Four Technologies That Could Disrupt the GHP Marketplace

Moderator: Mitch DeWein – *CHA Consulting, Inc.*

Speakers:

Matt Desmarais – *Energy Catalyst; Double Hybrid Heat Pump*

Robert Manning – *Climate Control Group; Single Pipe Risers*

Darren Jones – *Dandelion Energy; Dandelion Geo Heat Pump*

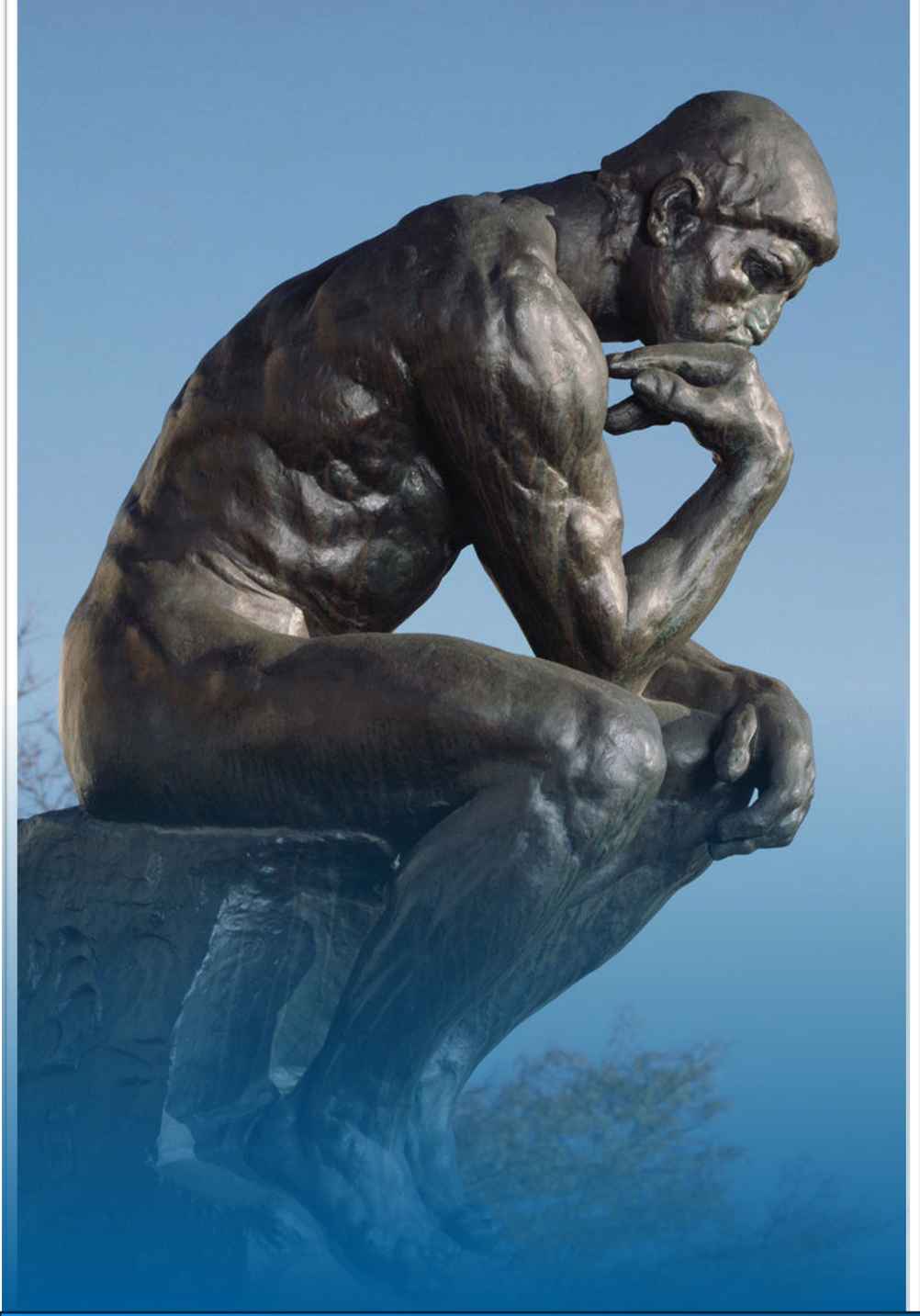
Geoff Ellison – *Envirohire Ltd; Loop Integrity Tester*

BUILDING ELECTRIFICATION TRACK – DAY 2 – 3:00 to 4:00

Reusing Existing Hot Water Infrastructure Efficiently

ENERGY CATALYST
GROUNDBREAKING CLEAN HEAT

Matt Desmarais
Founder
mattd@energycatalysttech.com



Traditional Thinking:
Hot water systems are the worst!

