
Tier 2 has higher base deduction of $2.5/ sq. ft. if the building also meets the prevailing wage and apprenticeship requirements.

ENERGY CODES

$330M for states and local governments to adopt or exceed the ASHRAE 90.1-2019 and / or IECC 2021 energy codes, and $ 670M to implement zero-energy stretch codes.

FEDERAL BUILDINGS AND INFRASTRUCTURE

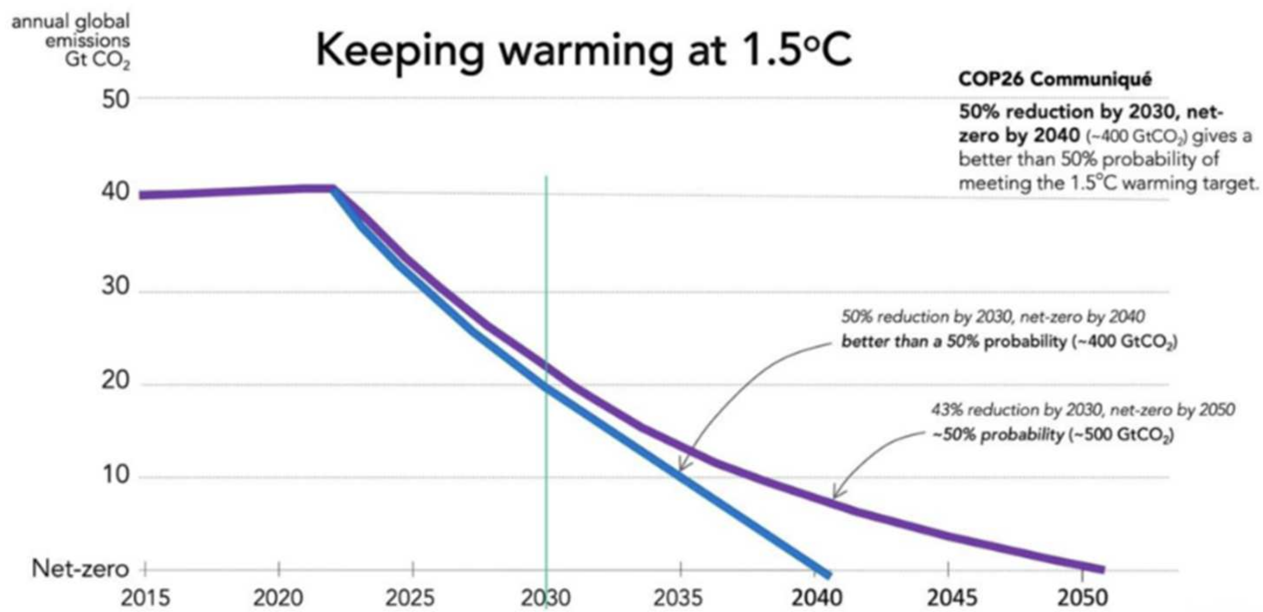
Multiple investments in the energy efficiency of federal buildings including $250M for GSA retrofits, $2.1B for Federal Buildings Fund for lowering embodied impacts of materials and products used in buildings and construction., and $975M for GSA Investments to sustainable technologies and programs.

HVAC Systems – Codes and Local Law Trends

MEP2040 – Committing to Zero

MEP 2040
Committing to Zero

"All systems engineers shall advocate for and achieve **net-zero carbon** in their projects: operational carbon by 2030 and embodied carbon by 2040."



(Source: architecture2030.org)

(Adapted from IPCC AR6 Figure SPM. 5(b), 2023)

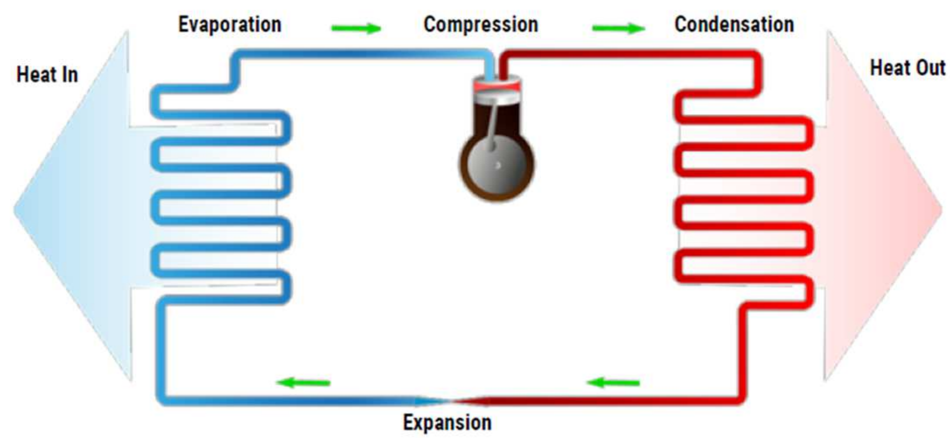
People

Low Lift Systems

People – Leading the CHARGE!

How Do We Electrify Our Buildings?

Heat Pumps are an emerging equipment category driven out of a desire to decarbonize HVAC systems through **electrified heating solutions**.

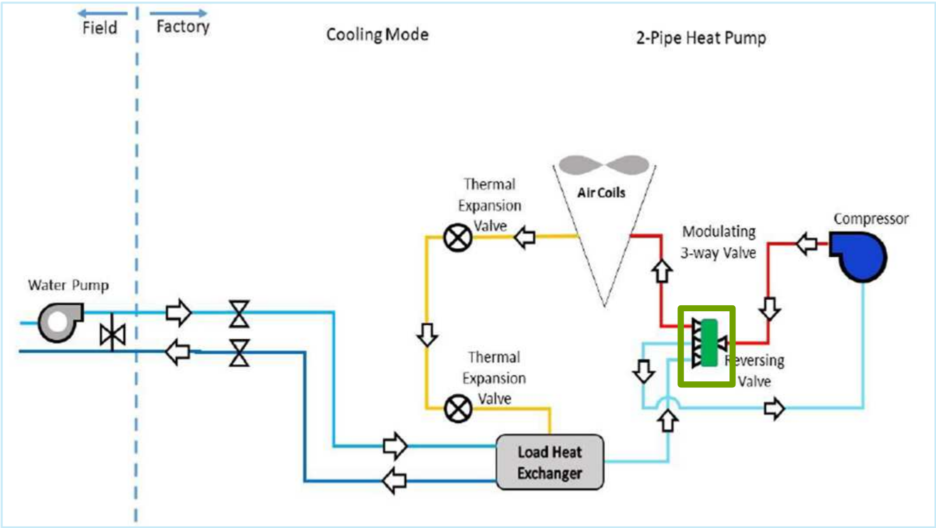


Fossil Fuel Free Labs – From Higher-Ed to Big Pharma, BR+A Consulting Engineers, Course # LDC2023B7 Lab Design Conference May 16, 2023

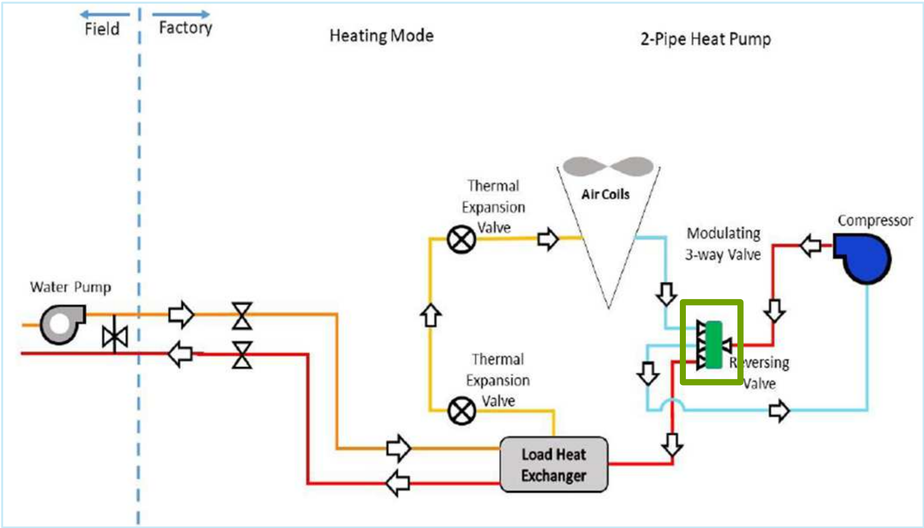
People – Leading the CHARGE!

Heat Pump Technology – How Does It Works?

Air-to-Water Heat Pump
(Cooling Mode)

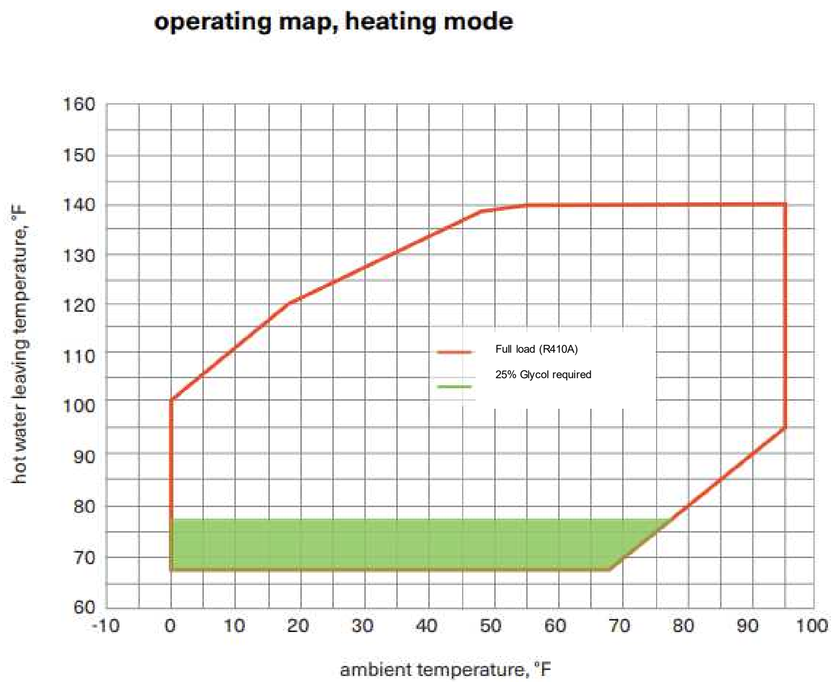


Air-to-Water Heat Pump
(Heating Mode)



