Water Source & Geothermal Heat Pump Systems

Agenda

- Who is Jacco
- Water Source & Geothermal Descriptions
- Water Source & Geothermal Basics
- Geothermal Loops
- Water Source & Geothermal Products
- Net Energy Loop
- Service & Maintenance
- Case Study
- Project Profiles
- Future

Who is Jacco

- Established 1968
  - Hudson, Ohio
  - Columbus, Ohio
  - Toledo, Ohio
- Focused on the Engineered Environment
  - Systems Knowledgeable
    - HVAC Systems
    - Service & Maintenance
    - Parts
- Full Circle Support
- 30 Minute Design

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Who is Jacco

- Operations Group
  - –Brenda Homjak
  - –Mike Spangler
  - –Chad Russell

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Purpose Statement

The purpose of our Company is to solve our customers problems, in the most economical way, at all times optimizing the owning experience.

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Who is Jacco

- 30 Minute Design
  - Unit Performance
  - Drawing
  - Weights
  - Electrical
  - Specifications?
  - Sequence of Operation?
  - Cartoon?
  - Narrative?

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Who is Jacco

2015 Seminars

Seminars	Instructor	Date
Psychrometrics	JKC	14-Jan
The Refrigeration Cycle	JKC	11-Feb
Energy Recovery	GAD	11-Mar
Applied Rooftop Systems	JKC	8-Apr
VRF Design & Installation	GAD	13-May
Geothermal Systems	GAD	10-Jun
Chilled Beam, Radiant Cooling & DOAS	JKC	12-Aug
Vertical Market Systems	GAD	9-Sep
Building Pressure & Air Flow Measurement	GAD	14-Oct
Controlling HVAC Systems - Sequence of Operations	JKC	11-Nov

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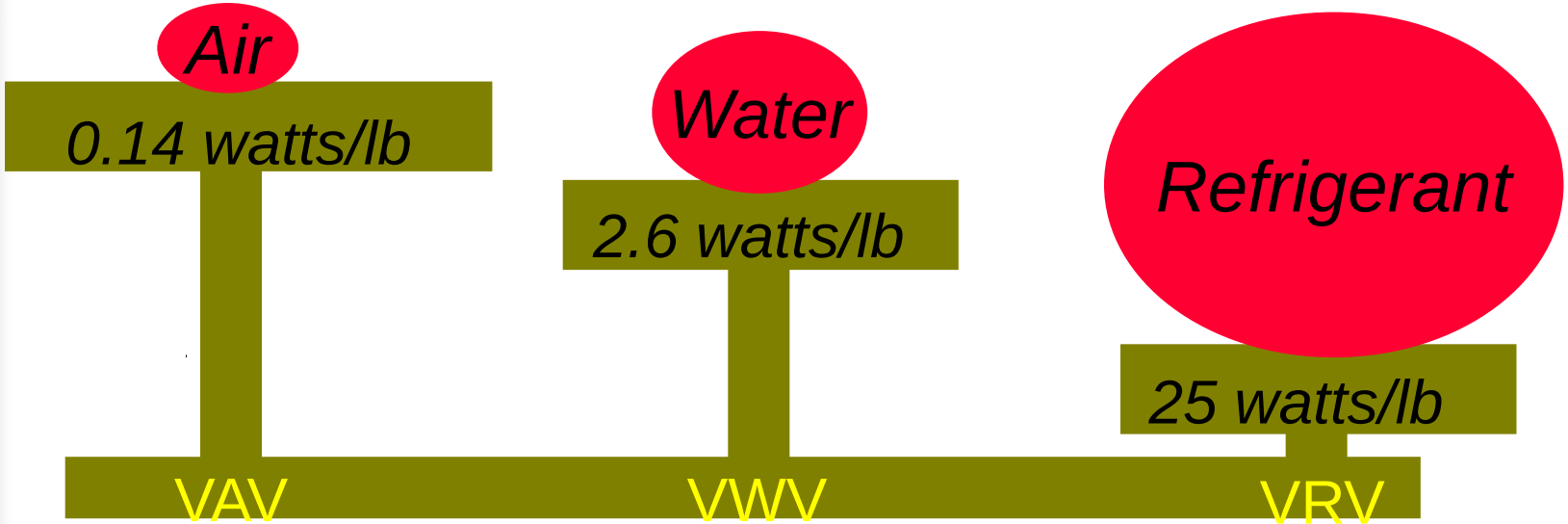
Water Source & Geothermal Descriptions

What is Geothermal Heating and Cooling?

- **ge·o·ther·mal** - Of or relating to the internal heat of the earth.

- **Geothermal Heating & Cooling** - the process of using low grade heat supplied by the earth to heat and cool a given facility.

Heat Transfer Media



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What Type of Buildings use Geothermal Systems?

Virtually Any Building can use a Geothermal Heating and Cooling System

- Schools
- Office Buildings
- Religious
- Hotels
- Government Buildings
- Museums

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Advantages of Geothermal

- Environmentally friendly
  - Reduction in energy consumption results in less emissions
- Design flexibility
  - Terminal units (decentralized)
  - Central Plant
- Low energy costs – reduce or eliminate natural gas usage
- Long term Solution – extended life cycle
  - Majority of equipment is indoors
  - Ground loops last a long time
- Lower maintenance
  - No cooling tower or boiler
  - Limited water treatment

What limits the use Geothermal Systems?

- Insufficient or limited land for ground loop
- Budget constraints
  - High cost of capital
  - Severely limited service life cycle expectations for calculating return on investment
  - Opportunity cost vs. alternative use of capital
- Inadequate soil conditions or excessive drilling requirements
- Severely imbalanced heating & cooling loads
- Limited knowledge of system capabilities

Water Source & Geothermal Basics

Commercial WSHP Basics

	ARI 320	ISO/AHRI 13256-1 WLHP	ARI 325	ISO/AHRI 13256-1 GWHP	ARI 330	ISO/AHRI 13256-1 GLHP
Cooling						
Entering Air - DB/WB °F	80/67	80.6/66.2	80/67	80.6/66.2	80/67	80.6/66.2
Entering Water - °F	85	86	50/70	59	77	77
Fluid Flow Rate	*	**	**	**	**	**
Heating						
Entering Air - DB/WB °F	70	68	70	68	70	68
Entering Water - °F	70	68	50/70	50	32	32
Fluid Flow Rate	*	**	**	**	**	**

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Commercial WSHP Basics

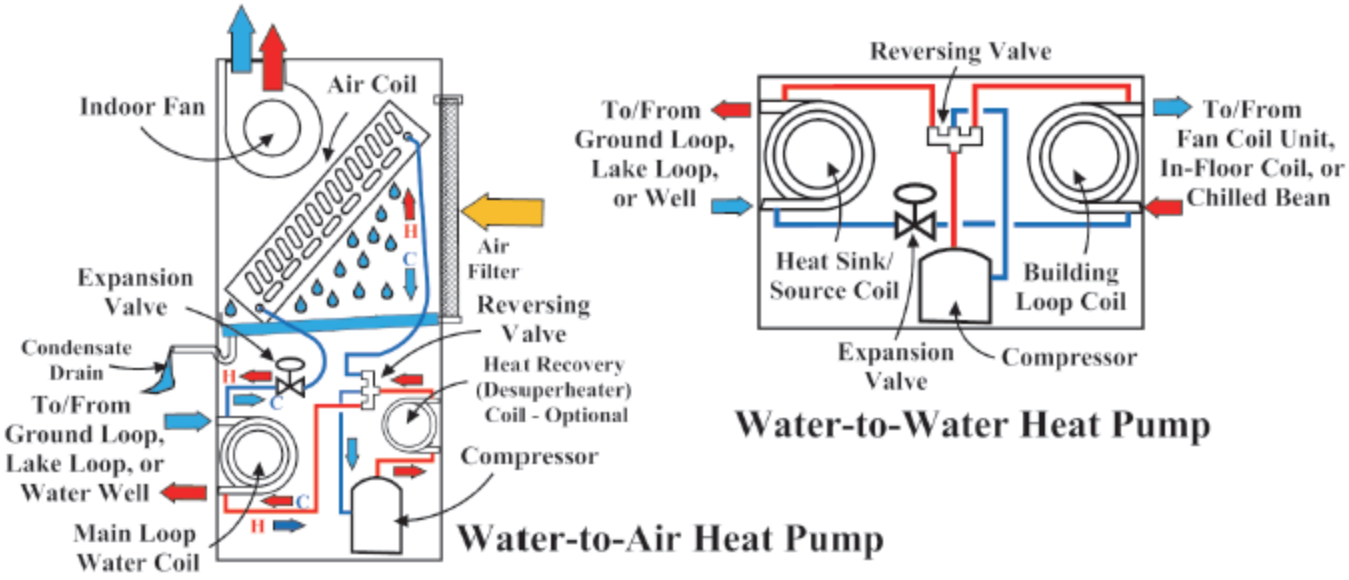

Figure 1.1 Primary GSHP Equipment Options

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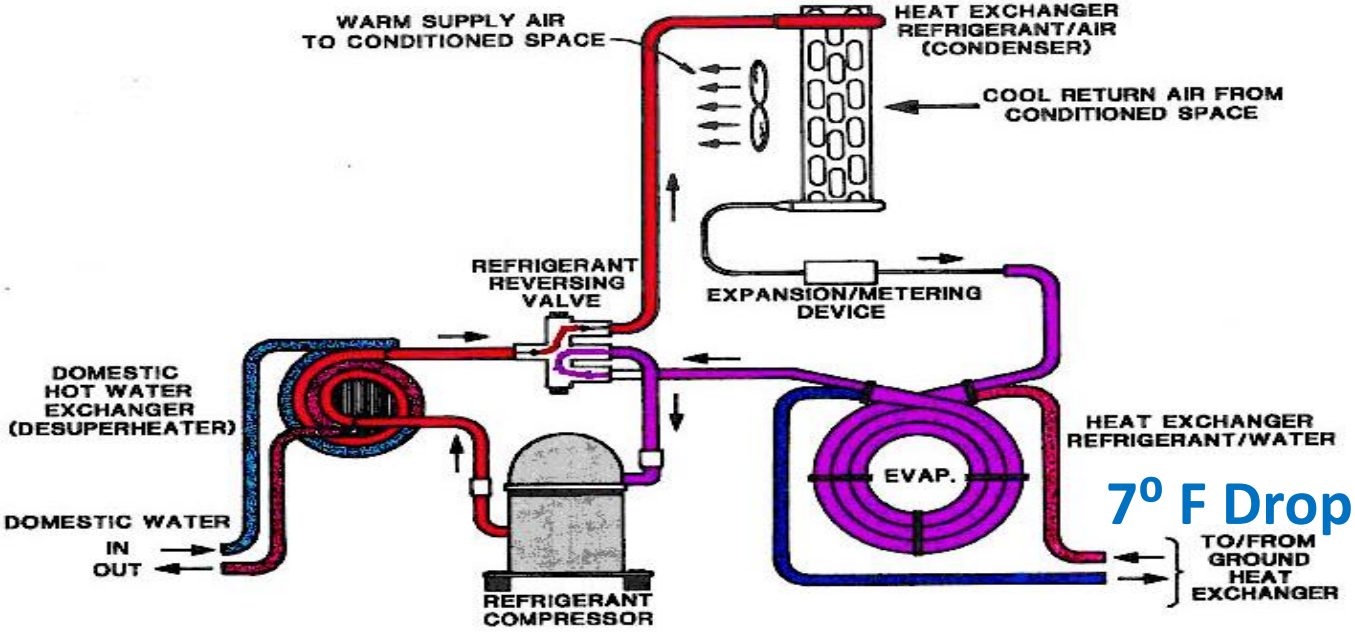
Commercial WSHP Basics

Refrigeration Basics – Heating Mode



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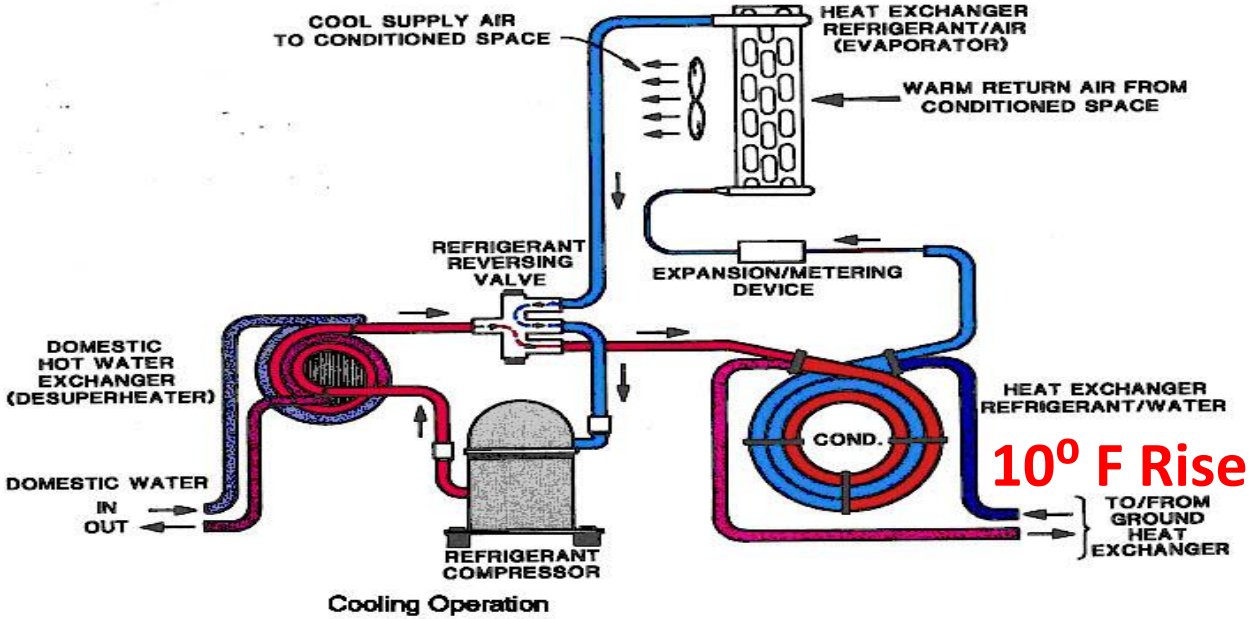
Commercial WSHP Basics