Much lower efficiency = less savings

COP of Water to Water heat pumps are much lower:
110°F = 3.3 COP
120°F = 3.0 COP
150°F = 2.4 COP

Cannot reuse existing infrastructure

Almost all heat emitters are designed for 160°F-180°F hot water temperatures which are prohibitively inefficient to produce with heat pumps.

Incomplete Coverage

Still need a separate cooling and fresh air ventilation system.

ENERGY CATALYST

“You cannot heat a building with 120°F hot water”

-Every Plumber

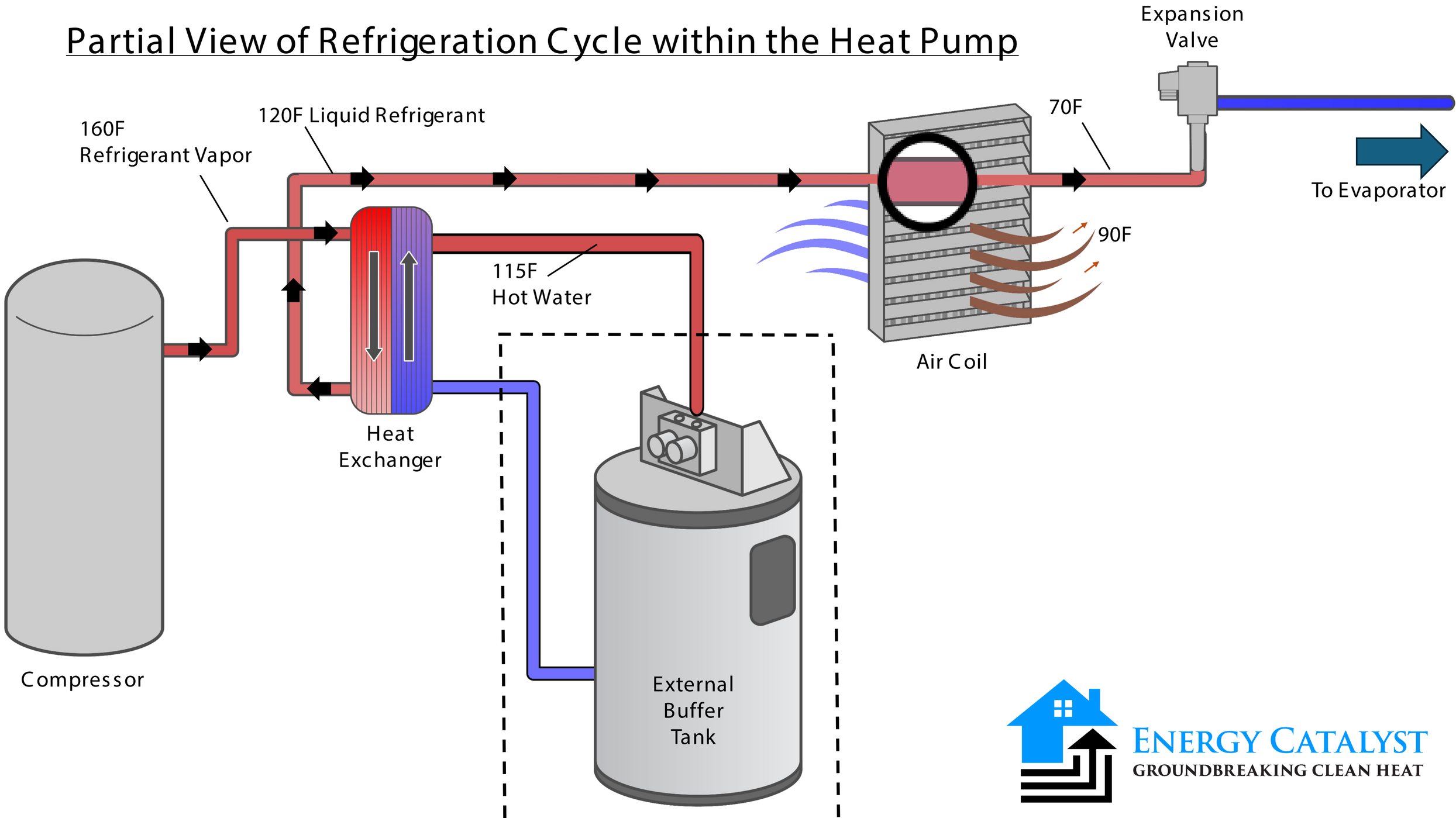
This is partially true.