Low Lift Systems

Heat Pump Technology – Fluid Temperature Range

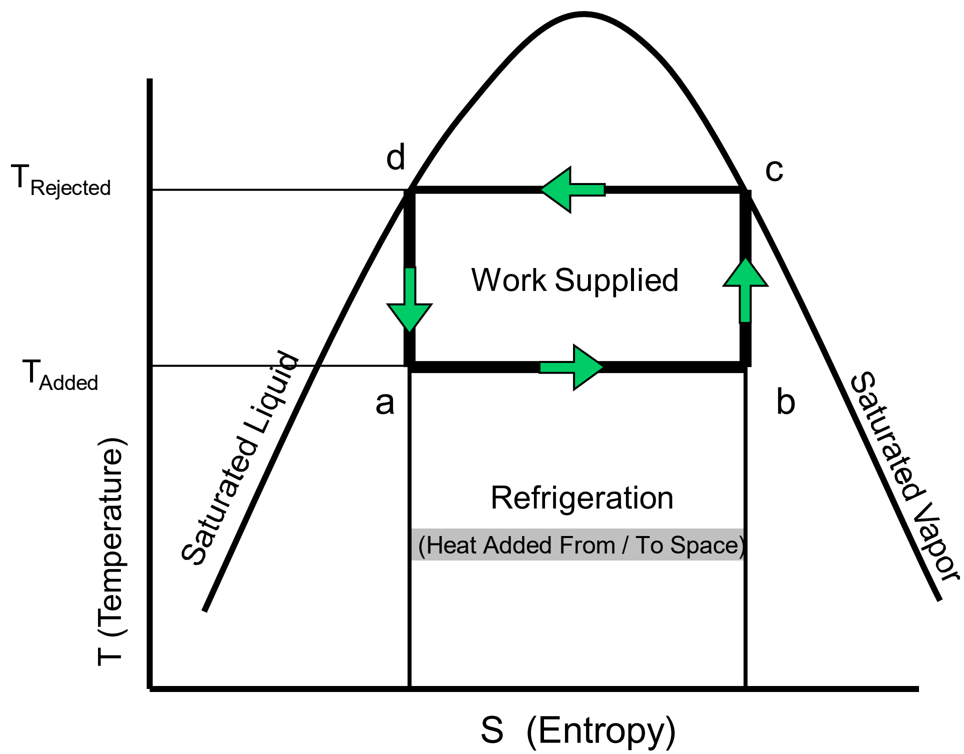


Limited Lift on Heating side

- **Leaving Heating Water Temperature: 75-140F**
  - Below 75 may be achievable with glycol
- **Operating Flow Delta T Range: 6F to 20F**

Low Lift Systems

Heat Pump Technology – Refrigeration Cycle



ab = Heat added from evaporator (space)

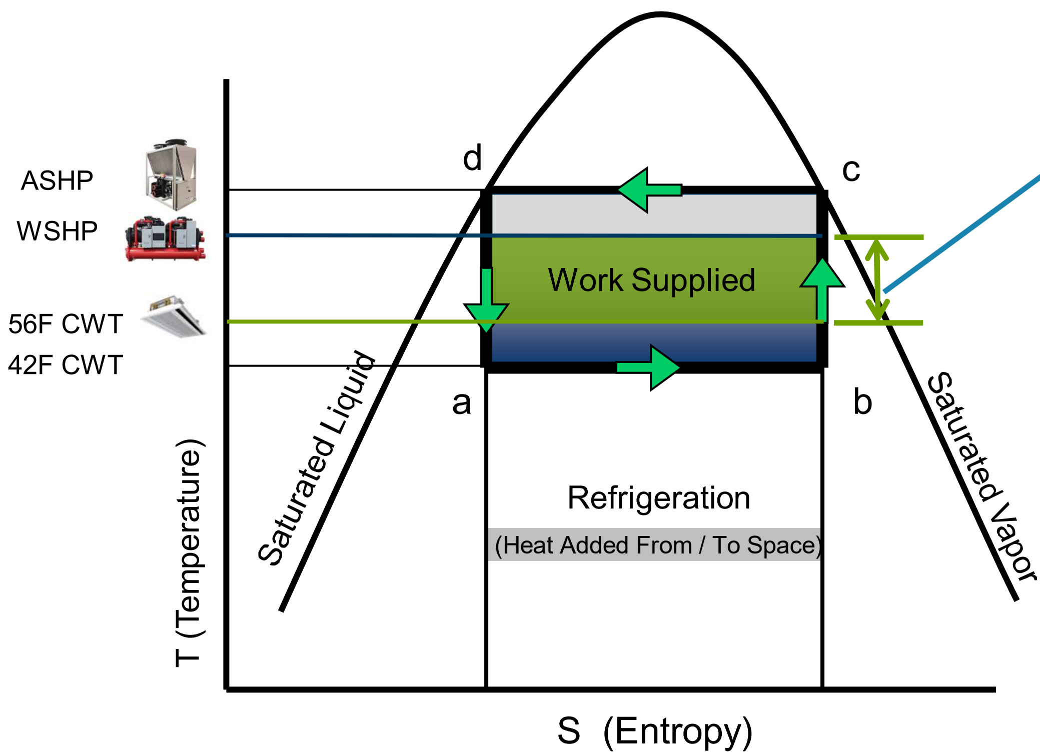
bc = Work added by compressor

cd = Heat rejected by condenser

da = Work produced by expansion (throttling) valve

Low Lift Systems

Heat Pump Technology – Refrigeration Cycle



Lower the "lift," higher the COP!

ab = Heat added from evaporator (space)

bc = Work added by compressor

cd = Heat rejected by condenser

da = Work produced by expansion (throttling) valve

Low Lift Systems

Heat Pumps – Heating Efficiency Requirements

ANSI/ASHRAE/IES 90.1–2019 Chiller/Heat Pump Efficiency Requirements

Table 1. **Air-source heat pump: minimum efficiency requirements (Source: ANSI/ASHRAE/IES Standard 90.1-2019, Table 6.8.1-16 and Addendum Y, Table 6.8.1-16)**

Equipment type	Size category refrigerating capacity (ton$_R$)	Cooling-operation efficiency air-source (EER, FL/IPLV), Btu/W-hr		Heating source conditions OAT (db/wb) °F	Heat pump heating full load efficiency (COP$_H$), W/W — Entering/Leaving heating liquid temperature			Test procedure
		Path A	Path B		Low 95°F/105°F	Medium 105F/120°F	High 120°F/140°F	
per ANSI/ASHRAE/IES Standard 90.1-2019 as originally published								
air-source	all sizes	≥9.595 FL ≥13.02 IPLV.IP	≥9.215 FL ≥15.01 IPLV.IP	47 db 43 wb	≥3.290	≥2.770	≥2.310	AHRI 550/590
		≥9.595 FL ≥13.30 IPLV.IP	≥9.215 FL ≥15.30 IPLV.IP	17 db 15 wb	≥2.230	≥1.950	≥1.630	
per ANSI/ASHRAE/IES Standard 90.1-2019 Addendum Y (approved December 9, 2021)								
air-source	<150.0	≥9.595 FL ≥13.02 IPLV.IP	≥9.215 FL ≥15.01 IPLV.IP	47 db 43 wb	≥3.290	≥2.770	≥2.310	AHRI 550/590
				17 db 15 wb	≥2.029	≥1.775	≥1.483	
	>150.0	≥9.595 FL ≥13.30 IPLV.IP	≥9.215 FL ≥15.30 IPLV.IP	47 db 43 wb	≥3.290	≥2.770	≥2.310	
				17 db 15 wb	≥2.029	≥1.775	≥1.483	

Note: See ANSI/ASHRAE/IES Standard 90.1-2019 and Addendum y for details and footnotes related to the date shown above.

27-30% efficiency increase by using 105F vs 140F for heating

Low Lift Systems

Heat Pumps – Cooling Efficiency Comparison

TABLE 1 Effect of chilled water temperature on chiller performance.

STANDARD 90.1-2016 STANDARD CONDITIONS		STANDARD 90.1-2016 55°F CHILLED WATER		STANDARD 90.1-2016 42°F CHILLED WATER	
FL	IPLV	FL_{adj}	PLV_{adj}	FL_{adj}	PLV_{adj}
KW/TON					
0.585	0.390	0.463	$\boxed{0.309}$	0.611	$\boxed{0.407}$

D. H. Nall, "Dual Temperature Chilled Water Plant & Energy Savings," ASHRAE Journal, vol. 59, no. 6, pp. 71, Jun. 2017.

26% efficiency increase by using 55F vs 42F

Approximately 2% energy savings per degree rise in CWT

Low Lift Systems

System HP - Standard vs “Low” Lift

	Standard Lift	Low Lift
Water ΔT	12°F	6°F
CHWT	42°F	56°F
GPM	167 gpm	334 gpm
Pump HP	3.15 HP	6.30 HP
Chiller HP	103 HP	75 HP
Total System HP	**106.15 HP**	**81.30 HP**

23.5% total HP reduction by using 56F vs 42F

*Pump HP = GPM * Head / 3690 / pump & motor efficiency*
Compressor HP = Load btuh / COP / 3413 btuh/kwh / 0.75kw/HP

Assumptions:

- *Sample building of 200’ × 200’*
- *Load at 25 btuh/sq. ft. = 25 × 200’ × 200’ = 1,000,000 btuh*
- *Delta T = 10F*
- *Head = 50 ft. (400 ft. of pipe run, + other equipment PD)*
- *Pump Eff. = 80%*
- *Motor Eff. = 90%*
- *Chiller COP = 3.8*
- *2% energy savings per degree rise in CWT*

People

Intro to Decoupled Systems

Introduction to Decoupled Systems

What is a Chilled Beam?