Refrigeration Basics – Cooling Mode



Cooling Operation

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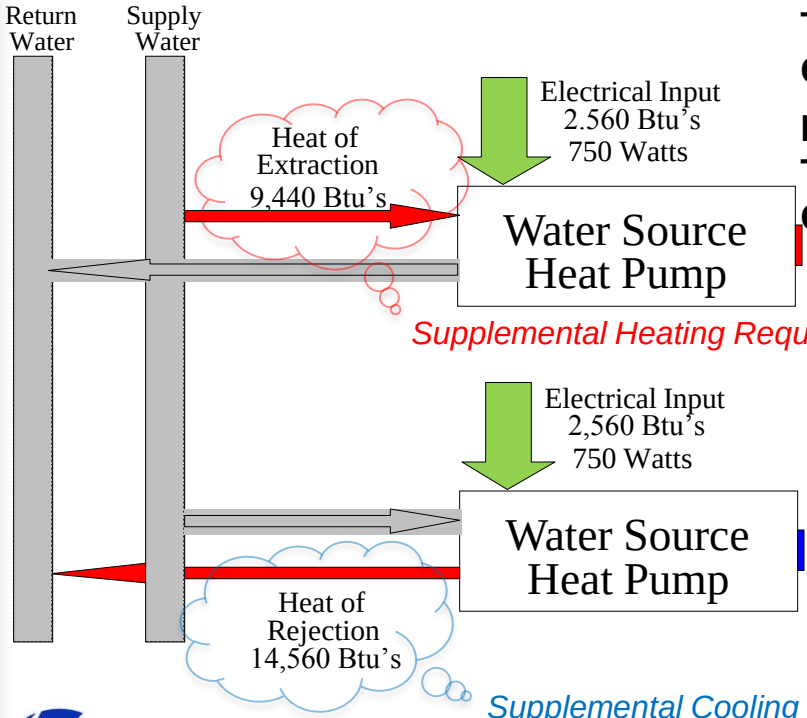
Commercial WSHP Basics



Heat of Extraction *Reduces* Water Loop Temperature by 9.44 Mbtu's per Hour of Operation

Heat of Rejection *Increases* Water Loop Temperature by 14.56 Mbtu's per Hour of Operation

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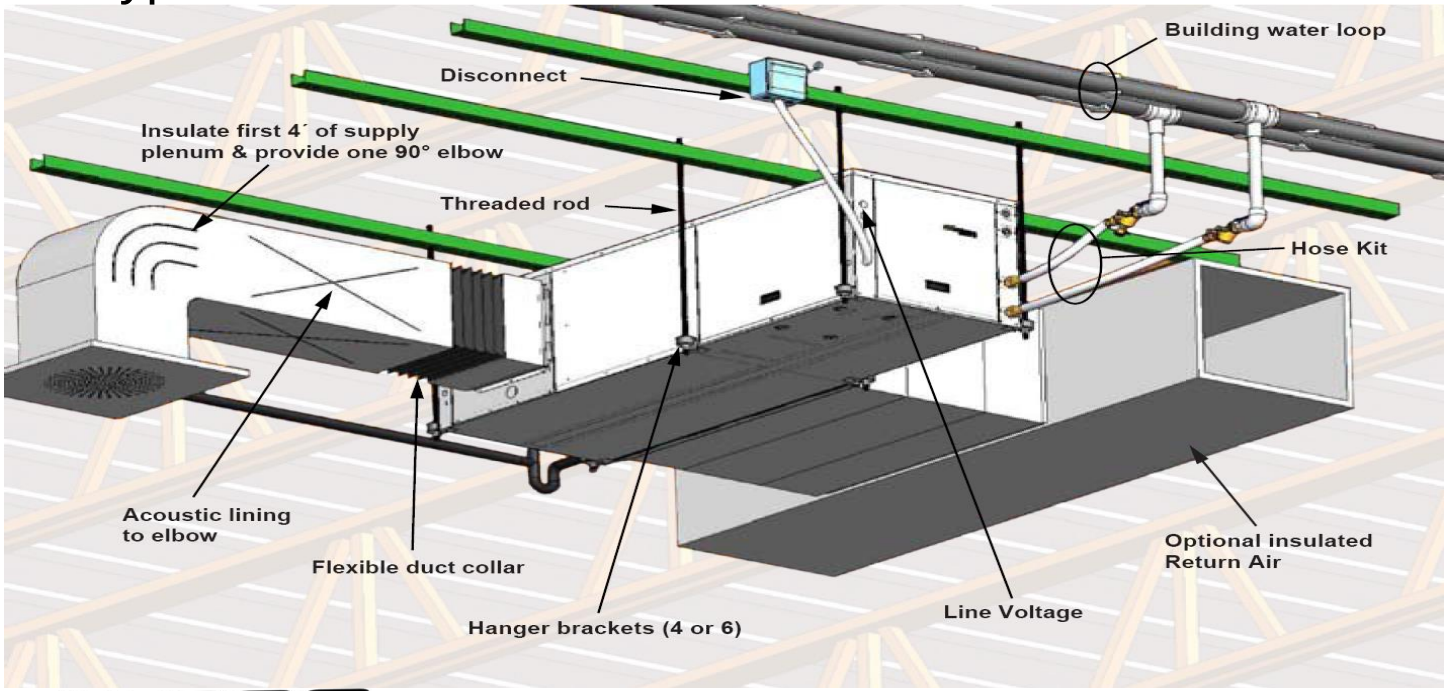
Commercial WSHP Basics

Typical Commercial Installation of a Horizontal WSHP



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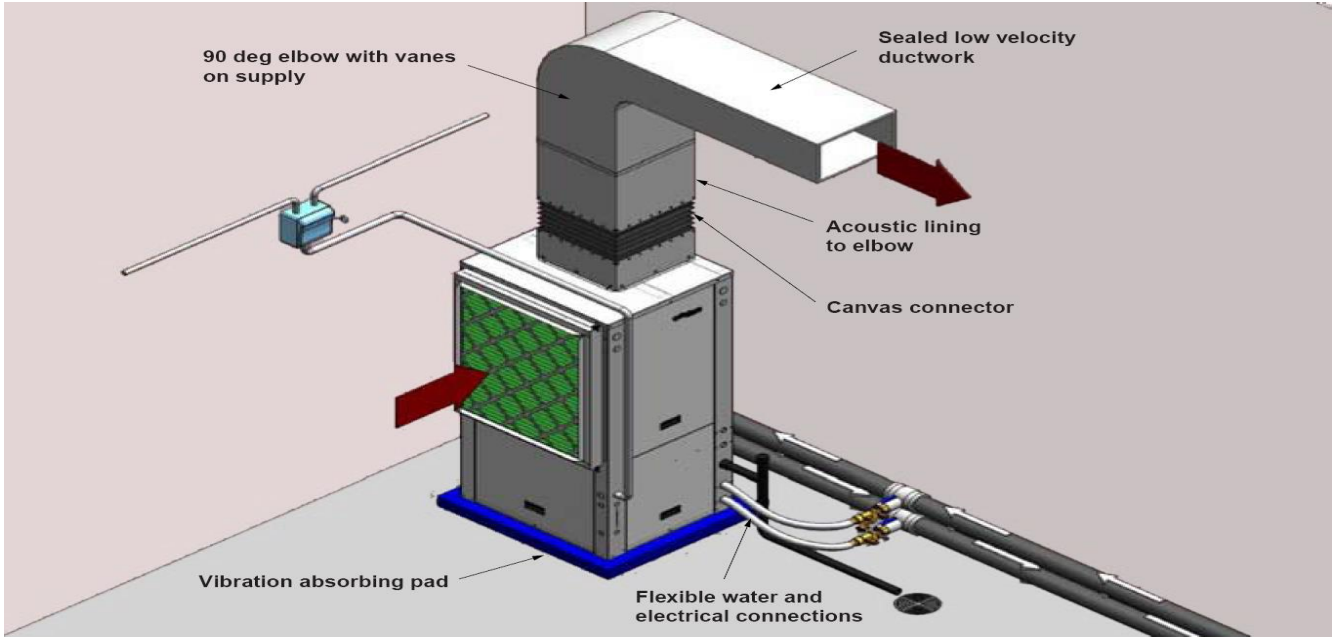
Commercial WSHP Basics

Typical Commercial Installation of a Vertical WSHP



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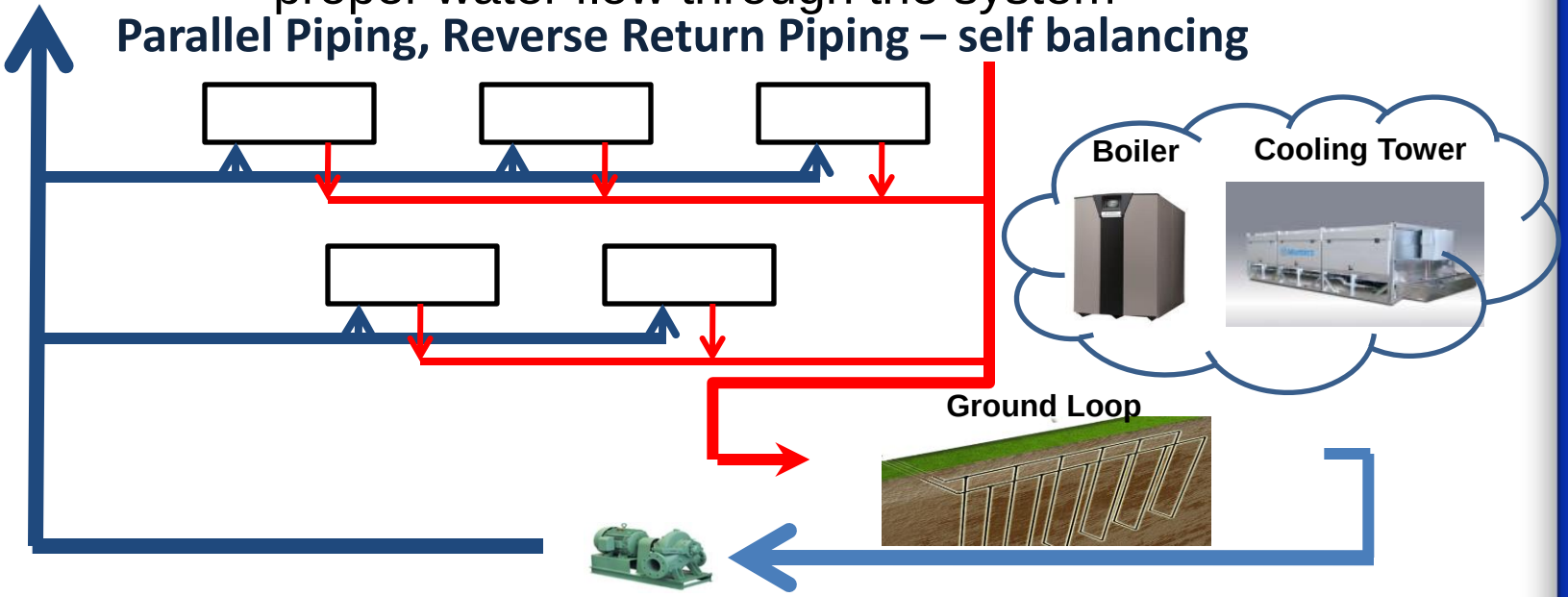
Commercial WSHP Basics

How your system is piped and pumps controlled are key to understanding proper water flow through the system

Parallel Piping, Reverse Return Piping – self balancing



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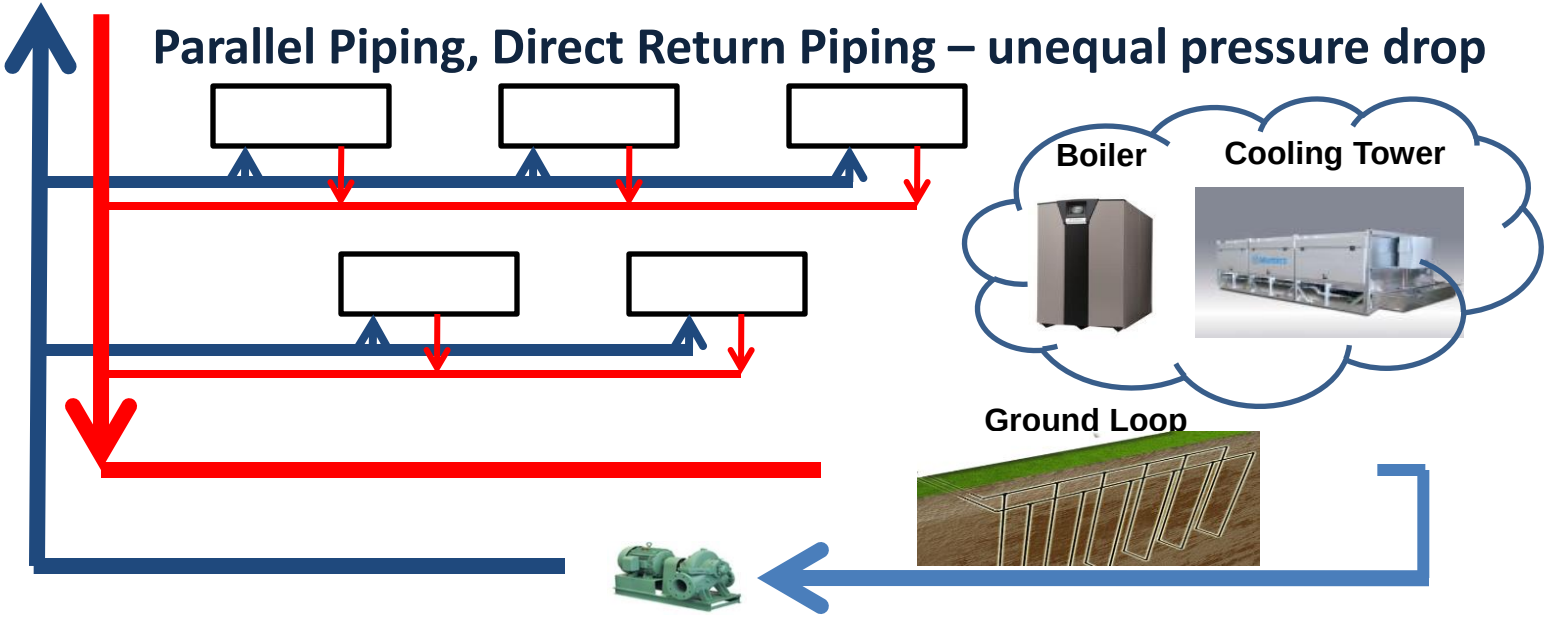
Commercial WSHP Basics