The condensing boiler industry has been heating buildings with 120°F water during non-peak periods for decades- it works fine.

Example: Aerco Boiler

Based on our own data logging:
80% of peak load can be met with 120°F.

Partial View of Refrigeration Cycle within the Heat Pump



ENERGY CATALYST
GROUNDBREAKING CLEAN HEAT

Patented Hot Water Technology:

Hot water systems have the most to gain!

Efficiency

~~3.3 COP @ 110°F~~
~~3.0 COP @ 120°F~~
~~2.4 COP @ 150°F~~

Double Hybrid
4.4-5.2 COP

☑

Reuse existing infrastructure

Huge reduction in project costs ☑

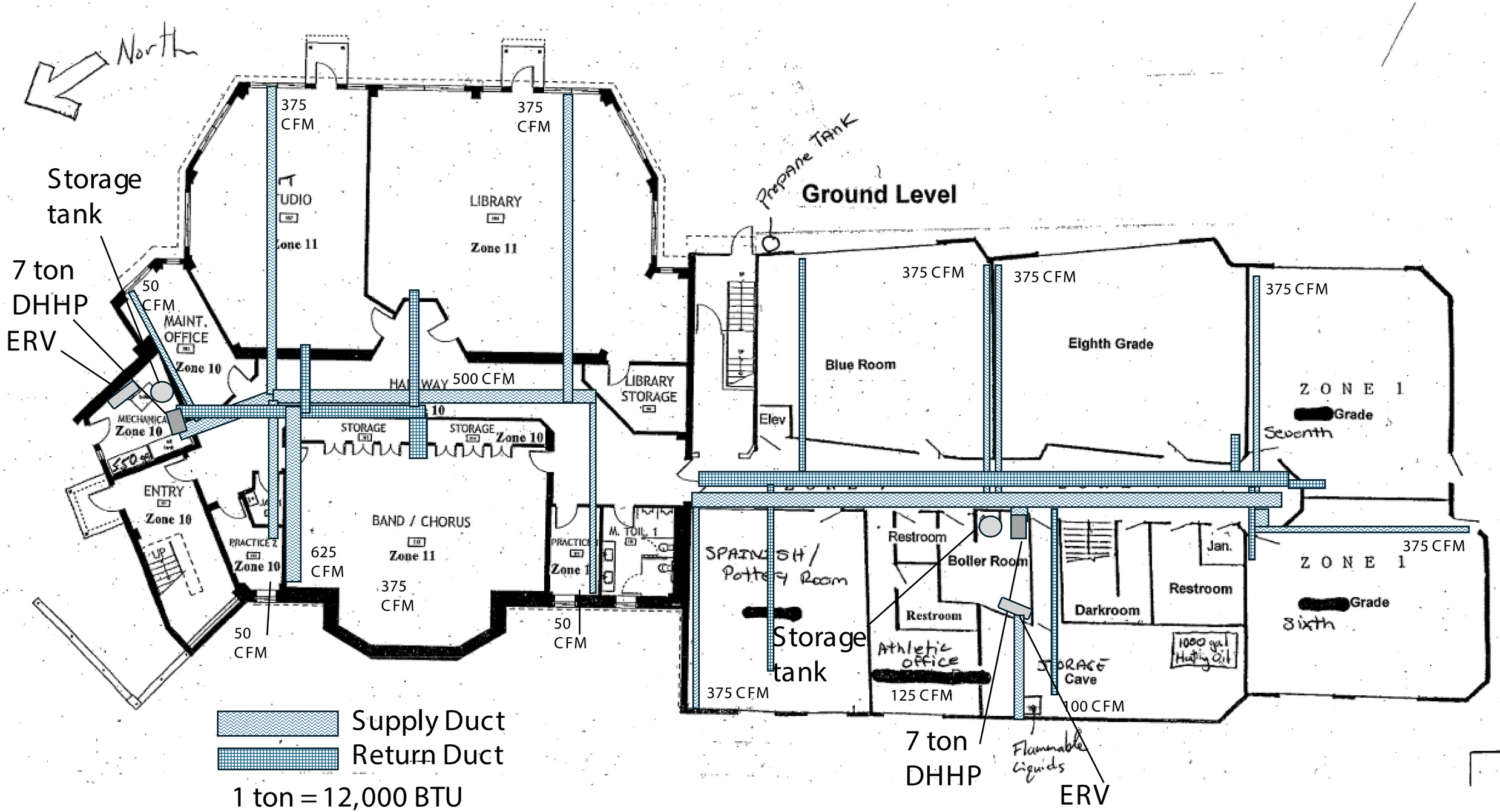
AC with 1/4th the ductwork ☑

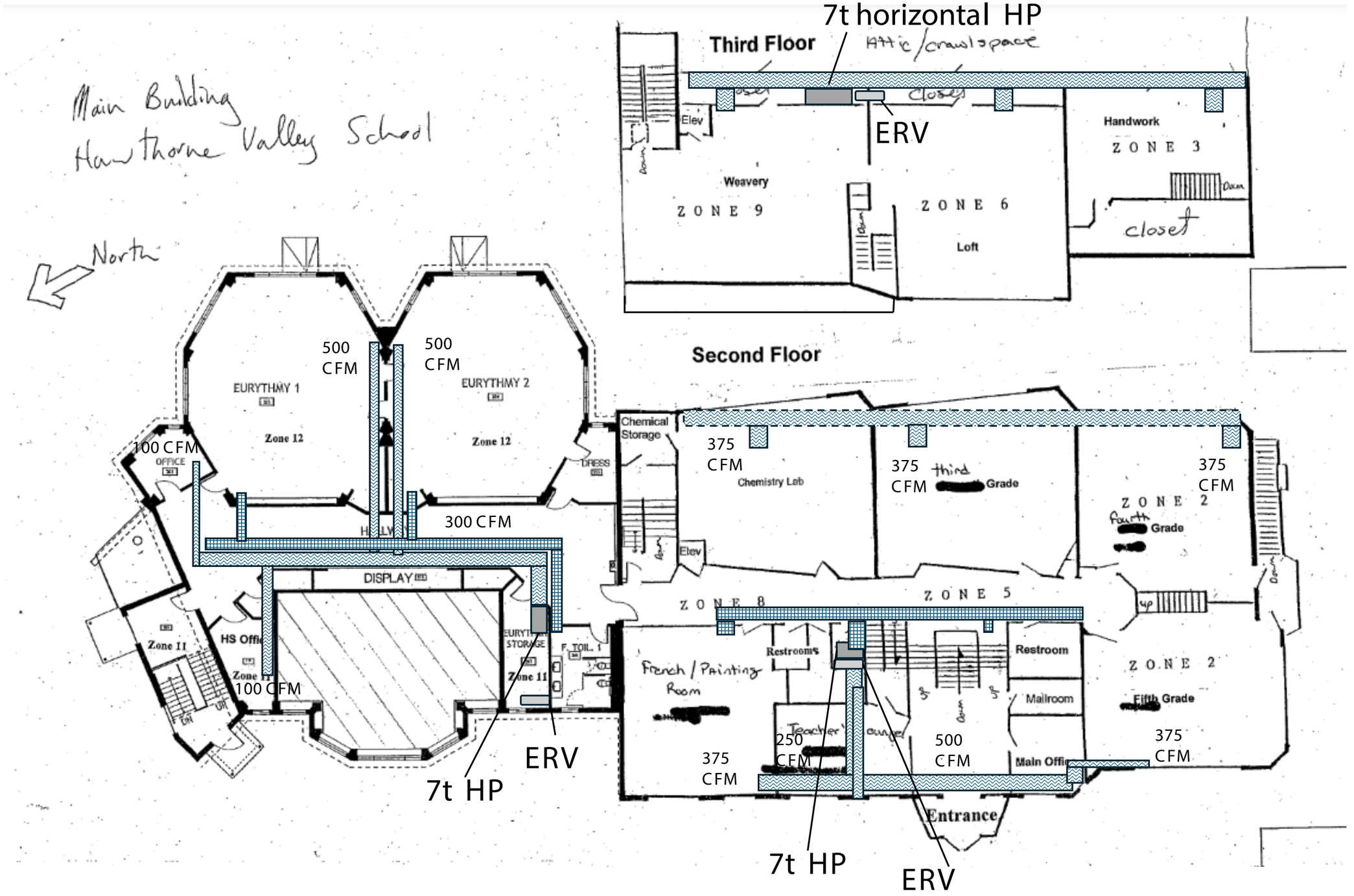
Super high efficiency cooling and fresh air ventilation system