- What is a Chilled Beam?
  - A ***SENSIBLE ONLY*** device that uses chilled or heated water supplied above the room dew point to cool or heat the space in which it is installed.
    - *Primary air is used to treat Latent loads*

Introduction to Decoupled Systems

Hydronic vs Air

Water Side Design

- Water heat transfer vs Air heat transfer
  - On Mass Flow Rate Basis
    - 1 lb of chilled water (6° Δt) transports 4x more cooling energy than 1lbs of air (20° Δt)
  - Transportation Energy
    - Transportation of a ton of cooling by air requires **7 to 10 times more** than chilled water

Introduction to Decoupled Systems

All-Air vs. Decoupled Systems

Traditional VAV

Total Sensible
Latent & Ventilation (At the AHU)

Chilled Beams

Partial Sensible (Beam)
Latent & Ventilation (Airside)

Introduction to Decoupled Systems

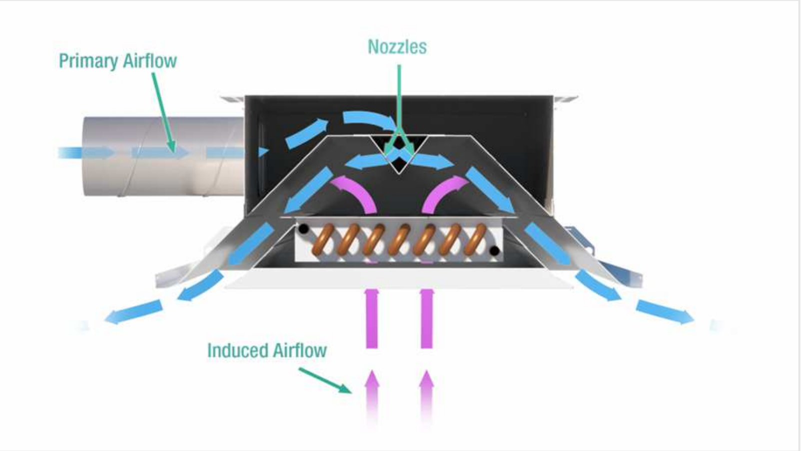
Decoupled Systems – Chilled Beams

Decoupled Systems allow the separation of primary air load from majority or all the space heating and cooling load.

Primary Air **Induced Air** **Total Airflow**

$$\boxed{50} + 4 * 50 = \boxed{250}$$

*Ex IR=4.0



Parameter		All Air System	Beam System
Cooling Capacity	Btu/h / cfm	1.08*dT ≈ 20	60 – 100

Chilled Beams can deliver 3-5 times the btuh/h/cfm

Introduction to Decoupled Systems

Types of Chilled Beams

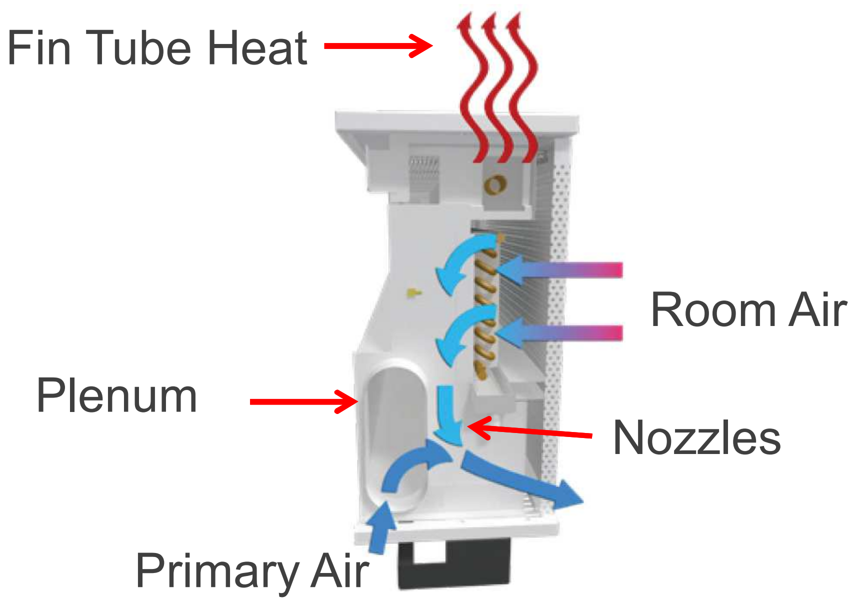
- Three types of Chilled Beams

Overhead Active Chilled Beams	Floor Mounted Chilled Beams	Passive Chilled Beams
		

Introduction to Decoupled Systems

Floor Mounted Chilled Beam

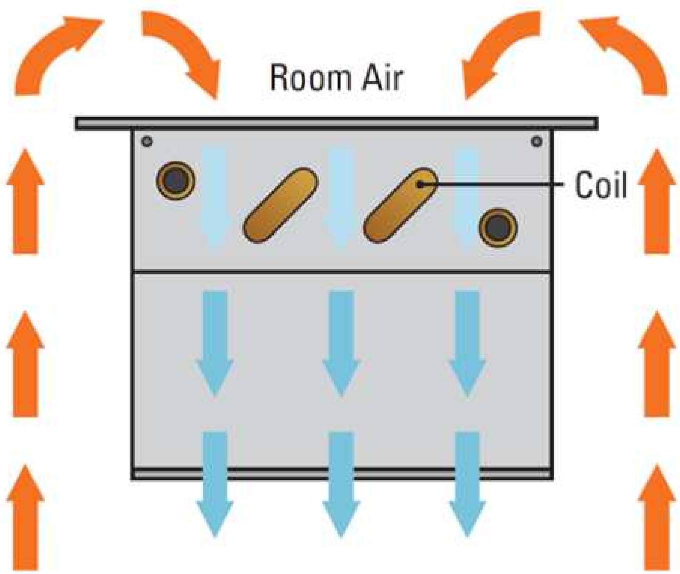
Parts of a floor mounted Active Chilled Beam.



Introduction to Decoupled Systems

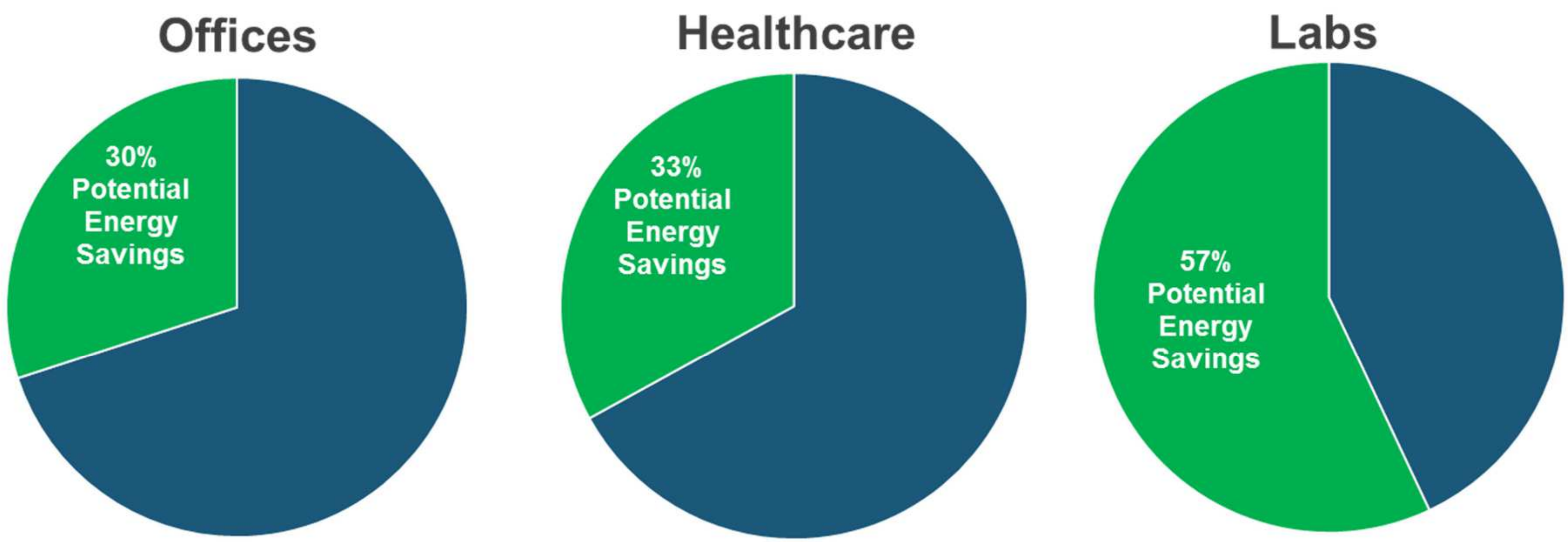
Passive Chilled Beams

- Parts of a Passive Chilled Beam



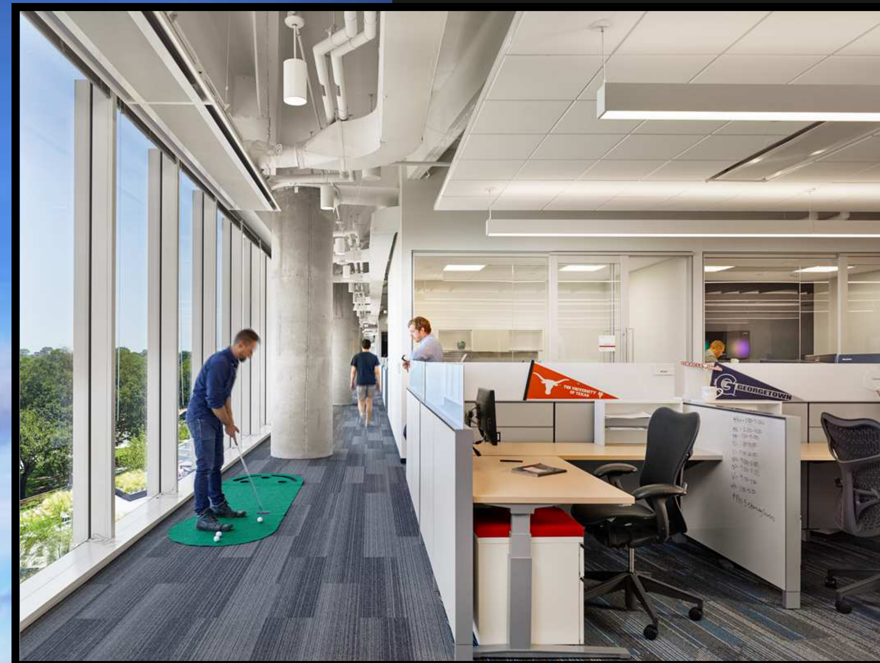
Introduction to Decoupled Systems

Why Chilled Beams?