Most common because it is lower cost, BUT…



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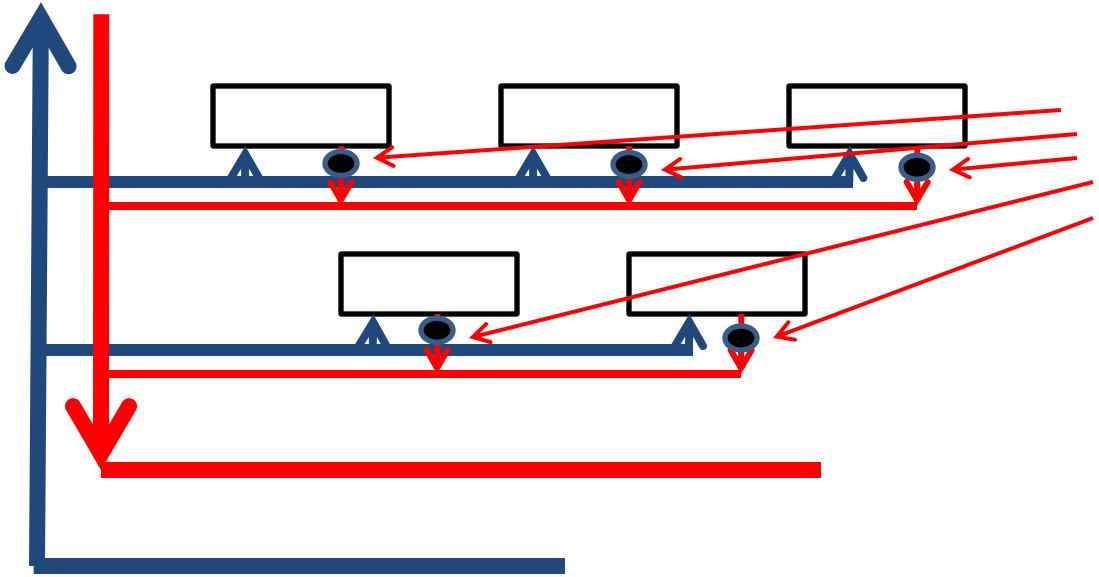
Commercial WSHP Basics

Direct Return Piping



Requires water flow control valves at every connected source of pressure drop to balance the water flow

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Geothermal Loops

Earth Coupled Water Loop

- **Geothermal Loop**
  - Closed loop
    - Horizontal
    - Vertical
    - Closed Pond
  - System temperatures range from 35 to 90

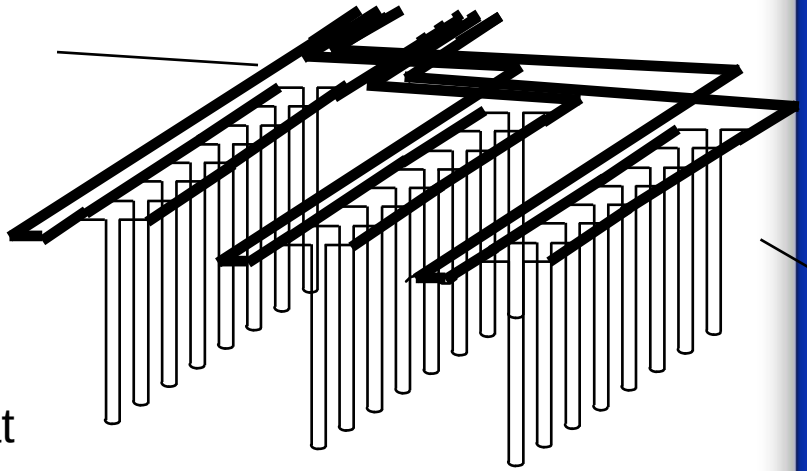
- **Open Loop**
  - “Pump and Dump”
    - Directly into the heat pump with suitable water
    - Intermediate heat exchanger if the water is a problem
  - System temperatures typically range from 45 to 60

Vertical Loops

Most common for commercial projects

Vertical Loops

- Smaller Land Requirement
  - 150 to 250 feet per ton
  - 250 square feel per ton (15 foot on center spacing min.)
- Soil conditions
  - Thermal conductivity of soil will dictate the amount of pipe
- Vertical bores
  - High Density Polyethylene pipe
  - Pipe is joined by heat fusion that makes the joints stronger that the pipe itself
  - Grouting



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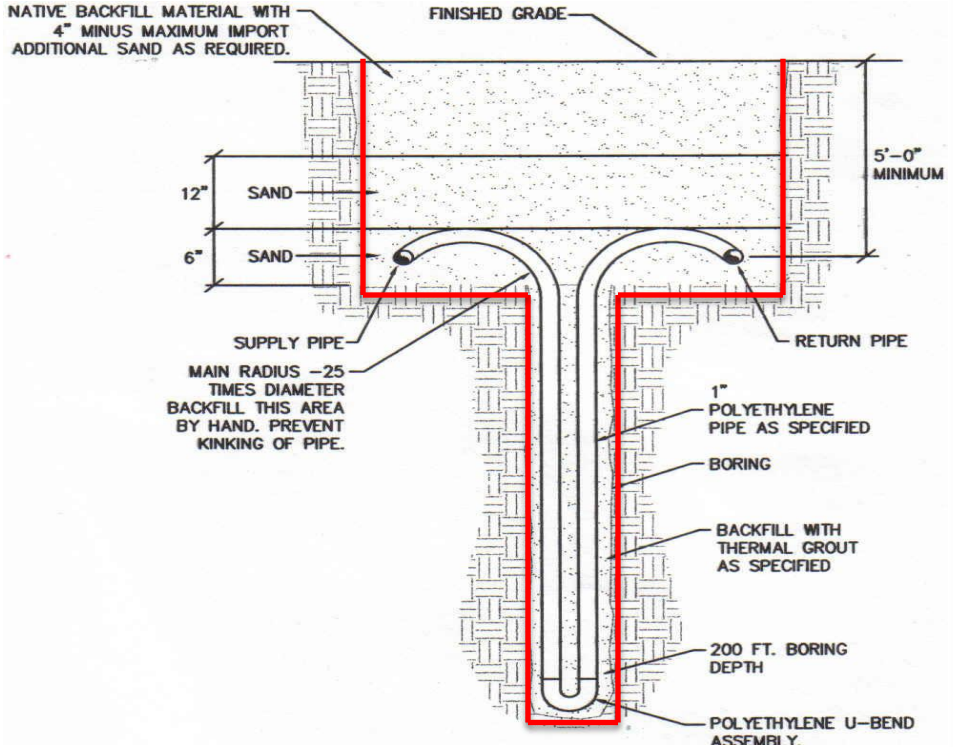
Geothermal Systems Operation

Vertical Closed Loop - Cross Section

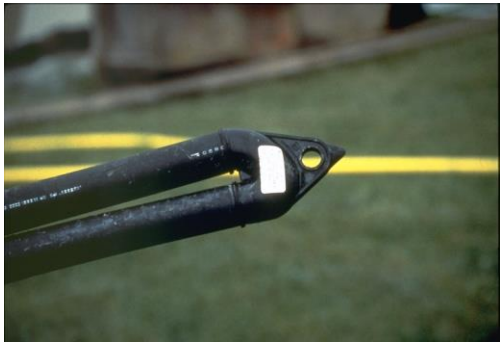
- Maximum of 12 wells connected to a single “run out” circuit
- Piping connections to run out is made 4-5’ below grade
- Continuous length of pipe with factory assembled U-bend fitting heat fused at the base of the well
- After pipe is installed, bore is backfilled with grout



Geothermal Systems Operation

HDPE Pipe with U-Bend Assembly (below)

Vertical Well with Pipe Installed (right - not grouted)



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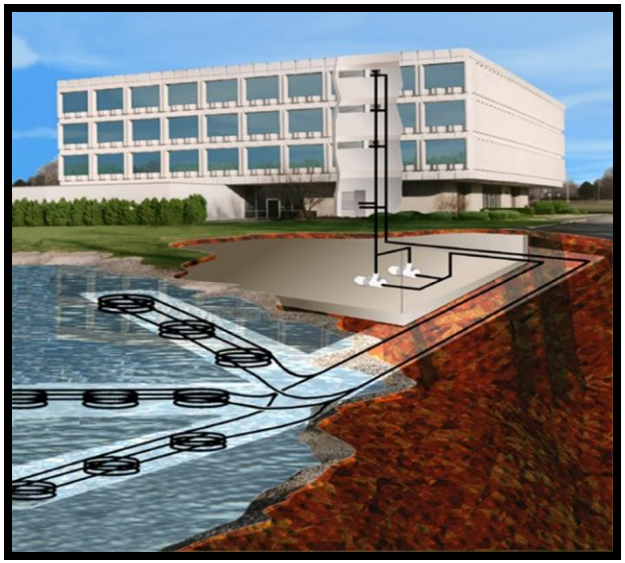
Closed Pond
Traditional Plastic Pipe on Pond Floor

- 300 to 350 feet of plastic pipe per ton
- Pipe coils separated by spacers
- Reverse Return piping
- Float out the pipes and then fill them with water to sink to the floor of the pond
- Labor intensive



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Closed Pond
Geo Lake Plate Heat Exchangers

- Long lasting
- Simplified installation
- Custom configurations

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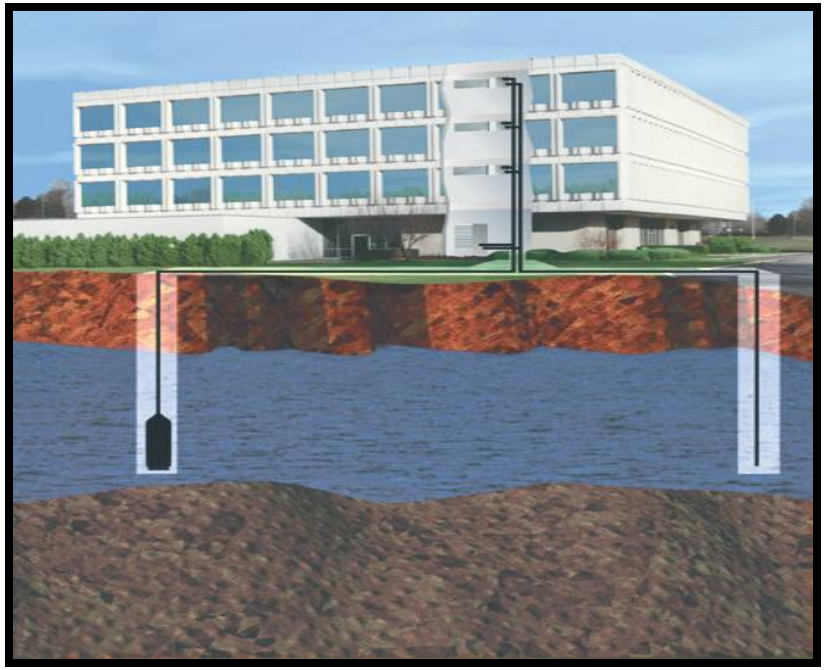
Open Loop

- “Pump and Dump”
- Colder water in cooling
- Filter out debris in the water
- Intermediate heat exchanger
- Water conservation and contamination issues
- Regulatory issues



Geothermal Systems Operation

Hybrid Loop

- Minimizes first installed costs by reducing wells
- Maximizes ground loop investment by equalizing heat of extraction and rejection of the system
- Allows adoption of advanced system control strategies for managing energy costs

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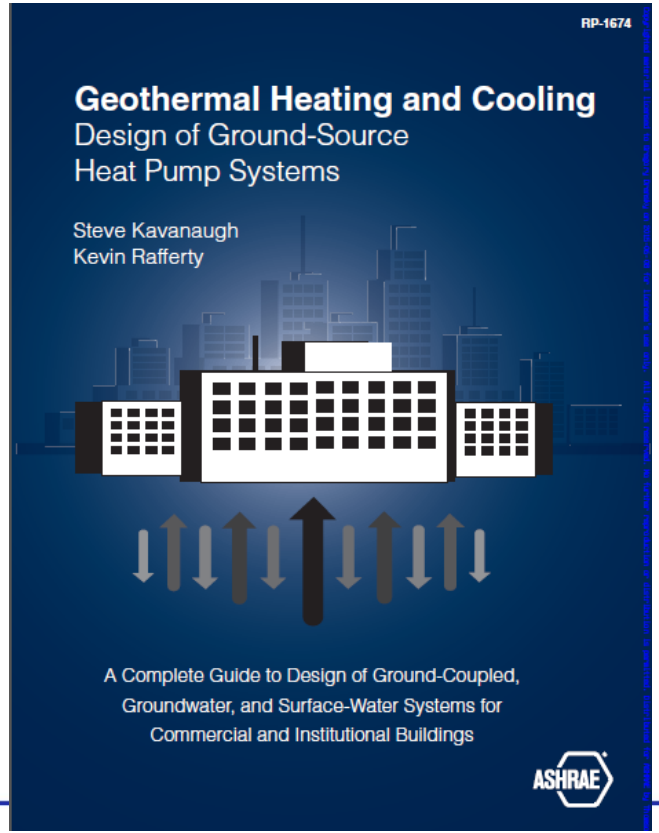
Earth Coupled Water Loop

- **Hybrid Loop**
  - Any combination of the two – typically a boiler and/or cooling tower attached to a closed loop
  - Lower first cost due to smaller loop
  - Popular with Geo retrofits

Geothermal Design

Geothermal Design



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Design Emphasis

- Water Source Heat Pump Layout
  - Central plant design
    - Newer design technique that utilizes reversible chiller heat pumps in two and four pipe hydronic systems commonly serviced by boilers and chillers
    - Allows increased usage of fan coils, unit ventilators, custom air handlers and other standard terminal devices
    - Hot water temperature limitation of 130° F

Design Emphasis

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Design Emphasis

- Antifreeze Considerations

Anti-Freeze Solution	Heat Transfer (%)	Pump Energy (%)	Corrosivity	Toxicity	Environmental Impact
Methanol	100	100	Biocide should be used to prevent fouling	Highly toxic by inhalation, skin contact and ingestion. Excessive or long term exposure may be hazardous. High flamability in high concentrations.	Biodegrades in CO_2 and H_2O. Non-persistent organic acids are formed
Ethanol	80	110	Anti-oxidant should be used to minimize corrosion.	Vapors burn throat and eyes. Ingestion of high quantities can cause sickness. Prolonged exposure may exacerbate liver damage. High flamability in high concentrations	Biodegrades in H_20. Long term impacts not available
Ethylene Glycol	90	125	Inhibitors required to protect mild steel, cast iron, aluminum and solder.	Eye/skin irritation. Single dose oral toxicity is moderate. Excessive or long term exposure is hazardous.	Same as Methanol
Propylene Glycol	**70**	**125**	Inhibitors required to protect cast iron, aluminum and solder.	Considered to be non-hazardous.	Biodegrades in H20. Considered to be non-hazardous

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Design Emphasis

- The “Heart” of the geothermal system is the ground loop. It must be sized correctly for the system to function properly.
- Improper sizing of the loop can cause a whole host of problems
  - Higher than expected energy costs
  - Equipment failures
- The ground loop is specifically sized for the loads and the specified water source heat pumps.