Quick Example:

Hawthorne Valley School Entire Campus Geothermal

4 buildings, 60,000 sq ft total.
All heated with hot water baseboards


North
Storage tank
7 ton DHHP ERV
375 CFM
375 CFM
50 CFM
MAINT. OFFICE
Zone 10
STUDIO
Zone 11
LIBRARY
Zone 11
HALLWAY
500 CFM
LIBRARY STORAGE
MECHANICAL
Zone 10
STORAGE
STORAGE
Zone 10
ENTRY
Zone 10
PRACTICE 2
Zone 10
625 CFM
BAND / CHORUS
Zone 11
375 CFM
PRACTICE
Zone 1
M. TOIL. 1
50 CFM
50 CFM
Propane Tank
Ground Level
Elev
Blue Room
375 CFM
375 CFM
Eighth Grade
375 CFM
ZONE 1
Grade
Seventh
SPANISH / Pottery Room
375 CFM
Storage tank
Restroom
Boiler Room
Restroom
Athletic office
125 CFM
Darkroom
Jan.
Restroom
375 CFM
ZONE 1
Grade
Sixth
STORAGE Cave
1000 gal Heating Oil
100 CFM
Flammable liquids
7 ton DHHP
ERV
Supply Duct
Return Duct
1 ton = 12,000 BTU


Main Building
Hawthorne Valley School
North
Third Floor
7t horizontal HP
Attic / crawlspace
ERV
Elev
Weavery
ZONE 9
ZONE 6
Loft
Handwork
ZONE 3
closet
Second Floor
500 CFM
500 CFM
EURYTHMY 1
EURYTHMY 2
Zone 12
Zone 12
100 CFM
OFFICE
300 CFM
DISPLAY
Zone 11
HS Offi
Zone 11
100 CFM
Chemical Storage
375 CFM
Chemistry Lab
375 CFM
third Grade
375 CFM
ZONE 2
fourth Grade
Elev
ZONE 8
ZONE 5
French / Painting Room
Restrooms
Restroom
Mailroom
Main Offi
ZONE 2
Fifth Grade
375 CFM
250 CFM
500 CFM
375 CFM
Entrance
7t HP
ERV
7t HP
ERV

Project Summary:

- Add ¼ the ductwork as a forced air system and reused everything else.
- Work to be completed during summer vacation
- Reduces asthma symptoms and risk of spreading germs with fresh air ventilation and centralize air filtration.
- Vertical and horizontally drilled Twister loops.

Transient season:	Peak Heating season:	Peak Cooling Season:
Cooling zones produce simultaneous hot water for zones that need heat	80% hot water and 20% forced air supplement	High efficiency cooling to individual zoned classrooms

Project Summary:

Expected seasonal COP: 5.1
Total project cost: ~$1,500,000, $25/sq ft

Patented Hot Water Technology:

Hot water systems have the most to gain!