Rumsey & Weale, Engineered Systems, Jan 11

Rumsey & Weale, ASHRAE Journal, 2009



ORACLE WATERFRONT

- LEED Gold
- 30.2% Savings over baseline
- Fan energy savings account for 23% of total building energy savings

MARSTON HALL, IA

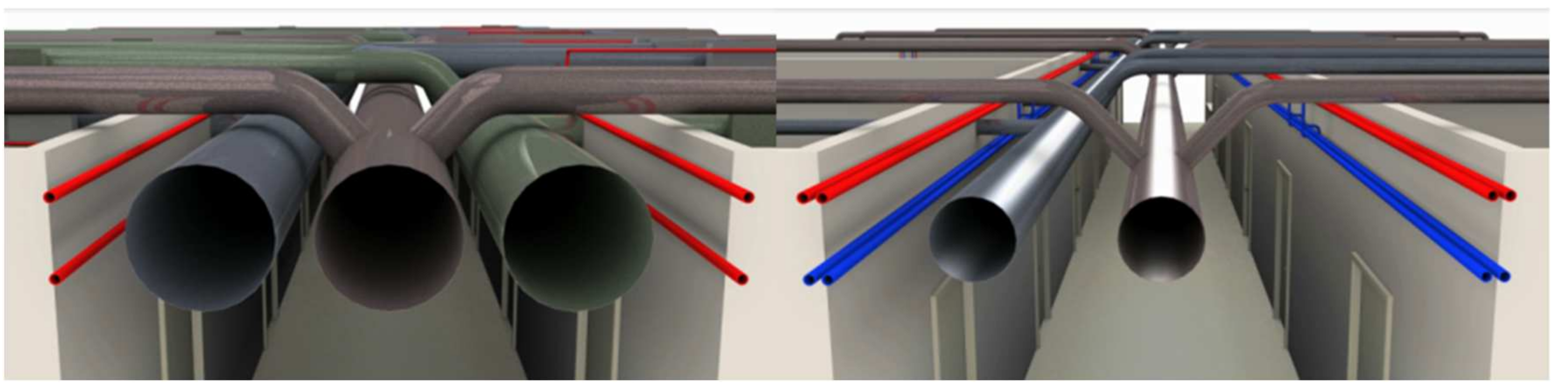
- LEED Gold
- 53 kBtu/SF/yr
- 33.5% Savings over baseline
- ~$39k savings annually
- Within 10% of energy model predictions

Introduction to Decoupled Systems

Why Chilled Beams?

- Reduction in total airflow
  - Works at Minimum Air Flow
  - Smaller/reduced Duct Work

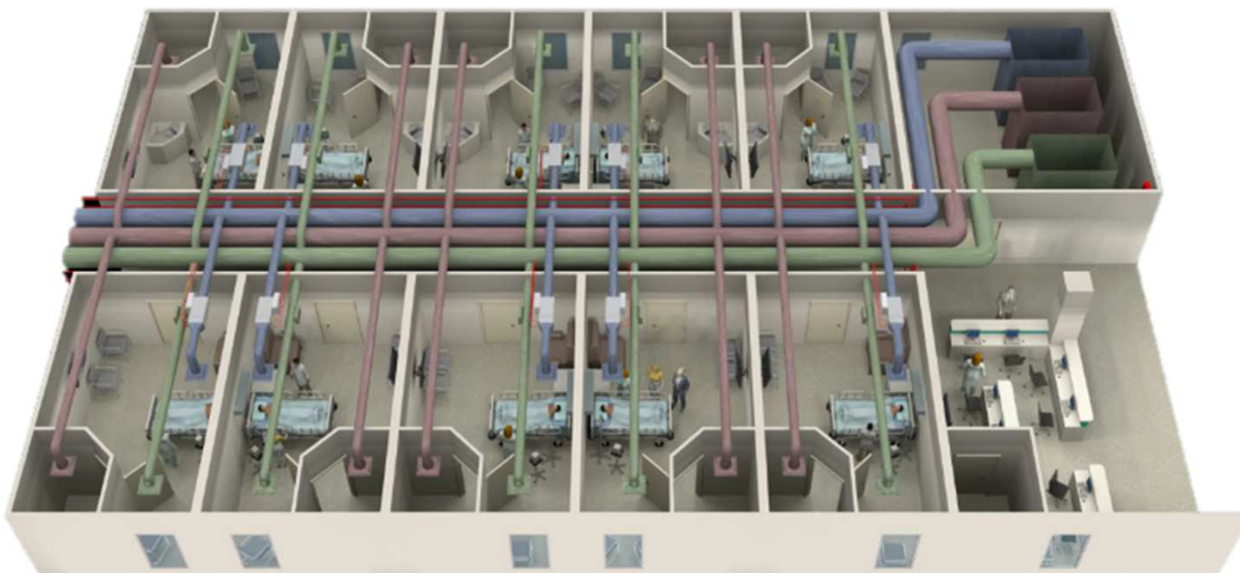
Dan Weiger, Johns Hopkins Hospital, Baltimore MD, April 2009



Introduction to Decoupled Systems

Why Chilled Beams?

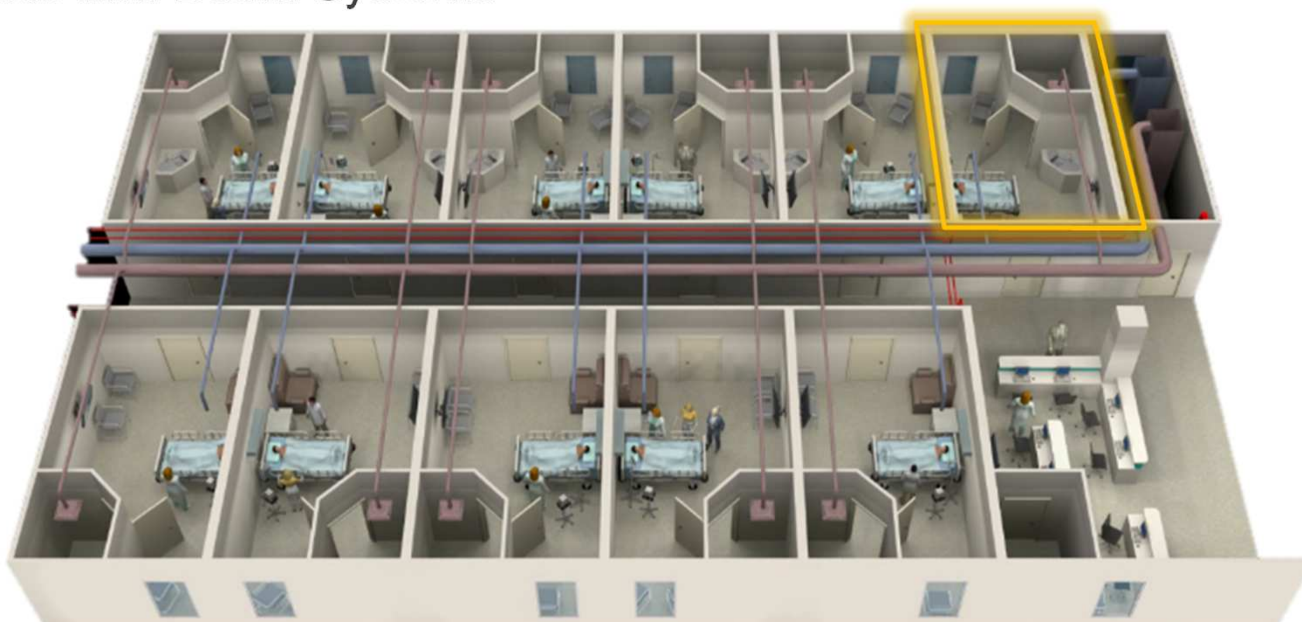
- Duct work reduction
  - Layout of Typical Mixing System



Introduction to Decoupled Systems

Why Chilled Beams?

- Duct work reduction
  - Layout with Beam Systems

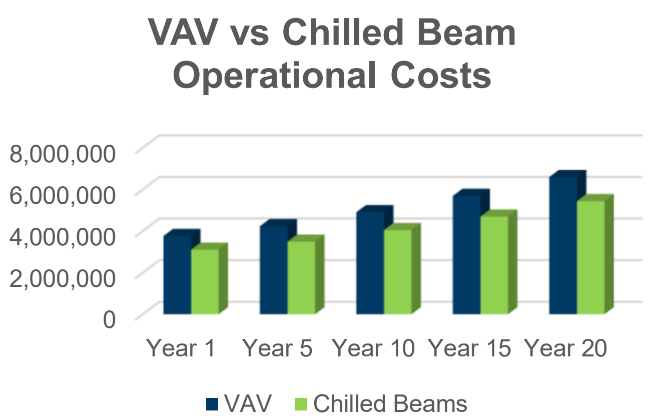


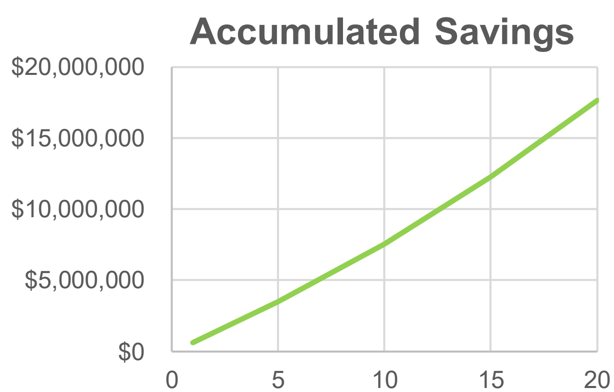
Introduction to Decoupled Systems

Why Chilled Beams?