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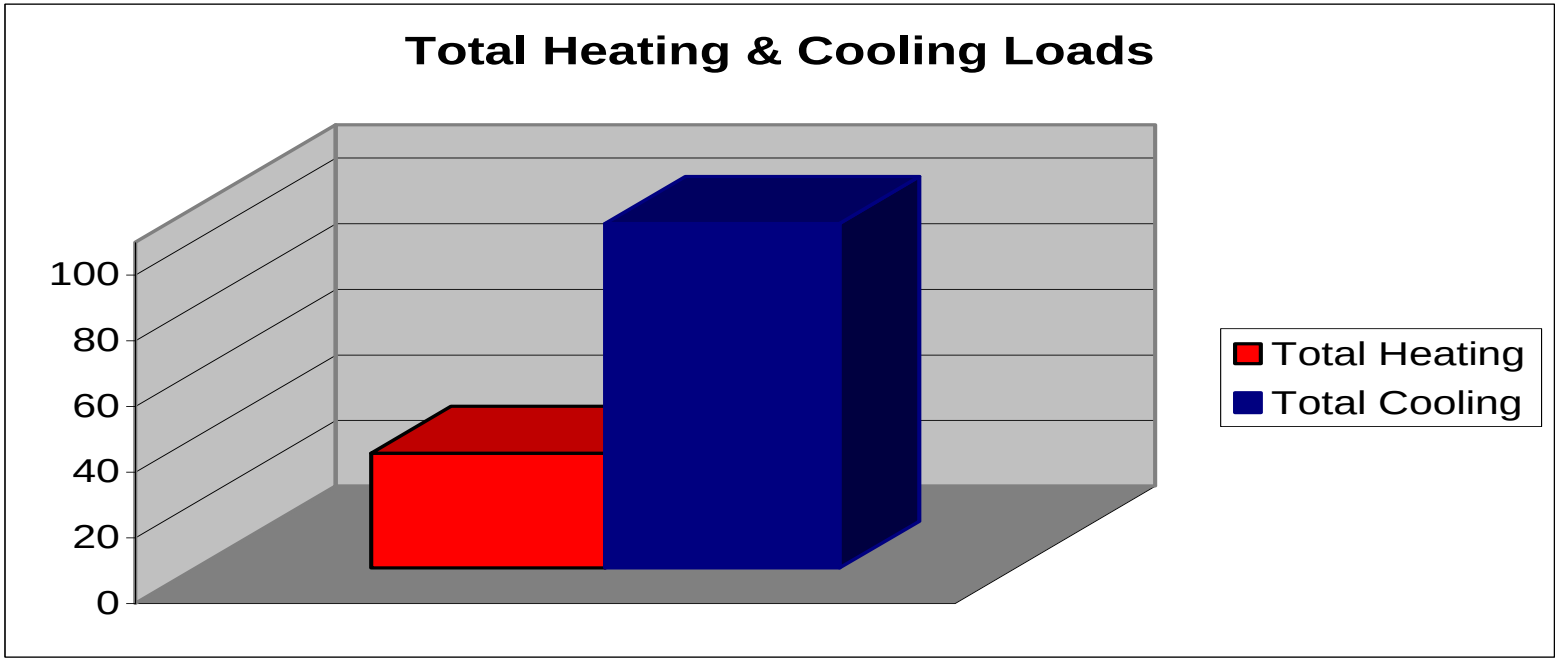
Design Emphasis

Typical Commercial HVAC Loads



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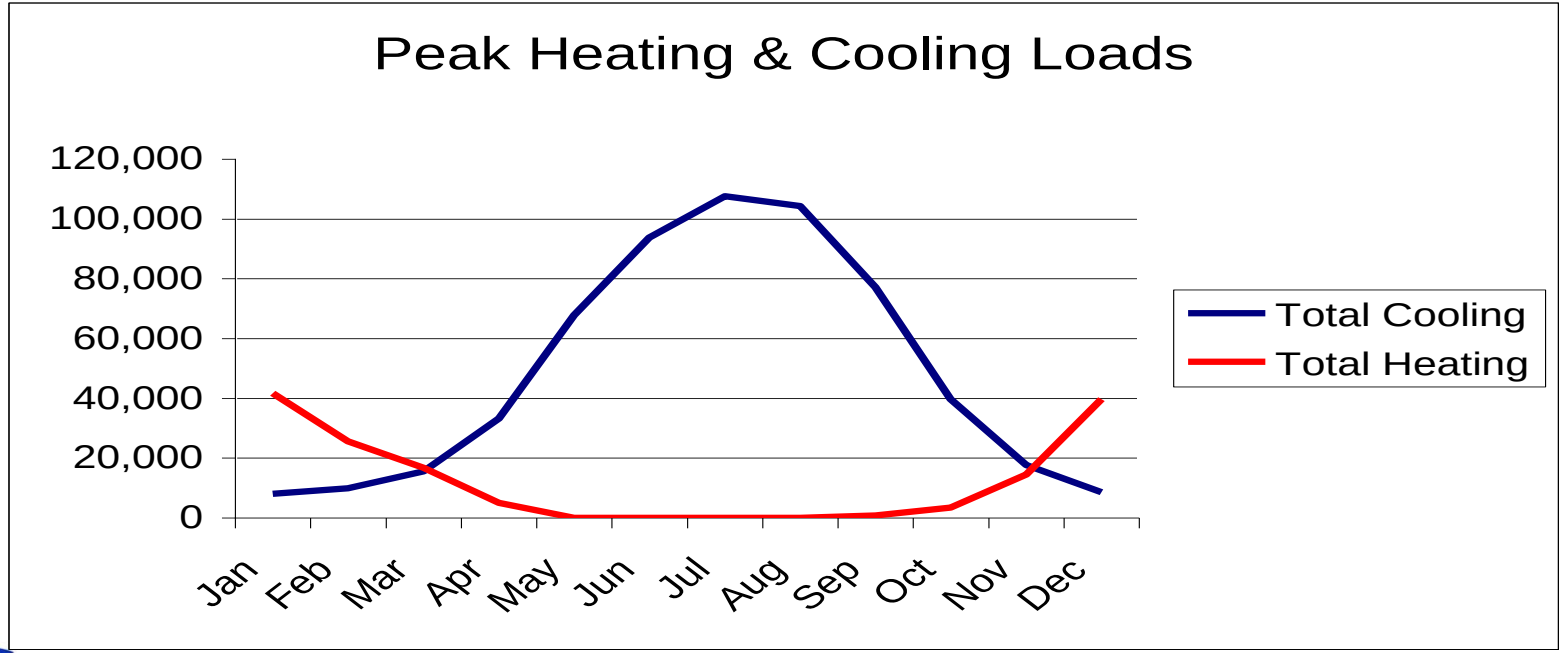
Design Emphasis

Typical Commercial HVAC Loads



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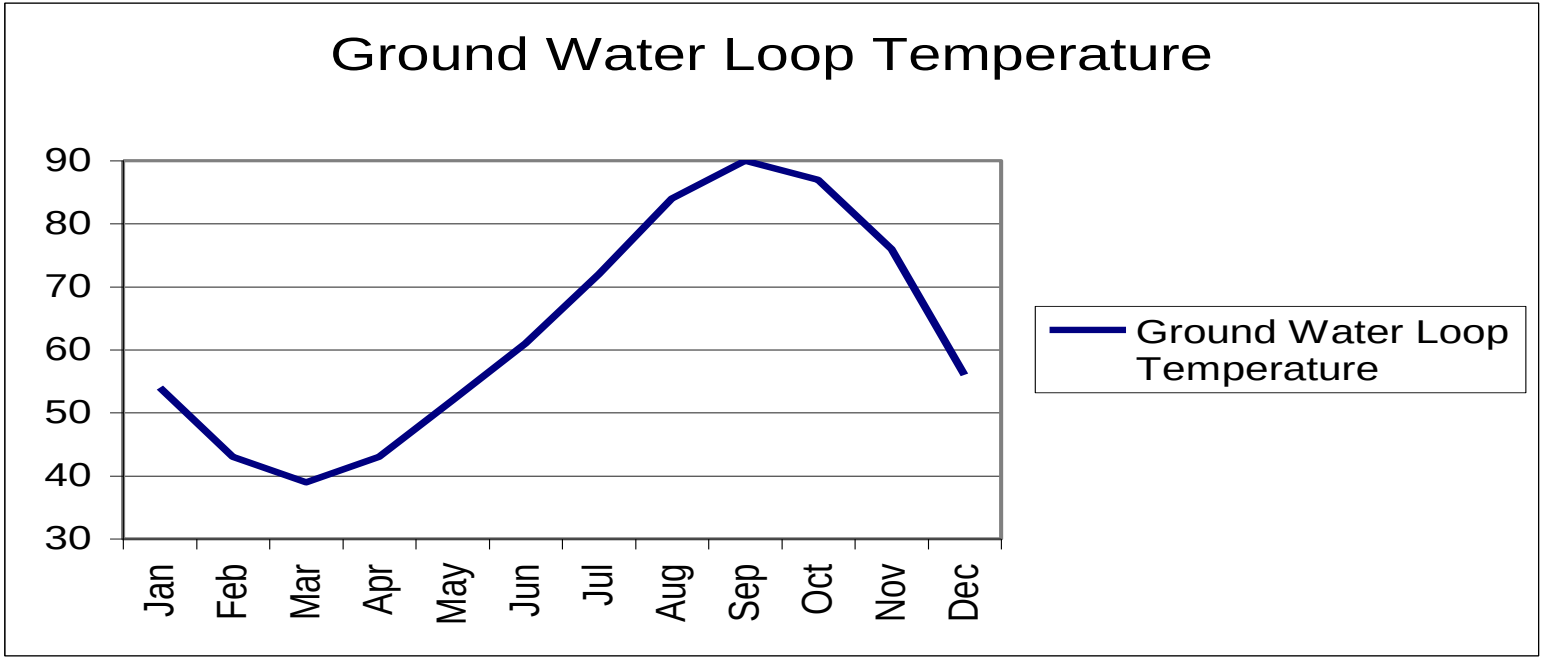
Design Emphasis

Typical Commercial HVAC Loads



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Design Emphasis

Typical Commercial HVAC Loads

- Understanding the actual heating and cooling loads is more critical in a geothermal heat pump design
  - Peak block load vs. actual annual load
  - Increased accuracy of return on investment analysis
  - Heat of rejection vs. heat of extraction
  - Integrating process heating and cooling loads in order to more equally balance ground loop design
  - Identifying hybrid loop design candidates

Project: Zanesville Elementary School

WaterFurnace vs FHP

R-410A Energy Efficiency Comparison - Ground Loop AHRI Ratings

Qty	Vendor	Model	ARI GPM	Ground Loop Heat Pump Ratings Tot Clg	EER	Tot Htg	COP	WFI Tot Clg	Watts	GPM	FHP Tot Clg	Watts	GPM
8	**WFI**	**NSH/V 009**	**3.0**	**9800**	**16.7**	**7800**	**3.4**	78,400	4,695	24.0			
8	FHP	EC009	2.5	8100	14.1	6400	3.1				64,800	4,596	20.0
	WFI	**NSH/V 018 PSC**	**5.0**	**18500**	**18.0**	**14700**	**3.8**	0	0	0.0			
4	**WFI**	**NSH/V 018 ECM**	**5.0**	**18500**	**19.0**	**14700**	**4.1**	74,000	3,895	20.0			
	FHP	EC018	5.0	19800	14.1	13400	3.1				0	0	0.0
	FHP	EV018	4.0	19500	18.5	14500	3.4				0	0	0.0
4	FHP	ES018	4.0	19500	19.6	14500	3.5				78,000	3,980	16.0
	WFI	**NSH/V 036 PSC**	**9.0**	**34600**	**19.6**	**24100**	**4.0**	0	0	0.0			
12	**WFI**	**NSH/V 036 ECM**	**9.0**	**35000**	**22.0**	**24100**	**4.4**	420,000	19,091	108.0			
	FHP	EC036	9.0	37800	14.2	27400	3.2				0	0	0.0
	FHP	EV036	9.0	34000	17.4	24000	3.4				0	0	0.0
12	FHP	ES036	9.0	34000	19.0	24000	3.5				408,000	21,474	108.0
	WFI	**NSH/V 060 PSC**	**15.0**	**66800**	**18.5**	**43200**	**3.7**	0	0	0.0			
4	**WFI**	**NSH/V 060 ECM**	**15.0**	**66800**	**19.5**	**43200**	**3.9**	267,200	13,703	60.0			
	FHP	EC060	15.0	63600	14.7	50000	3.2				0	0	0.0
	FHP	EC061	15.0	61000	15.8	44600	3.5				0	0	0.0
	FHP	EV060	12.0	60000	15.0	45000	3.2				0	0	0.0
4	FHP	ES060	12.0	60000	15.6	45000	3.3				240,000	15,385	48.0
3	**WFI**	**NLV/NXV 120**	**28.0**	**122000**	**18.0**	**83000**	**3.6**	366,000	20,333	84.0			
	WFI	**NLH/NXH 120**	**28.0**	**119500**	**16.2**	**89000**	**3.4**	0	0	0.0			
3	FHP	EC120	28.0	127200	14.7	100000	3.2				381,600	25,959	84.0
31	Total Units						Totals	1,205,600	61,716	296.0	1,172,400	71,393	276.0

Project Summary

	WFI	FHP
Total Cooling (BTUH)	1,205,600	1,172,400
Total Power Input (Watts)	61,716	71,393
Project Average EER	19.5	16.4

Electrical Savings

Based on a fractional runtime of 35% there are 1,541 run hours per year
After correcting for total capacity, WFI will save 17,527 kWh per year
And reduce the Peak Demand Load by 9.7 kW
Based on electrical costs of $0.08 per kWh and $14.00 per kW monthly demand surcharge,
WFI will save $3,027.83 per year

Ground Loop Impact

Due to Increased competitor electrical consumption results in increased heat of rejection to the ground loop.
Thus requiring more ground loop to compensate for the higher heat of rejection.