100% domestic hot water models available

Efficiency

~~3.3 COP @ 110°F~~
~~3.0 COP @ 120°F~~
~~2.4 COP @ 150°F~~

Double Hybrid
4.4-5.2 COP

☑

Reuse existing infrastructure

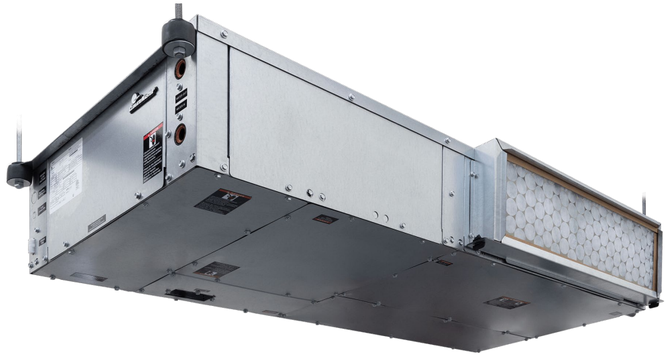
Huge reduction in project costs ☑

AC with 1/4th the ductwork ☑

Super high efficiency cooling and fresh air ventilation system

CLIMATEMASTER®

Single Pipe Systems with Water Source Heat Pumps and Geothermal Systems



Bob Manning - Northeast Regional Manager

WATER-SOURCE HEAT PUMPS

CLIMATEMASTER

Strategies for Reducing First Cost

- Hybrid Geothermal Systems
  - –Size Well System for Part of Full Building Load

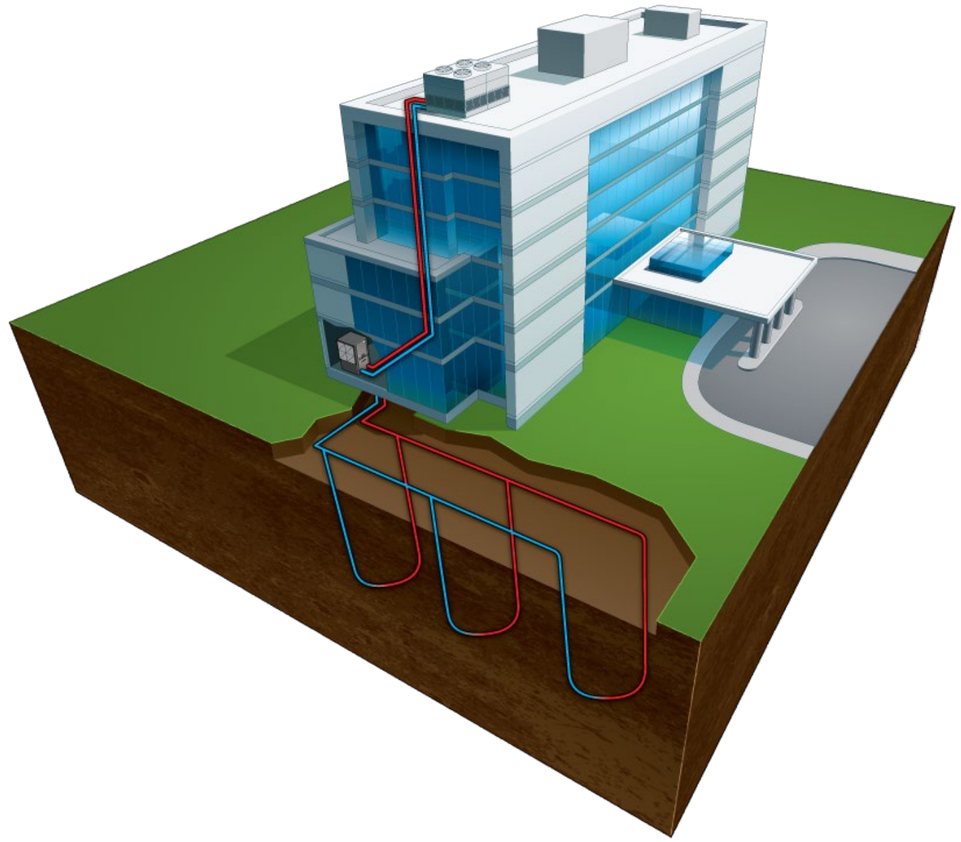
- Single Pipe Systems
  - –Cut Down on Installed First Cost