Financial

- ~$1000/ft^2/yr for useful space
- +>$18M/yr increased revenue
- $2.5M Façade savings
- $575k Mechanical system savings





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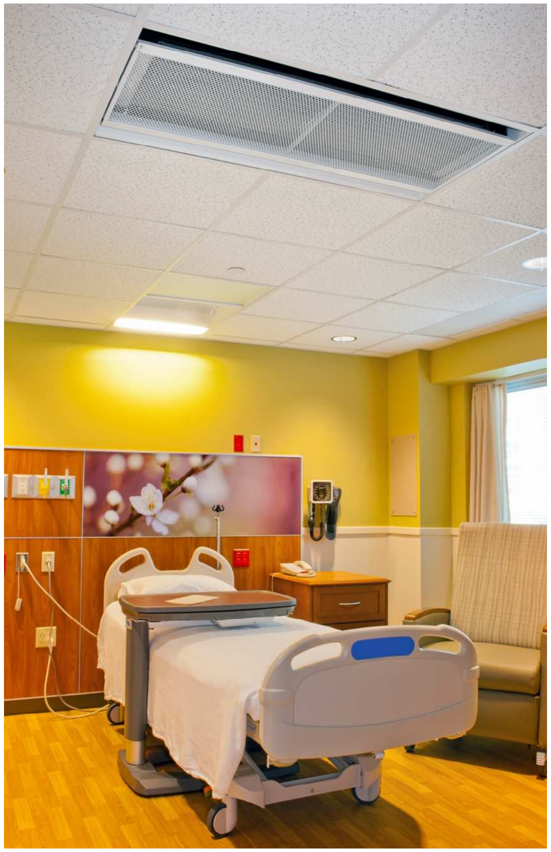
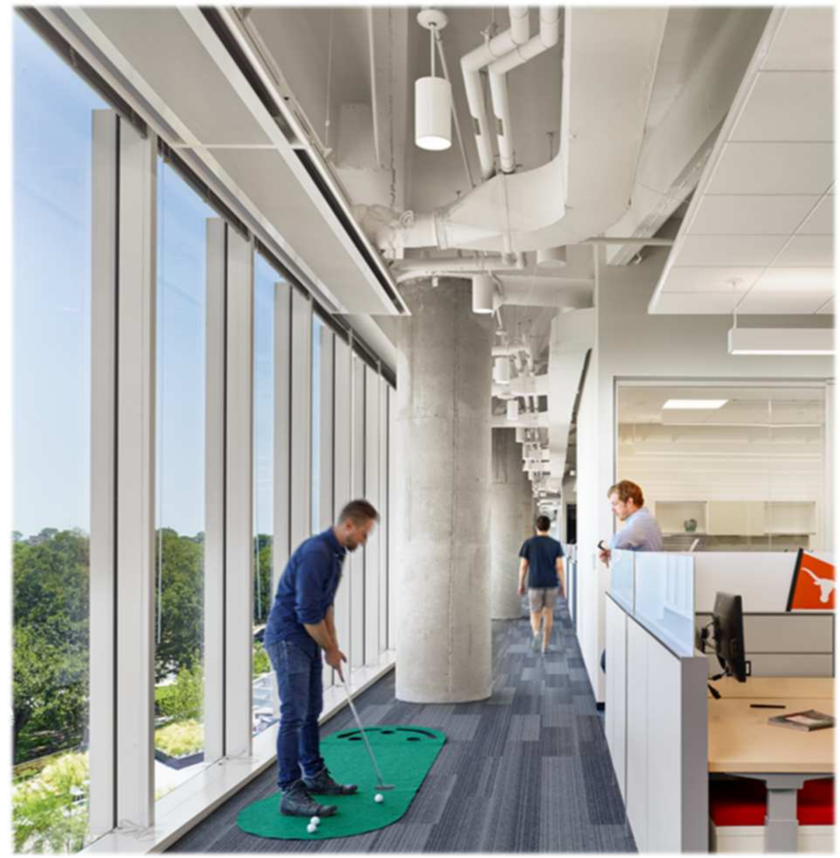


Introduction to Decoupled Systems

Why Chilled Beams?

Benefits

- Energy Savings
- Reduced Ductwork
- Reduced Mechanical Equipment Size
- Comfort
- Maintenance
- Quitter Operation



People

Decoupled System Design Considerations

Decoupled Systems – Design Considerations

Airside Design – Moisture Depression

Humidity Control:

- Room Conditions: **75° F, 50%**
- Moisture Content: **64.6 gr/lb**
- Dew Point: **55.2° F**

Primary Air Flow Sizing

- Ventilation Air
- Space Latent Load
- Active Beam Sensible Capacity

Typical All Air System Design:

- Entering Air Conditions: (55 DB / **54.2** WB)
- Moisture Content: **61.7 gr/lb**
- Latent Capacity/CFM: **1.97 BTU/hr**
- Dew Point: 53.6° F

Decouple Cooling w/ **Moisture Depression**:

- Entering Air Conditions: (55 DB / **51** WB)
- Moisture Content: **50.0 gr/lb**
- Latent Capacity/CFM: **9.93 BTU/hr**
- Dew Point: 49.0° F

Moisture Depression allows for higher latent capacity per cfm

Decoupled Systems – Design Considerations

Airside Design – Primary Airflow per Occupant

- Primary Air Dew Point

		Latent Load (Btu/hr) per Occupant			
		155	185	200	275
Min. Ventilation per Occupant (cfm)	9.5	43	36	36	28
	13.5	47	46	44	38
	15	48	46	45	40
	18	50	48	47	43
	20	51	49	48	46
	24	52	51	50	47

Dew Point variation based on application

- Goal is to create the right balance between min. ventilation airflow & a reasonable DOAS Dew Point

Decoupled Systems – Design Considerations

Selection Software – System Sizing

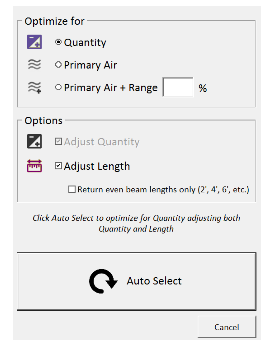
Project Name	Owner
Test Project	
	Revision
	001
Project Elevation (ft)	Date
0	4/28/2016

Room Conditions		Cooling	Heating
Dry Bulb °F		75.0 °F	72.0 °F
Relative Humidity % RH		50 %	50 %
Wet Bulb	°F	62.7 °F	60.2 °F
Dew Point	°F	55.1 °F	52.3 °F
	gr/lb	65.5	59.1
On-Coil Temperature °F (if different to Room Dry Bulb)		75.0 °F	72.0 °F
Noise NC		35	
Room Attenuation (dB)		10	

Primary Air Conditions (ducted to room)			
Dry Bulb °F		55.0 °F	55.0 °F
Relative Humidity % RH		80 %	80 %
Wet Bulb	°F	51.6 °F	51.6 °F
Dew Point	°F	48.9 °F	48.9 °F
	gr/lb	52.0	52.0
Max Airside ΔP in w.g.		0.75	

Entering Water Conditions		
Temperature °F	57.0 °F	120.0 °F
Fluid Type (Cooling)	Water	
Glycol Concentration %		
Fluid Type (Heating)	Water	
Glycol Concentration %		
Max Waterside ΔP ft w.g.	10.0	

RESET DEFAULT BUILDING PARAMETERS



Auto Selections
- ALL ROOMS/ZONES
- INDIVIDUAL ROOM/ZONE

Models
- BEAM TYPES

Total Quantities for the Project					
Primary Air:	31,550	CFM	Beams:	208	QTY
Chilled Water:	432.2	GPM	Beams:	1164	Feet
Hot Water:	89.3	GPM	No. Zones:	66	Zones

Room or Zone Number/Name	Input Design Zone Requirements: Sensible Load (BTUH)	Latent Load (BTUH)	Heating Load (BTUH)	Min Outside Air (CFM)	Number of Beams in Zone	Total Outputs for Zone (not per beam): Cooling Sensible (BTUH)	Cooling Latent (BTUH)	Heating (BTUH)	Primary Air Flow (CFM)	Chilled Water (GPM)	Hot Water (GPM)
Zone 1	12,000	1,000		109	1	7,848	1,702		185	0.5	
Zone 2	7,500	500	9,000	54	1	6,738	506	-1,029	55	2.3	0
Zone 3	5,200	600		65	1	5,871	552		60	2.1	
Zone 4	25,000				6	23,250	2,484		270	14.4	
Zone 5	130,000	20,000		2174	16	99,200	8,833		960	35.2	

Room or Zone Number/Name	Selection Parameters per Active Beam: Zone/Room Selection Options	Model	2 or 4 Pipe Coil	Coil Circuit	Beam Length ft (nom)	Beam Width in (nom)	Primary Air Flow CFM	Primary Air Target Pressure (in W.G.)	Primary Air Exact Pressure (in W.G.)	Air Inlet Size (in)	Chilled Water (GPM)	Hot Water (GPM)
Zone 1	Default	ACBL-R2	2	Single	8	24	185	0.75	0.54	8E	0.5	
Zone 2	Default	ACBL-R2	2	Dual	8	24	55	0.75	0.64	5	2.3	0
Zone 3	Default	ACBH	2	Single	6	17	60	0.75	0.56	4	2.1	
Zone 4	Default	ACBM-S4	2	Single	4	24	45	0.75	0.70	6	2.4	
Zone 5	Default	ACBL-R1	2	Dual	8	24	60	0.75	0.56	5	2.2	

Decoupled Systems – Design Considerations

Waterside Considerations

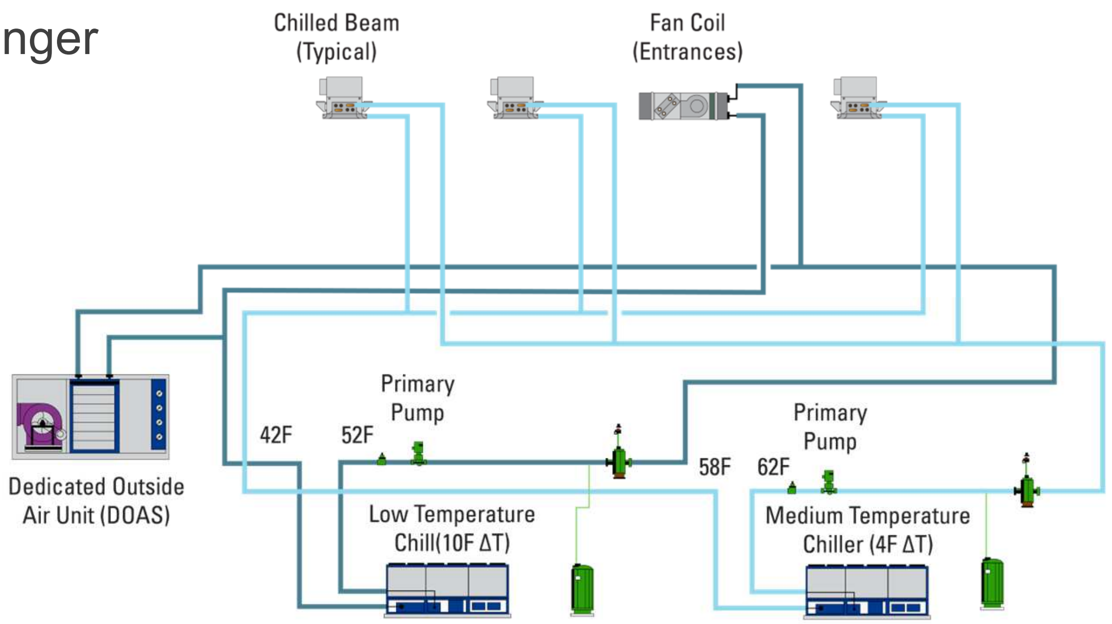
	Cooling	Heating
EWT	Dew point + 2°F	90-140°F
Water ΔT	4 – 7°F	10-20°F
Water Flow Rate	min – 0.5 gpm	min – 0.5 gpm
	max – 3 gpm	max – 3 gpm
	(Optimal ≥ 1 gpm)	(Optimal ≥ 1 gpm)
Water ΔP	0 - 10’	0 - 10’