Increased Btu rejected to loop	33,026	Btuh
Ground loop Differential	0.23	° F
Based on $4,000 per ton additionl loop cost equals	$9,632.72	

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Design Emphasis

Process Loads

- Radiant floor heating
  - Interior space heating
  - Snow melt systems
- Chilled beam cooling
- Hot water reheat
- Domestic hot water pre-heat
- Energy recovery
- Industrial process heating or cooling

Design Emphasis

Typical Design

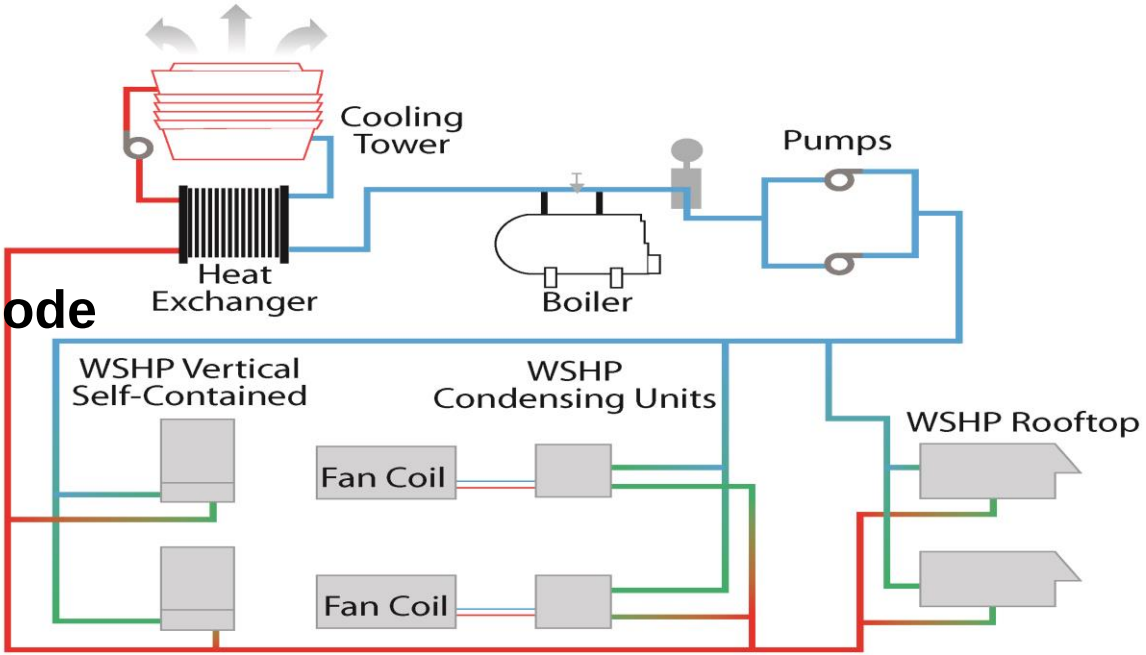
Ventilation Air

- Air Hander with heat recovery wheel tied to a water to water or remote water cooled DX unit
  - Indoor or outdoor air handler
  - 2 pipe hydronic cooling/heating coil
  - Face and by pass?
  - Hot gas or water loop reheat for neutral air
  - Short piping run between AHU and water to water normally requires a water storage tank
  - Split system DX eliminates secondary water circuit

Water Source and Geothermal Products

Water Source Heat Pump

Cooling Mode



AAON Units

Packaged Units

- RQ Series, 2-5 tons
- RN Series, 6-70 tons
- RL Series, 45-230 tons

Double Wall Rigid
Polyurethane Foam Panel

RN Series Geothermal or
Water-Source Heat Pump

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AAON Units

Self Contained Units

SA Series, 23-70 tons

SB Series, 2-30 tons

M2 Series, 5-70 tons

M2 Series Geothermal or Water-Source Heat Pump

SA Series Geothermal or Water-Source Heat Pump

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AAON Units

- Condensing units
  - CC Series units matched with M3, M2, SA, H3/V3, F1, RL, RN and RQ Series Air Handling Units, 2-63 tons
  - CB Series Units matched with H3/V3, F1 and RQ Series Air Handling Units, 2-5 tons

Whalen Whisperline™ heat pump

- Whisperline™ Vertical Stack – 14 EER
  - Slide-out chassis for ease of service
  - Quiet operation
  - Stainless steel drain pan standard
  - Fail-safe condensate overflow protection
  - Easy access control box & blower housing
  - Double isolation on compressors
  - Multiple supply grille configurations
    - Front, back, side, or top
  - Factory mounted internal water options
  - Microprocessor controls standard (DDC option)
  - Optional ECM variable speed motor
  - Optional closed cell or foil faced, cleanable insulation

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Whalen Whisperline™ heat pump

- Whisperline ™ Vertical Stack – 14 EER
- Whisperline™ Ducted Vertical Stack – 14 EER
  - Standard water source heat pump
  - Standard slide-out chassis for ease of service
  - Short cabinet height to allow ductwork
  - Ducting from top of unit

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DVM-S Water-Cooled Systems

- Indoor Condensing units
- Up to 48 Tons Capacity Per System
- Most efficient VRF system on the market
- Heat Pump and Heat Recovery Systems
- Same compressors as air cooled units
- 6, 8, 10 , 12, 14, and 16 Ton Modules
  - Units Can be “Twinned Together”

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What is DVM S?

DVM S Water

- Water Cooled units are available in 6, 8, 10, and 16 ton nominal capacities
- Any combination of up to 3 Compressor units can be piped together to achieve desired capacity up to 48 tons.
- Heat pump or heat recovery – configured during installation

Nominal Tons	Module Qty.	DVM S Water Unit Combinations			
		6 Tons	8 Tons	10 Tons	16 Tons
6	1	1			
8			1		
10				1	
12	2	2			
14		1	1		
16	1				1
18	2		1	1	
20				2	
22		1			1
24			1		1
26				1	1
28	3	2			1
30		1	1		1
32	2				2
34	3		1	1	1
36				2	1
38		1			2
40			1		2
42				1	2
48					3

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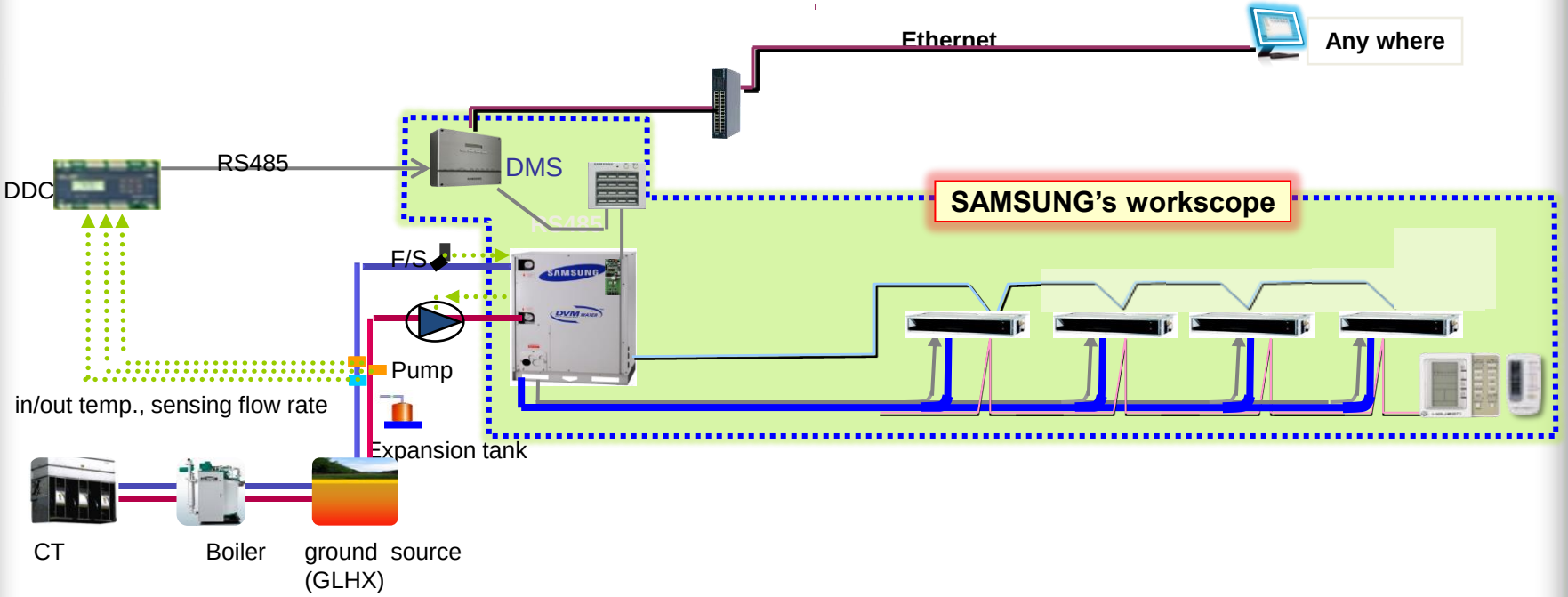
Samsung DVMS



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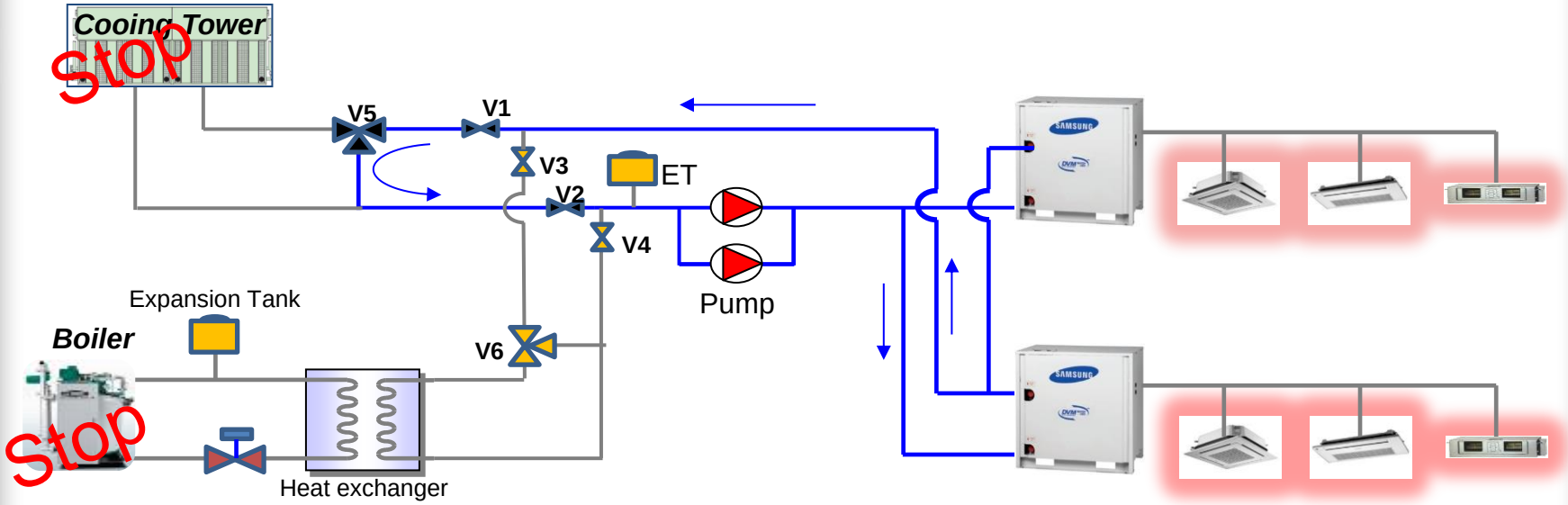
Samsung DVMS



Net Energy Loops

Net Energy Water Loops

- **Net Zero Energy Building Design:**
- Analyze the unique energy profile of the building
- Increase the efficiency of each system as they function as part of a whole within the building
- Share energy across all of the systems within the building to minimize waste energy

- **The Goal:**
- Reduce the energy foot print without sacrificing comfort or functionality
- Increase the impact of onsite renewable energy

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Net Energy Water Loops

HVAC Systems for a Net Zero Energy Building Design must meet specific characteristics:

1. Capture and effectively transport energy from HVAC and non-HVAC sources throughout the structure
2. Be scalable for any size building with minimal effects to overall efficiency
3. Provide maximum efficiency and maximum comfort with controllable performance for each zone
4. Easily connect to onsite renewable energy opportunities

Net Energy Water Loops

<u>Requirements</u> for a Net Energy Loop:

Low cost transportation of energy throughout the building

AIR

1. Requires a large amount of conditioned space to run ductwork
2. Fan Power excessive as net energy loop increases

Net Energy Water Loops

<u>Requirements</u> for a Net Energy Loop:

Low cost transportation of energy throughout the building

REFRIGERANT

1. Can only share energy within a single circuit
2. Compressor losses limits size (440 equivalent ft of line sets causes 20% reduction in compressor efficiency)