Geothermal Hybrid Heat Pump System

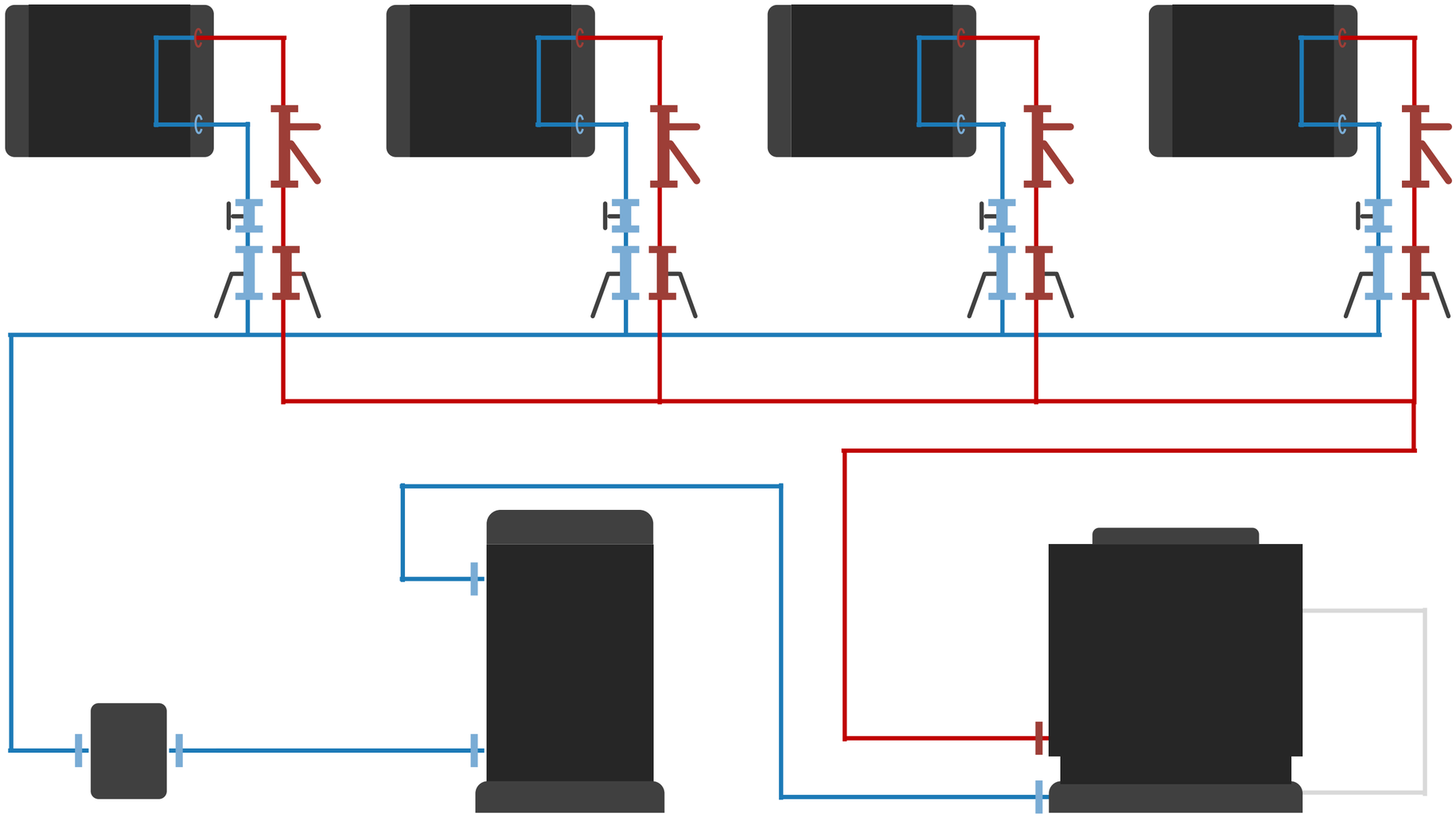
- Reduces the size of the Geo Loop
  - When paired with Cooling Tower (Cooling Dominated Buildings or,
  - When paired with Boiler (Heating dominated buildings)

- Advantages:
  - Geo Loop is designed to meet the smaller load
  - First cost of the geo loop is significantly reduced