Decoupled Systems – Design Considerations

Design Considerations

- Closed Loop Mixing Valve
- Plate and Frame Heat Exchanger
- Dedicated Chiller
- District Loop

Conventional Radiant/Chilled Beam System



People

Decoupled System Application

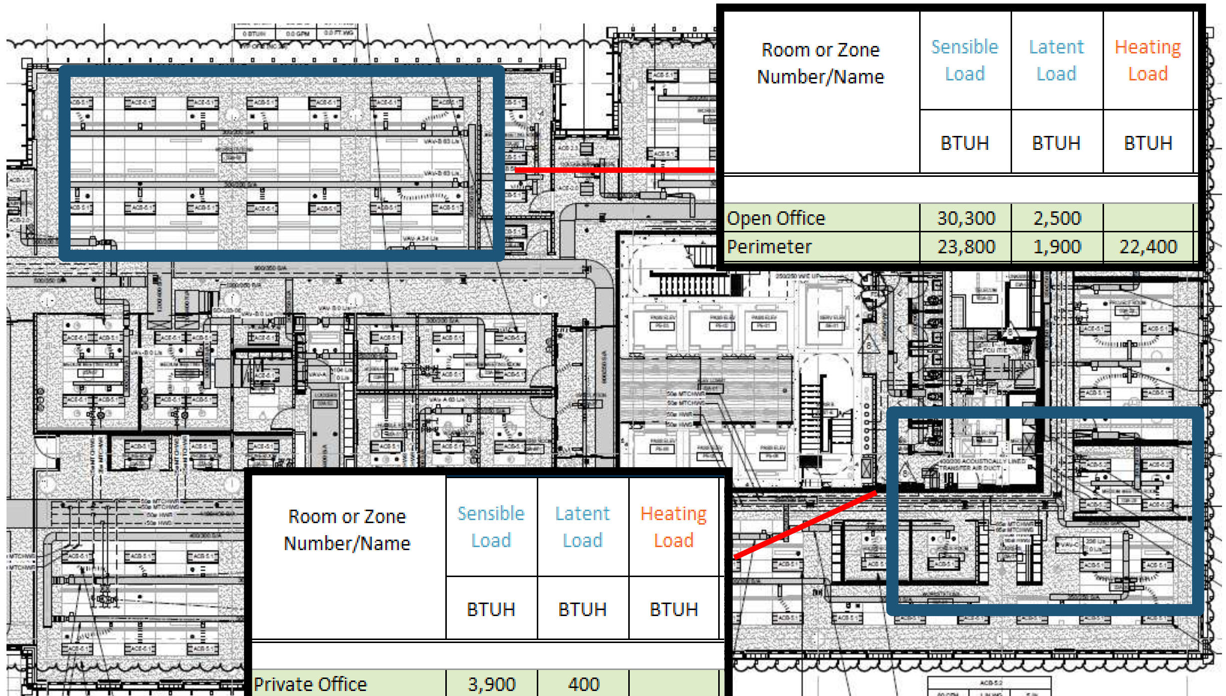
People – Leading the CHARGE!

Chilled Beams – Low Lift Application

Room Conditions	Cooling	Heating
Dry Bulb °F	75.0 °F	72.0 °F
Relative Humidity % RH	50 %	50 %

Primary Air Conditions (ducted to room)		
Dry Bulb °F	55.0 °F	55.0 °F
Relative Humidity % RH	80 %	80 %

Entering Water Conditions		
Temperature °F	57.0 °F	105.0 °F



Room or Zone Number/Name	Sensible Load	Latent Load	Heating Load
	BTUH	BTUH	BTUH
Open Office	30,300	2,500	
Perimeter	23,800	1,900	22,400

Room or Zone Number/Name	Sensible Load	Latent Load	Heating Load
	BTUH	BTUH	BTUH
Private Office	3,900	400	
Conference Room	12,400	1,100	9,700

People – Leading the CHARGE!

Chilled Beams – Office Buildings

Open Office - 1616 ft²

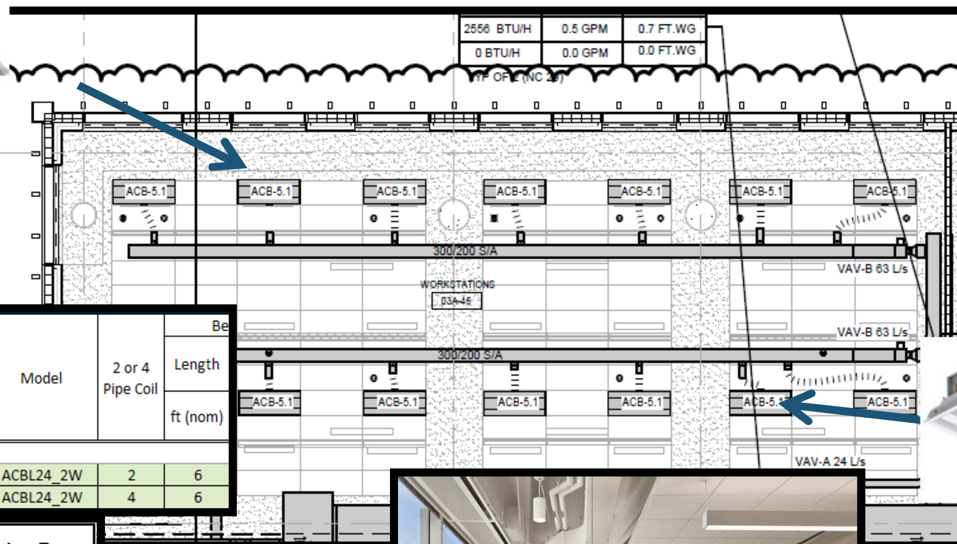
- Cooling – 19 BTUH / ft²

Perimeter – 71 ft

- Cooling – 338 BTUH /ft
- Heating – 308 BUTH / ft

Perimeter

- ACBLs 4-pipe heating and cooling

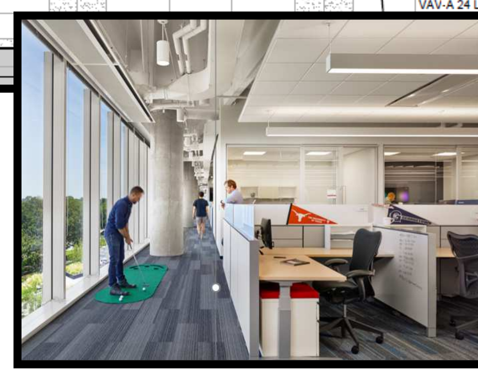


Interior / Open Office

- ACBLs 2-pipe cooling

Room or Zone Number/Name	Number of Beams in Zone	Cooling Sensible	Cooling Latent	Heating	Primary Air Flow	Chilled Water	Hot Water	Model	2 or 4 Pipe Coil	Be… Length
		BTUH			CFM	GPM				ft (nom)
Open Office	7	30,499	2,577		280	7.7		ACBL24_2W	2	6
Perimeter	7	24,033	1,933	21,879	210	8.4	4.9	ACBL24_2W	4	6

Airside Data per Active Beam: Transfer Effectiveness	Discharge Air Temp: Cooling	Discharge Air Temp: Heating	Sound Level		Waterside Data per Active Beam: Chilled Water Leaving Temp	Chilled Water Delta T	Hot Water Leaving Temp	Hot Water Delta T
BTUH/CFM	ºF		dB(A)	NC	ºF	ºF	ºF	ºF
109	60.6		29	<15	63.3	6.3		
114	59.9	85.7	21	<15	61.6	4.6	94.5	10.5



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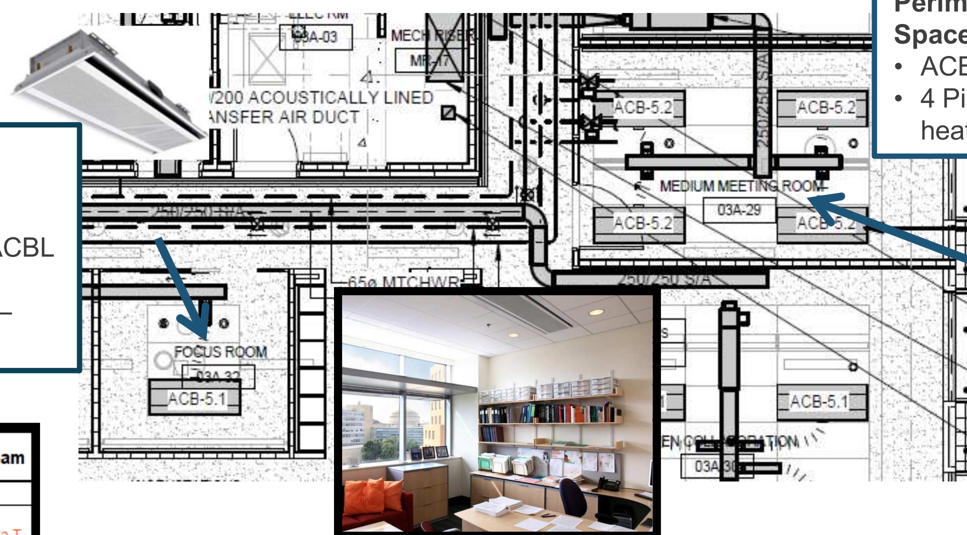
Chilled Beams – Office Buildings