Net Energy Water Loops

<u>Requirements</u> for a Net Energy Loop:

Low cost transportation of energy throughout the building

WATER

1. Moves energy 10 times more efficient than air
2. Small diameter piping moves large amount of energy
3. Easy to shut off flow to zones that are satisfied for minimizing operating costs of the transportation system
4. Easy to connect to onsite renewables like solar, ground loop, and bio-mass heat

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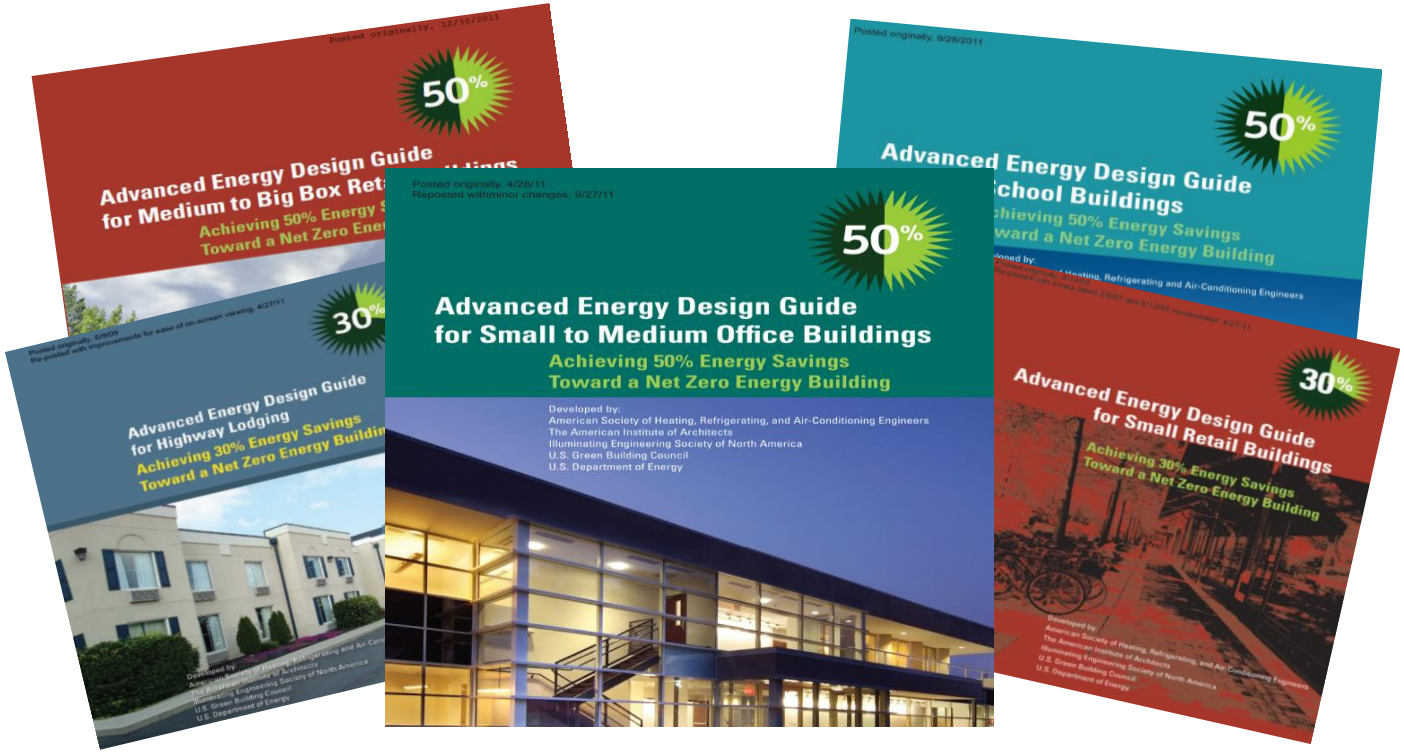
Net Energy Water Loops



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Net Energy Water Loops

- **Integrate as much system efficiency as your budget allows**

Upgrade to High Efficiency WSHP's

- Add Heat Recovery to DHW
- Add Heat Recovery from Exhaust Air/Makeup Air
- Add Renewable Energy Hybrid Ground Loop
- Add other Renewable Energy (solar, wind, biomass)
- Integrate chilled beam, radiant floor, six pipe simultaneous chiller/boiler technology
- Integrate non-HVAC equipment:
    - ice making machines, freezer cases, refrigeration cases, snow melt, ice rinks, process water, black water waste, grey water, sprinkler water

Net Energy Water Loops

- **Integrate as much system efficiency as your budget allows**

- Upgrade to High Efficiency WSHP's

  - Standard efficiency 12 EER means for every 1 watt of electricity consumed, 3.52 watts of energy is removed from the conditioned space (1 ton of cooling) resulting in 4.52 watts of waste heat delivered to the net energy water loop

  - High efficiency 21.6 EER reduces the electricity consumed from 1 watt to only 0.56 watts to remove the same amount of energy from the zone and reduces the waste heat delivered to the net energy water loop from 4.5 watts to 4.08 watts

Net Energy Water Loops

- **Impact of system efficiency and waste heat to a ground loop**

BORE DEPTH TO BOTTOM FROM ROUGH GRADE AND NUMBER OF BORE HOLES VARIES PER TABLE BELOW

BORE DEPTH (FEET)	HEAT PUMP MANUFACTURER	ADDITIONAL BORE HOLES
305	WATER FURNACE	0
310	Alternate # 1 18.5 EER	8
305	Alternate # 2 17.5 EER	16
318	Alternate # 3 17.0 EER	16

75.5 Connected Tons of GLHP's
Cost of Heat Pumps with Accessories
$ 60,000.00

Basis of Design:
60 bore holes x 305 ft per hole x $10/ft
Total: **$ 183,000.00**

Add for Alt #1:
60 bore holes X 5 ft per hole = 300 bore ft
Plus 8 holes X 310 ft = 2,480 bore ft
Total: 2,780 bore ft X $10/ft = **$ 27,800.00** **15% add**

Add for Alt # 2:
16 holes X 305 ft = 4,880 bore ft
Total: 4,880 bore ft X $10/ft **= $ 48,800.00** **27% add**

Add for Alt # 3:
60 holes X 10 ft per hole = 600 bore ft
Plus 16 holes X 315 ft = 5,040 bore ft
Total: 5,640 bore ft X $10/ft = **$ 56,400.00** **31% add**

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Net Energy Water Loops

- **Hybrid GLHP Systems**
-

Take Advantage of Part Load Operation

- Commercial Building Loads are only 50% or less of the Peak Load for 80% - 90% of the Year

- **Renewable Energy Hybrid GLHP Systems should be sold just like Solar PV Panels**
- Only install the amount that is most economical

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WSHP Net Energy Loops

- **Integrate as much system efficiency as your budget allows**

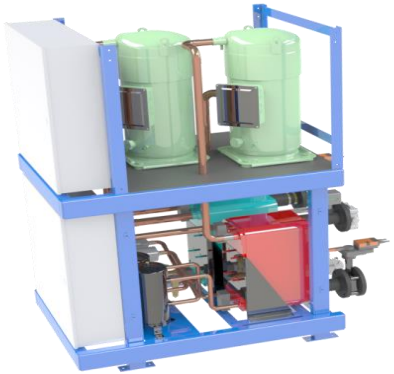
Using six pipe simultaneous chiller/boiler technology, integrate more hydronic technologies in zones of the building where the application makes sense:

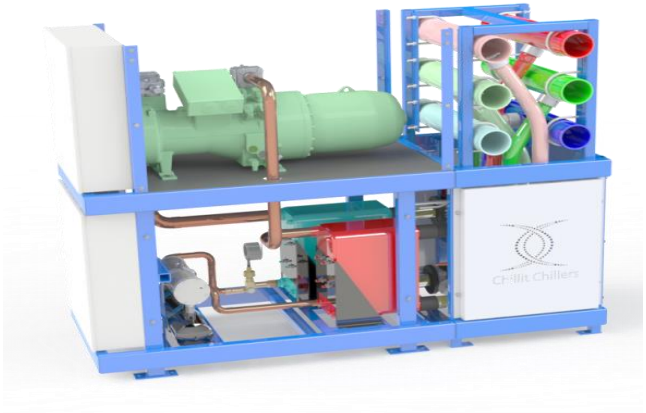
- Chilled beam
- Underfloor Displacement Ventilation
- Radiant floor
- Ice Storage
- Integral Waterside Economizer

WSHP Net Energy Loops

- **Six pipe simultaneous chiller/boiler technology**

Modular Screw & Modular Scroll Series (30-80 Tons)





WSHP Net Energy Loops

Six pipe simultaneous chiller/boiler technology

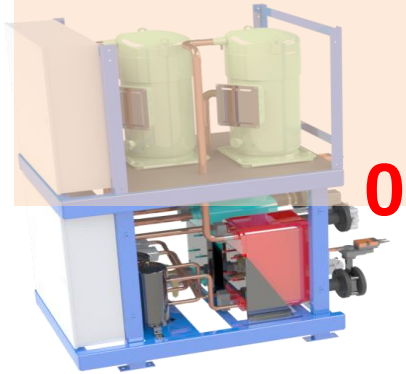
Modular Screw & Modular Scroll Series (30-80 Tons)

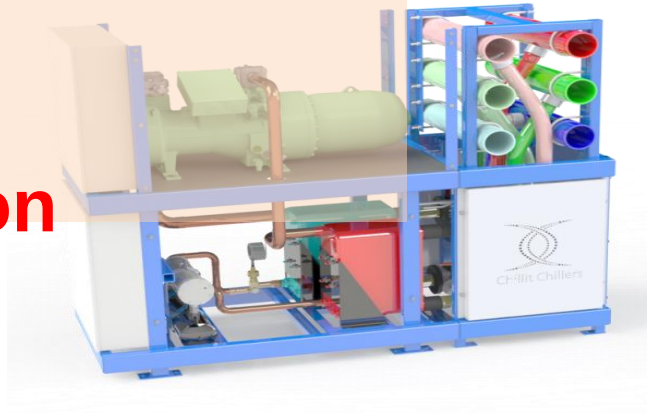
Full Load Plant Efficiencies

27 EER

8 COP

0.4 kW/Ton





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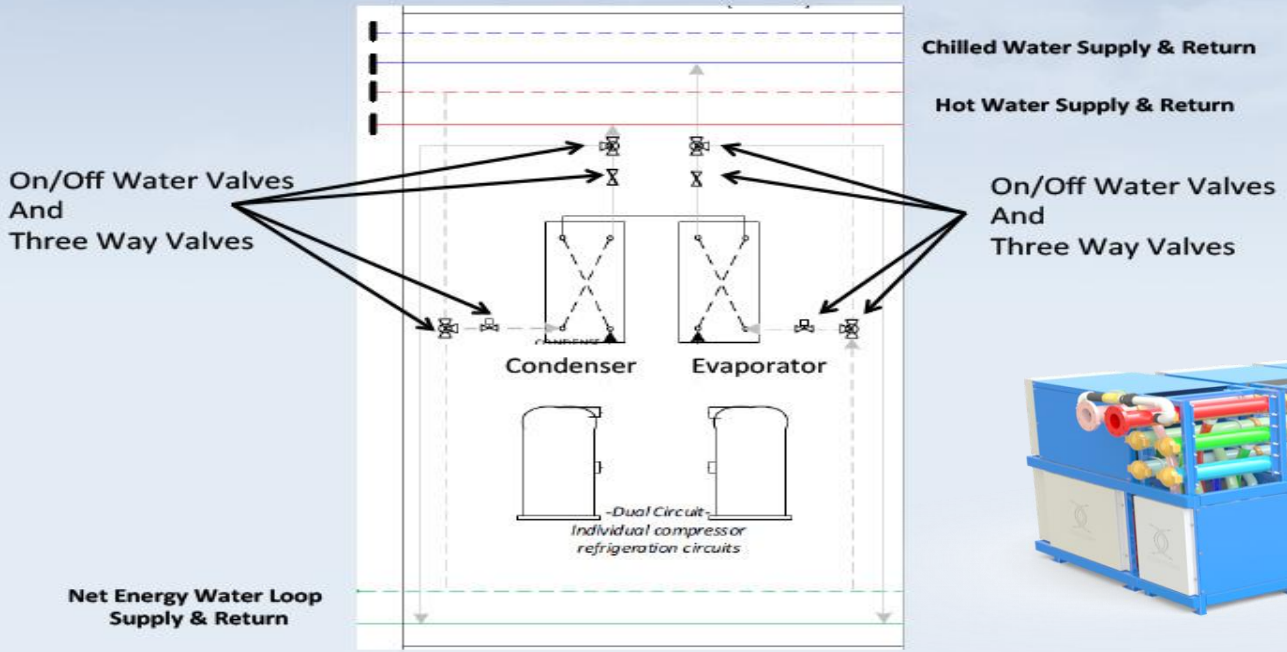
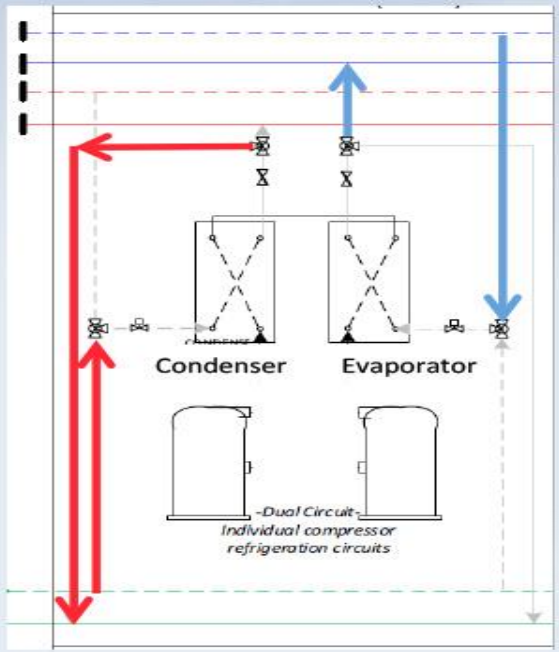
WSHP Net Energy Loops