Private Office – 97 ft^2
- Cooling – 50 BTUH / ft^2

Conference Room – 253 ft^2
- Cooling – 47 BTUH /ft^2
- Heating – 1041 BTUH /ft

Interior Enclosed Spaces
- Model ACBL
- 2 Pipe system – cooling



Perimeter Enclosed Spaces
- ACBL
- 4 Pipe system, heating and cooling

Airside Data per Active Beam					Waterside Data per Active Beam			
					Chilled Water		Hot Water	
Transfer Effectiveness	Discharge Air Temp		Sound Level		Leaving Temp	Delta T	Leaving Temp	Delta T
	Cooling	Heating						
BTUH/CFM	°F		dB(A)	NC	°F	°F	°F	°F
97	60.4		30	15	63.3	6.3		
104	61.2	83.6	21	<15	64.0	7.0	92.2	12.8

Room or Zone Number/Name	Number of Beams in Zone	Cooling		Heating	Primary Air Flow	Chilled Water	Hot Water	Model	2 or 4 Pipe Coil	Bea
		Sensible	Latent							Length
		BTUH			CFM	GPM				ft (nom)
Private Office	1	4,872	460		50	1.2		ACBL24_2W	2	6
Conference Room	4	12,489	1,104	10,618	120	2.8	2	ACBL24_2W	4	6

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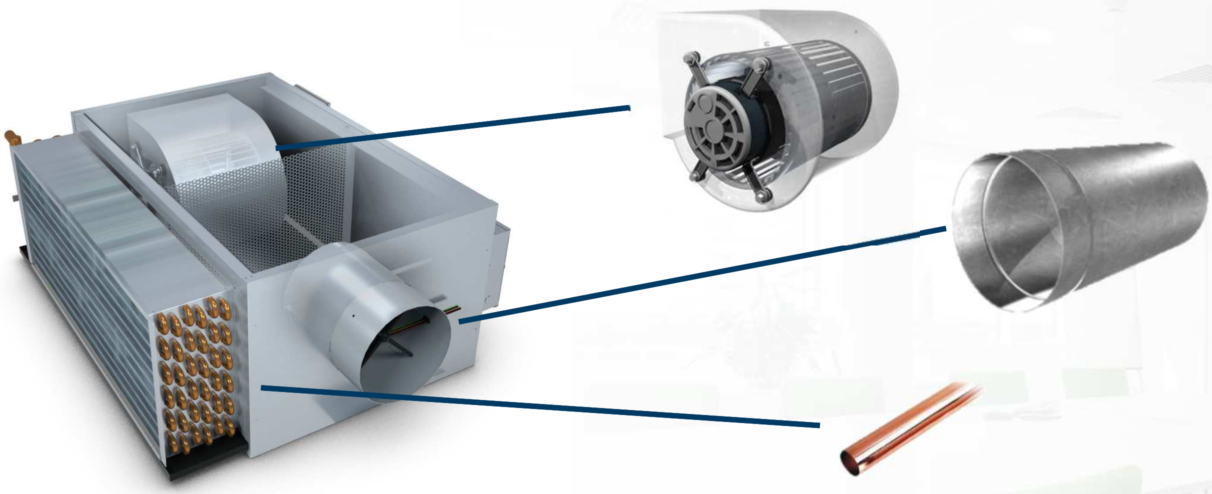
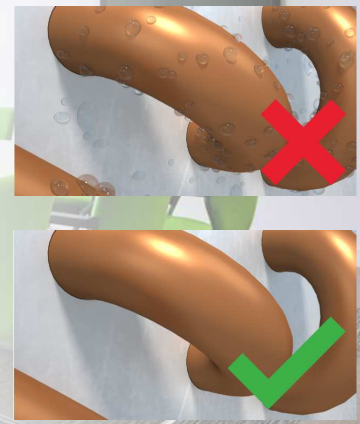
Sensible Cooling Fan Powered Terminal Units

Fan powered terminal units with sensible cooling coils are an effective solution to capitalize on the benefits of DOAS.





- ***Valve*** - maintains flow of ventilation air and meets latent (wet) load,
- ***Sensible Cooling Coil*** - handles space sensible (dry) cooling load,
- ***ECM Fan*** – accounts for all downstream pressure requirements.

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Hybrid Solution

Equipment Type	Acoustics	Heating	Architectural	Maintenance	Variable Loads
	✓ < NC 30 even in smaller zones	✗ Reheat available but less flexible	✓ Viewed as a visual asset by architects and engineers	✓ Low maintenance, no motors or filters	✗ Less turndown for variable occupancy and loads
	✗ Better suited for larger zones and loads	✓ Fully flexible reheat (electric coils and low EWT capable)	✗ Often hidden behind cloud or full ceilings	✗ Motors and filters requiring scheduled maintenance	✓ Perfectly positioned for variable occupancy

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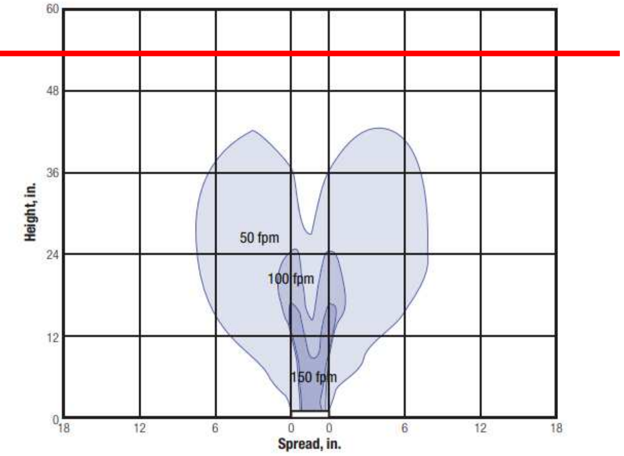
Ventilation Effectiveness Improvements

4.5 ft height

Air Distribution Configuration	E_z
Well-Mixed-Air Distribution Systems	
Ceiling supply of cool air	1.0
Ceiling supply of warm air and floor return	1.0
Ceiling supply of warm air 15°F (8°C) or more above space temperature and ceiling return	0.8
Ceiling supply of warm air less than 15°F (8°C) above average space temperature where the supply air-jet velocity is less than 150 fpm (0.8 m/s) within 4.5 ft (1.4 m) of the floor and ceiling return	0.8
Ceiling supply of warm air less than 15°F (8°C) above average space temperature where the supply air-jet velocity is equal to or greater than 150 fpm (0.8 m/s) within 4.5 ft (1.4 m) of the floor and ceiling return	1.0
Floor supply of warm air and floor return	1.0
Floor supply of warm air and ceiling return	0.7
Makeup supply outlet located more than half the length of the space from the exhaust, return, or both	0.8
Makeup supply outlet located less than half the length of the space from the exhaust, return, or both	0.5
Stratified-Air Distribution Systems (Section 6.2.1.2.1)	
Floor supply of cool air where the vertical throw is greater than or equal to 60 fpm (0.25 m/s) at a height of 4.5 ft (1.4 m) above the floor and ceiling return at a height less than or equal to 18 ft (5.5 m) above the floor	1.05
Floor supply of cool air where the vertical throw is less than 60 fpm (0.25 m/s) at a height of 4.5 ft (1.4 m) above the floor and ceiling return at a height less than or equal to 18 ft (5.5 m) above the floor	1.2
Floor supply of cool air where the vertical throw is less than 60 fpm (0.25 m/s) at a height of 4.5 ft (1.4 m) above the floor and ceiling return at a height greater than 18 ft (5.5 m) above the floor	1.5



Twist Pattern at 70 cfm

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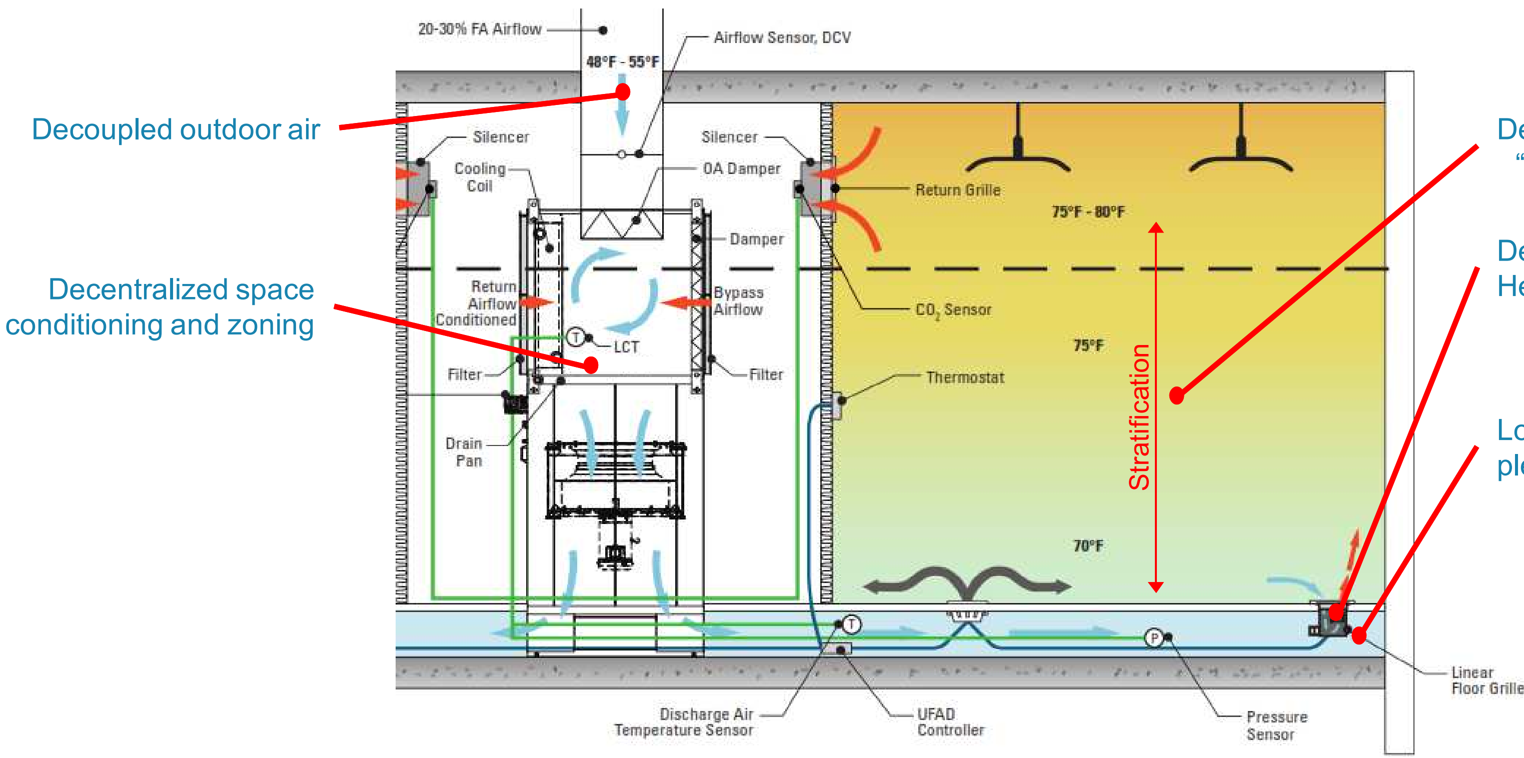
Low-Lift Systems Using UFAD