- **Six pipe simultaneous chiller/boiler technology**



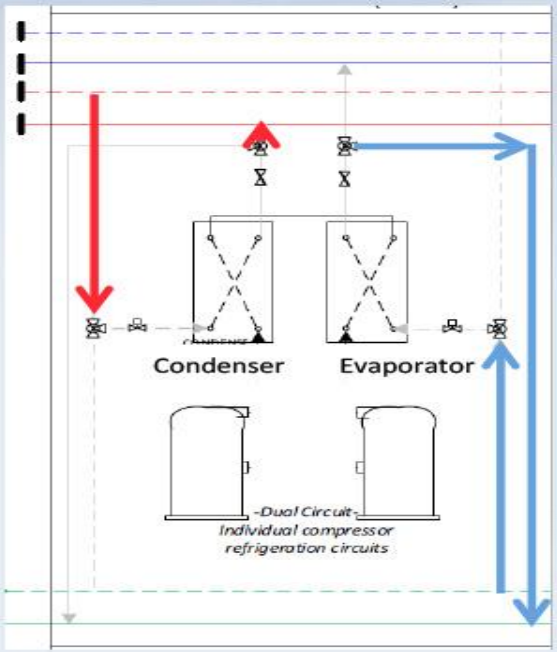
WSHP Net Energy Loops

- **Six pipe simultaneous chiller/boiler technology**



WSHP Net Energy Loops

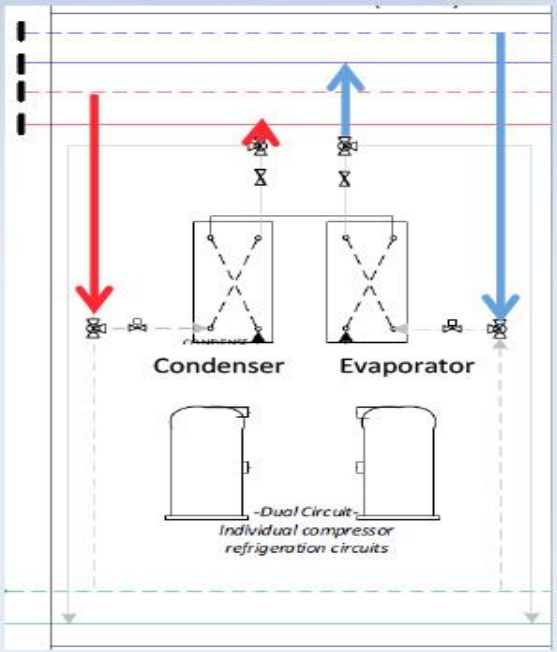
- **Six pipe simultaneous chiller/boiler technology**



WSHP Net Energy Loops

- **Six pipe simultaneous chiller/boiler technology**

Simultaneous Chilled Water & Hot Water Mode

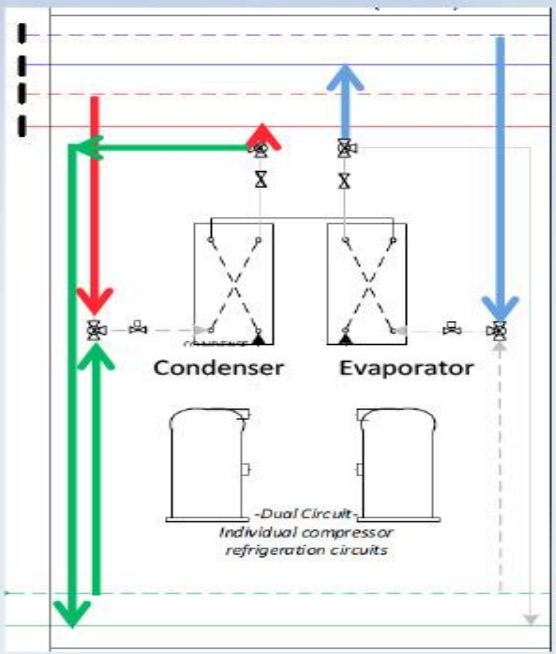


WSHP Net Energy Loops

- **Six pipe simultaneous chiller/boiler technology**

Partial Simultaneous Mode

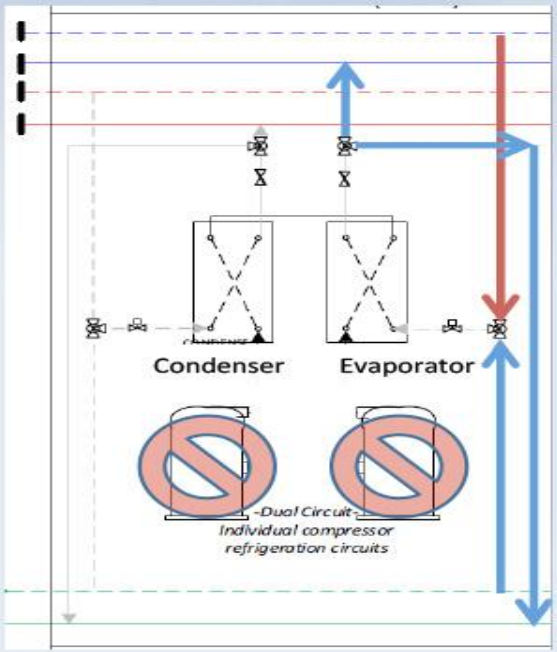
Allows for simultaneous control of both Chilled water and Hot water Set Point



WaterFurnace
Commercial Solutions Group

WSHP Net Energy Loops

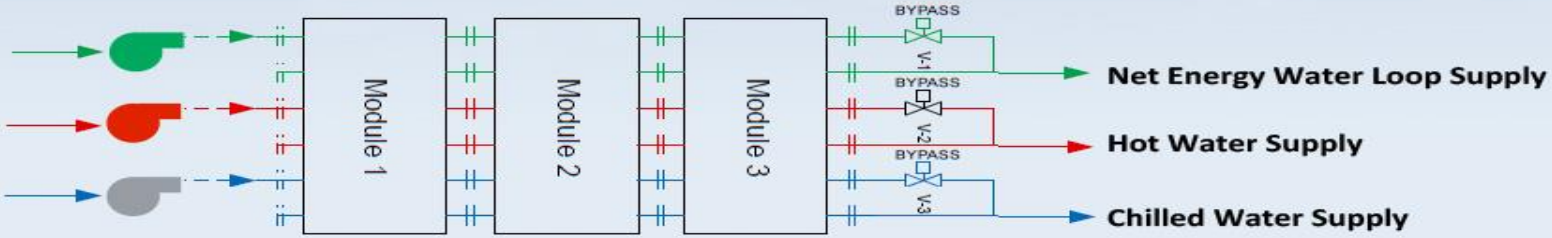
- **Six pipe simultaneous chiller/boiler technology**



WaterFurnace Commercial Solutions Group

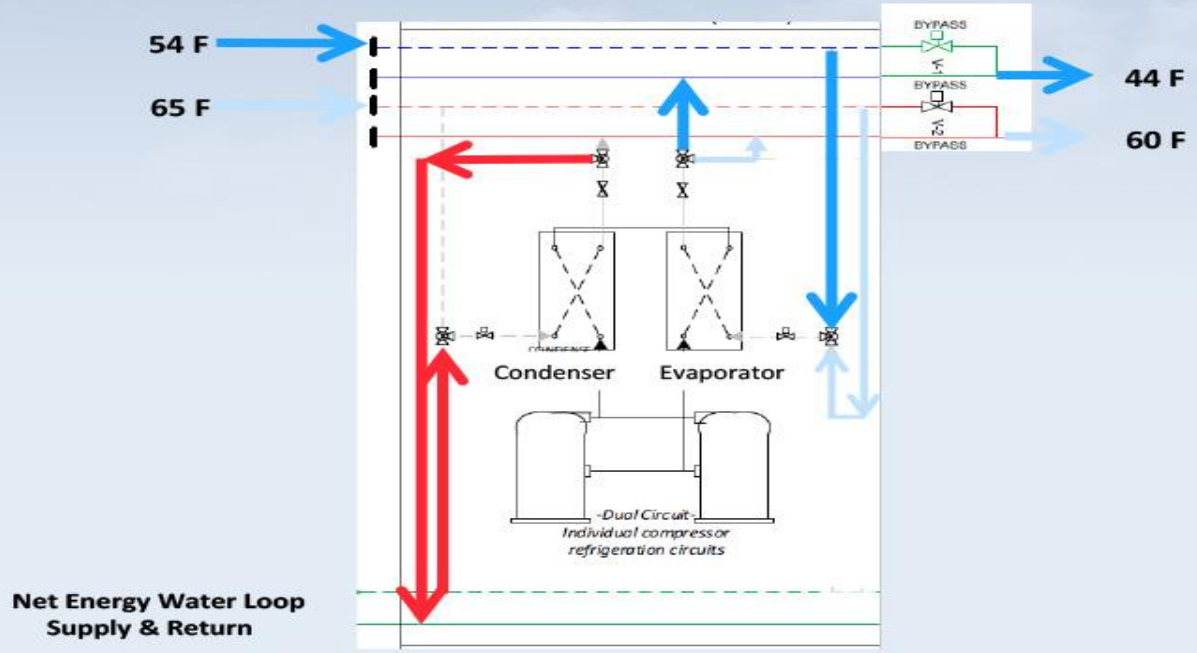
WSHP Net Energy Loops

- **Six pipe simultaneous chiller/boiler technology**
- Primary Variable Speed Pumping



WSHP Net Energy Loops

- **Two Independent Chilled Water Set Point Mode**



WSHP Net Energy Loops

- **Integrate as much system efficiency as your budget allows**

- **Integrate non-HVAC equipment:**

ice making machines, freezer cases, refrigeration cases, snow melt, ice rinks, process water, black water waste, grey water, sprinkler water

WSHP Net Energy Loops

•Ice Making Machines, Freezer Cases, Refrigeration Cases, Walk-in Freezers

•AHRI Certified EER improves 20% using water cooled Ice Making Machines as compared to air cooled machines.

- Units are quieter
- Units do not add a heat load to the zone
- Units require less maintenance

•Freezer and Refrigeration Cases are free sources of energy while improving efficiency, reducing refrigerant charge, and improving comfort by reducing sound levels

Service & Maintenance

Geothermal Heat Pumps –

- Properly commission the heat pumps to ensure proper system operation after installation and *establish base line performance*. Create a plan for continuous commissioning of the heat pumps and critical system components.
- Establish a regular maintenance schedule for air filter replacement, water strainer and condensate drain inspection *(cleaning and flushing as required)*. Check for any signs of water leaks, piping component or duct work system damage.
- Establish a periodic evaluation of control operations and functions to ensure continuity over time.

Job Name: Notes:

City: State: Zip:

Sart-up Technician:

Technician Employer:

Mechanical Contractor:

Mechanical Engineer: Test Date:

WaterFurnace
Smarter from the Ground Up™

Check Test and Start
Equipment Start-up &
Check Test Sheet

Unit #	Model No.	Serial Number	Mode H/C	Tag #	Pressure Drop (ft/hd)	Flow Rate (GPM)	EWT	LWT	HR/HE	EAT	LAT	Line Voltage	L1/L2/L3 Amps	Compressor Amps	Fan Amps	Fan Speed Settings	Control Circuit Volts	FP Setting	Unit Pass Y/N

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Water Circulating System –

- Maintain log of pump maintenance including: operational run time, strainer inspection & cleaning, valve inspection and repairs.
- Annually send a water sample for analysis to evaluate water particulate or bacterial contamination as well as ensure proper antifreeze levels.
- Inspect any water makeup feed system for improper operation. Alarm or meter any automated system to identify potential problems quickly.
- Periodically increase system water flow to purge air and contaminants from system.

Controls System –

- Annually review controls settings for all applicable variables (occupancy schedules, heating & cooling set points, temperature setback, over-ride timer, temperature sensor calibration, etc.).
- Periodically test control sequences to ensure proper operation of the heat pumps and system components.
- Building Automation Systems –
  - Begin simply. Monitor, test, verify, adjust.
  - Establish trend data reports for most useful information
  - Correlate and synchronize trend data reports (e.g. HP alarms & pump control)
  - Integrate energy usage and cost if possible

Case Study

“Innovative Best Practices”

Proud Winner of Mayor’s Climate Protection Agreement Award!

Posted: 2015 04 30 In: **SOA news**

On April 20th, SOA’s new building was announced to be a winner in the “Innovative Best Practices” category for Columbia’s first annual Mayor’s Climate Protection Agreement Award! The building, designed by, and home to, SOA and CM Engineering, was selected for its extremely energy and water efficient design.