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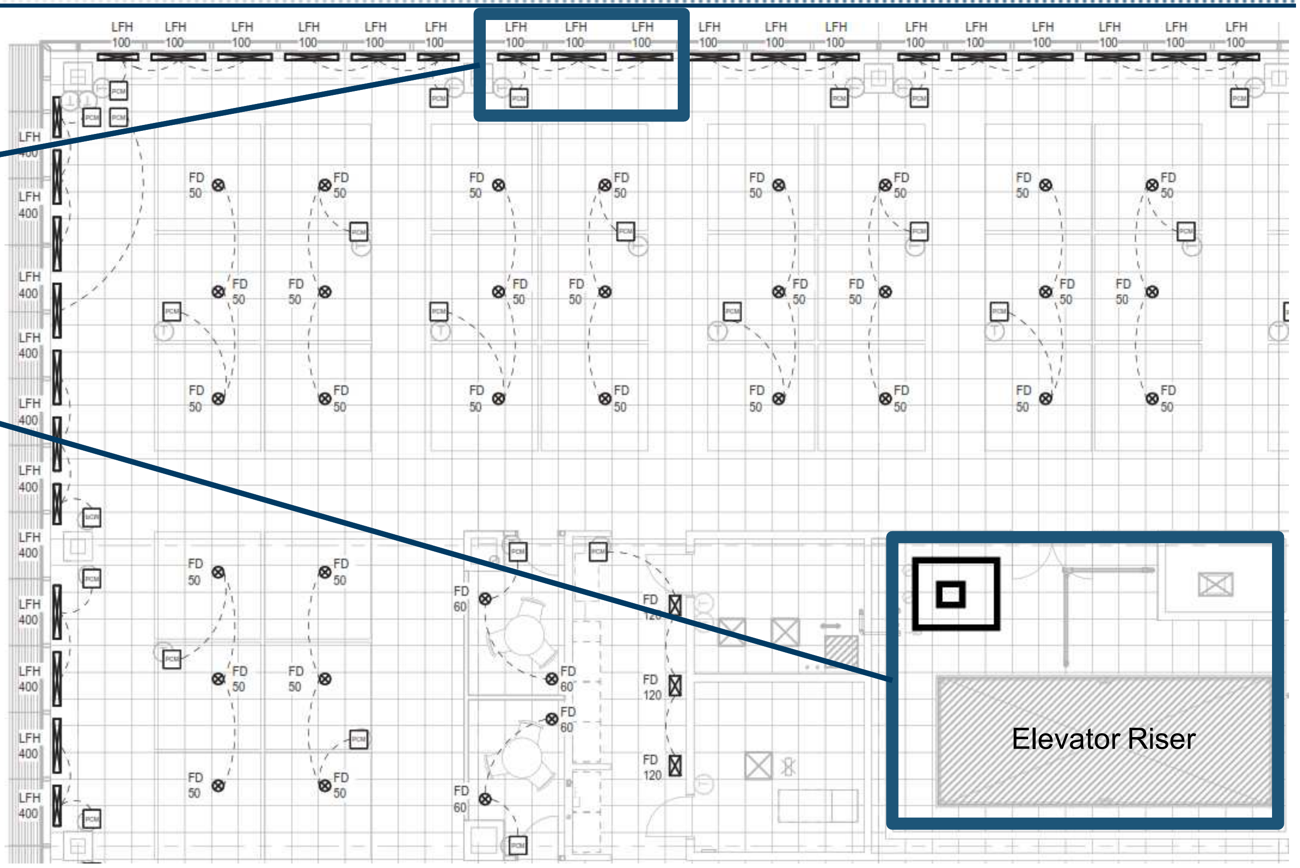
Low-Lift Systems Using UFAD

Perimeter – 150 ft
- Cooling – 500 BTUH /ft
- Heating – 750 BUTH /ft

Open Office - 5400 ft^2
- Cooling – 5400 cfm



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Low-Lift Systems Using UFAD

Performance shown based on:

- Outdoor Air: 55F/52F
- Return Air: 80F/ 67F
- EWT: 55F
- Supply air: 62F/ 57F

Coil handles sensible only

Model	Rated Airflow (cfm)	SAT (F)	Design OA (cfm)	Design Coil Airflow (cfm)	EWT (F)	Total Coil Capacity (MBH)	Coil PD at Design (in.w.c)
PFC25	2500	62/57	750	1460	55	33.1	4.2
PFC50	5000	62/57	1500	3010	55	63.3	3.7
PFC75	7500	62/57	2250	4400	55	99.5	10
PFC100	10000	62/57	3000	5990	55	128.2	15.4
PFC125	12500	62/57	3750	7410	55	164.2	18.7
PFC150	15000	62/57	4500	8940	55	194.7	14.6
PFC175	17500	62/57	5250	10540	55	221.1	16

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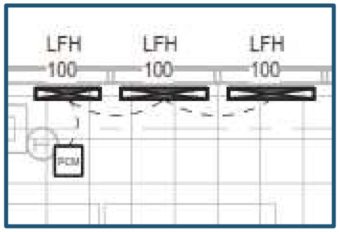
Low-Lift Systems Using UFAD



3 units piped in parallel with one control valve per zone

LFT Performance

Unit					Heating									
Model	# of Rows	Length	Width	Depth	Total Coil Capacity	Sensible Coil Capacity	Capacity per Linear ft	Entering Fluid Temp.	Leaving Fluid Temp.	Delta T	Entering Air Temp.	Leaving Air Temp.	Fluid Flow	Air Flow
		in (nom)	in (nom)	in (nom)	MBH	MBH	MBH/ft	°F	°F	°F	°F	°F	GPM	CFM
LFT	4	72	10	7.625	11.65	11.65	1.94	135	111.3	23.7	65.0	110.0	1	240
Unit					**Cooling**									
Model	# of Rows	Length	Width	Depth	Total Coil Capacity	Sensible Coil Capacity	Capacity per Linear ft	Entering Fluid Temp.	Leaving Fluid Temp.	Delta T	Entering Air Temp.	Leaving Air Temp.	Fluid Flow	Air Flow
		in (nom)	in (nom)	in (nom)	MBH	MBH	MBH/ft	°F	°F	°F	°F	°F	GPM	CFM
LFT	4	72	10	7.625	3.49	3.41	0.57	55.00	61.82144	6.8	78.0	64.8	1.0	240

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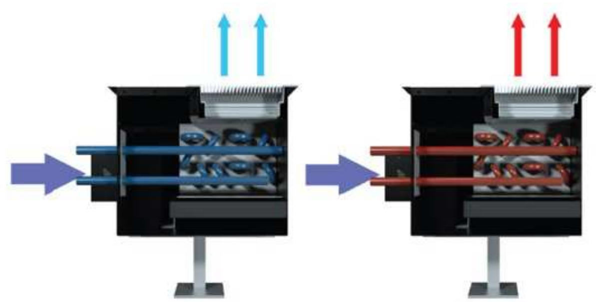
Solution for all Perimeter needs!

Linear Floor Heater

CFM/FT	50 - 80
Heat Output (105F EWT)	400 - 900 BTH/FT
Cool Output (55F EWT)	150 - 250 BTH/FT
Height	11”

Heat/Cool Terminal



CFM/FT	20 – 50
Heat Output (105 EWT)	480 - 900 BTH/FT
Cool Output (55F EWT)	340 - 500 BTH/FT
Height	10.5”

Linear Fan Terminal

CFM/FT	25 – 45
Heat Output (105 EWT)	550 – 1000 BTH/FT
Cool Output (55F EWT)	300 - 600 BTH/FT
Height	4 - 7.5”

Plenum Air **Room Air**

First Cost ⟷ **More Control**

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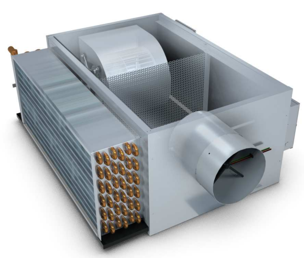
What to Remember

The lower the "lift", the higher the system efficiency!

Active Chilled Beam

Fan-Powered Terminal Unit
with sensible cooling



Fan Columns

Perimeter Trough Terminal

Decoupled technologies like chilled beams, sensible FPBs, fan columns and perimeter troughs can help minimize the "lift":

- 27-30% heating plant efficiency increase when using 105F EWT in lieu of 140F
- 26% cooling plant efficiency increase when using 55F EWT in lieu of 42F

Additional Decoupled System benefits include:

- Lower BTUH transport energy
- DECOUPLE: Better measuring and control of ventilation and latent capacity
- DECENTRALIZE: Better zone level control
    - Remember, the most efficient piece of HVAC equipment is one that is turned OFF
- DECREASE: "The 40-40-40 Rule"
    - Consider Stratification & IAQP

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Questions?

Planet to People – Low Lift Decoupled Systems

This training session is accredited for 1 Professional Development Hour (PDH)