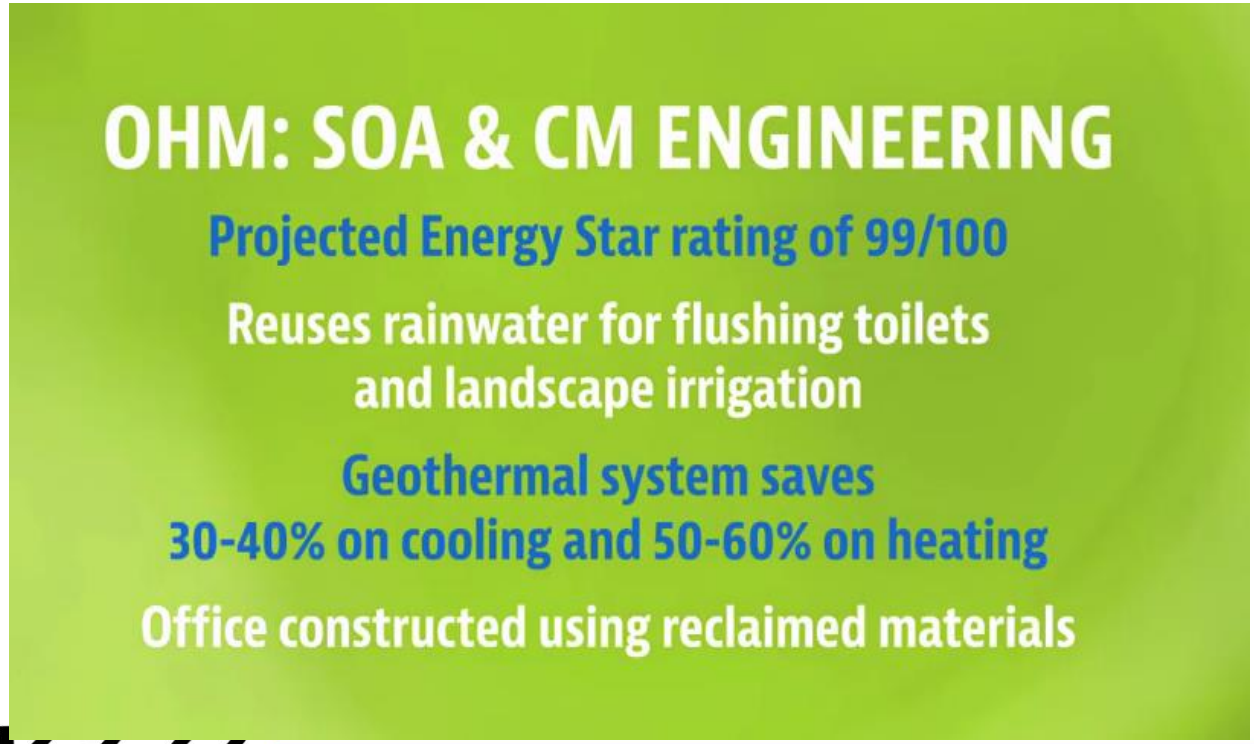
MCPA Awards

City of Columbia

Simon Oswald Architects and CM Engineering

www.soa-inc.com or www.cmeng.com

https://www.youtube.com/watch?v=Rro4dsjdW_w&index=7&list=PLRUFCaIrdzZhJ0HpwO3CriOWBt1Pley_7



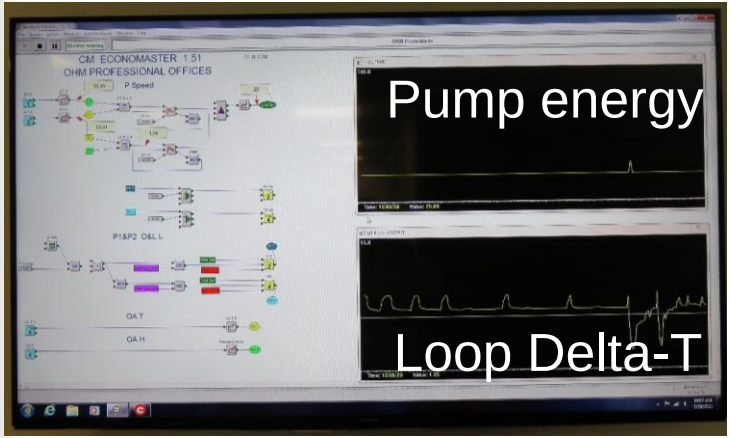
Concept to Completion

above is a concept and below is the real thing

Planning to Performance

Kirk Mescher, CM Engineering, Owner:

"I'm a businessman and an energy guy. $34 a working day for 12,000 sq. ft.
I think we can afford it!"



2015 MCPA Winner: OHM: Simon Oswald Architecture and CM Engineering

JACCO

Adrienne Stolwyk, RA, LEED AP BD+C
Architect

- Architects and Interior Designers, like many professionals, often work in teams. Teams need to meet frequently and for a variety of purposes. Having a variety of spaces for SOA's designers to meet was an important part of the design for our new office.
- Question:

  "How do I explain the efficiency of a Water Source Heat Pump versus an air source heat pump?"

Kirk Mescher, PE, Owner:

- “They are both heat pumps, and can be 400% efficient, but water transfers heat 10 times better than air.
- One difference is that the air source efficiency is reported as adjusted, based on seasonal and part-load operating points.
  - Water Source efficiency is calculated at the extremes of operation.
    - Air Source capacity and efficiency is penalized when it is hot and when cold outside.
    - **A double penalty because that’s when utility rates and equipment loads peak**
  - Water Source always operates inside the “certified” test points.
- It is like buying energy where it is never hotter than 90 degrees or colder than 37^{o}F outside.”

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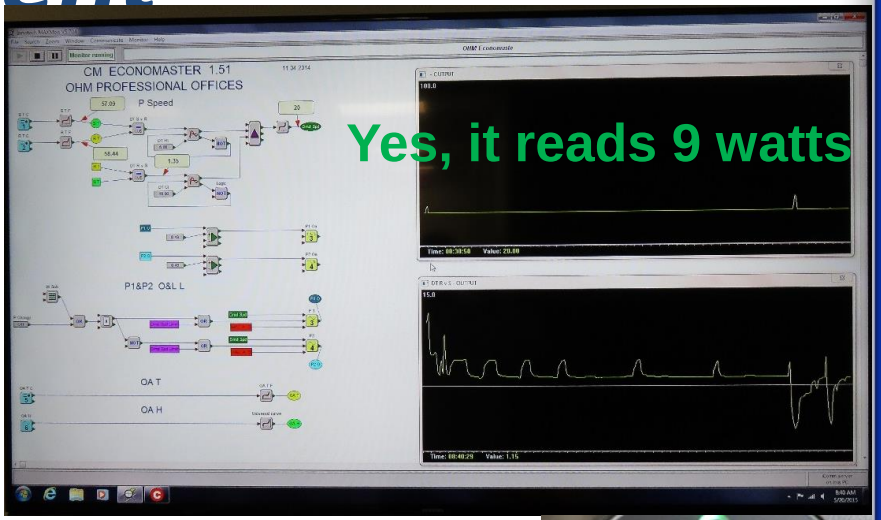
Energy Management

Energy Transport Horsepower

Variable digital control

- Minimum pressure
- Loop Delta-T
- Units have individual circulators
  - Demand controlled
  - Self-balancing
  - Control signal and power from the unit
- One primary pump set for building and ground HX
- Water uses 1/10th the energy to move Btu's Vs. air



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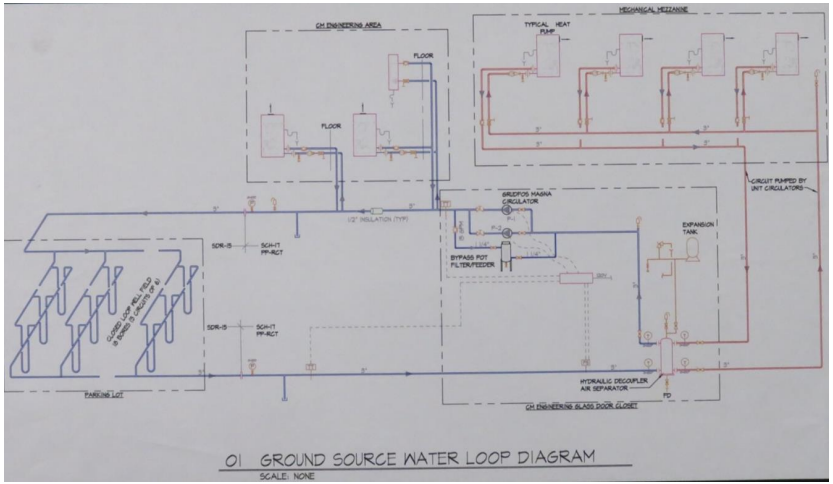
One-pipe design

4-pipe performance, Demand Controlled



WSHP's Heat or Cool based on each occupant thermostat
The One-Pipe System operates within design Delta-T.
Efficiency and capacity changes very little over the designed temperature range

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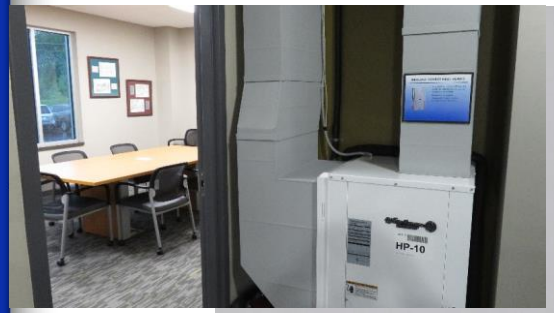
One-pipe in the building thermostat call starts flow



This system "Nets" the energy in the building before it goes to the ground

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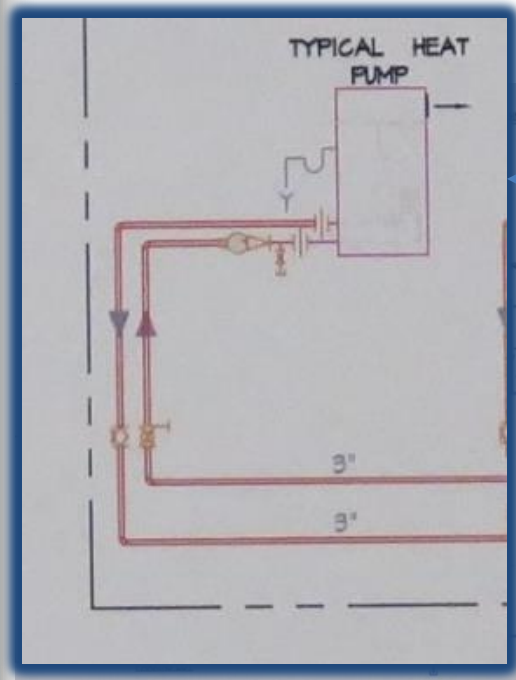
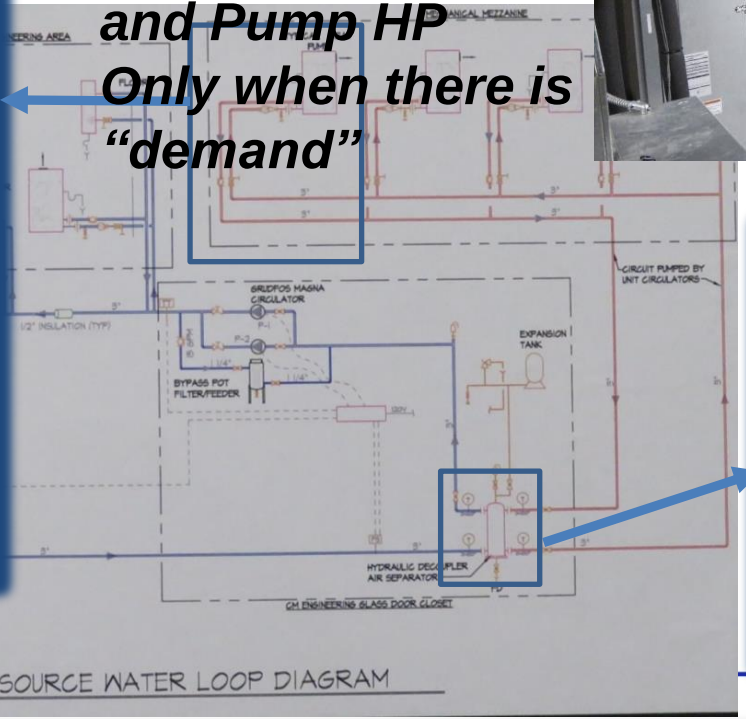
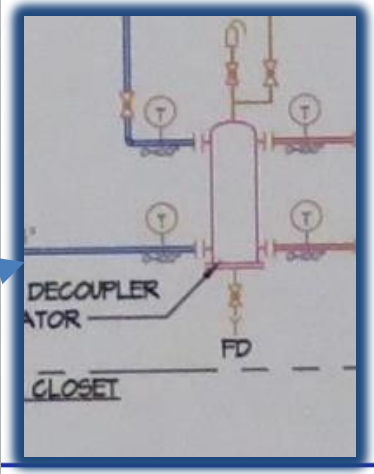
Hydraulic Decoupler

(no primary pump)

Variable flow Compressor, Fan, and Pump HP Only when there is "demand"

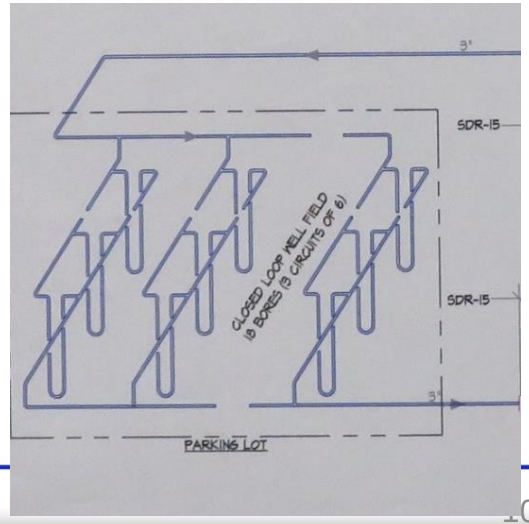






Ground loop under parking lot

1” dia. HDPE loop, fused U-bend
5.125” diameter bore
18-300 ft. deep
Thermal grout elite
(power tec graphite,1.2 tc)



Planning for Performance

- Owner requirements for the Whole Building
  - **SOA …what we believe**
    - **Good design is a thoughtful process producing inspiring spaces and places to enrich people's lives.**
    - The result is **"appropriate design"**
  - **CM Engineering…**the new office building is another example of our commitment to the environment
    - to engineering excellence
    - In budget
    - Simple – Low Maintenance
- Our new building showcases many of the same technologies that we utilize in our client work. It will be among the most energy-efficient buildings in the area.
- $34/12000 = $0.00283/square foot per "Working Day"

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Project Profiles

Project Profiles

Boardman YMCA

- Geothermal
- Water To Water Serving Pool Dehumidification Unit
- Water to Water Pool Water Heat
- Horizontal HP’s

Project Profiles

Museum of Contemporary Art

- Geothermal
- Dedicated OA Systems
- Single Zone VAV
- Horizontal HP’s

Project Profiles

Schools

- Geothermal
- Variable Dedicated OA Systems
- Single Zone VAV
- Horizontal HP's

Project Profiles

Schofield Building

- Water Source
- Dedicated OA Systems
- Stacker HPs
- Vertical HPs

Future

What's New on the Horizon?

- Variable output capacity for improved part load efficiency.
  - Variable speed compressor technology
  - Variable speed blower and pump motor control
- Hybrid geothermal systems
- Advanced automated control systems and strategies.
  - Integration of occupancy verification
    - Multiple temperature setback strategies (unoccupied, occupied & stand by)
    - Ventilation reduction and control
  - Energy cost hedging and utility rate structure control
  - Earth coupled loop "heat harvesting"

Thank You!