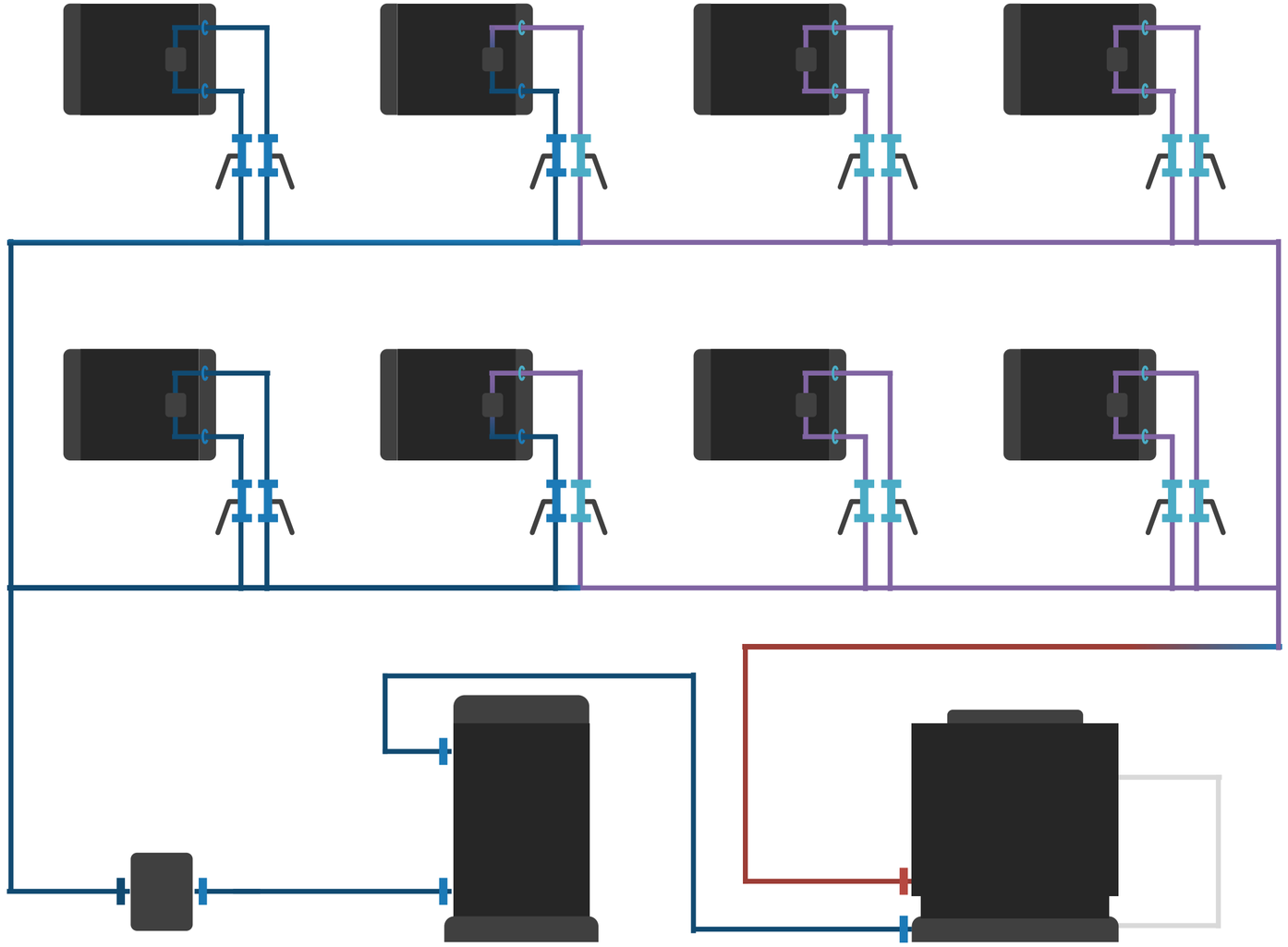
- In many commercial applications, the building requirements are cooling dominated 365 days / year.
  - People
  - Computers
  - Lighting
  - Solar



Typical Water Loop System



Single-Pipe Loop System



Advantages of a Single-Pipe System

- Easy System Design
- Saves Money
- System Simplicity
- Efficient Operation

Easy System Design

Unit Configuration

Include internal pump

Ball valves for service isolation

No balancing valves

Simple System Layout

No unit flow control required

Simple loop control

Smaller system pump

Reduces the motor size required for a standalone pump, making this redundancy cost effective. In some cases, electrical wiring savings can be significant.

Easy System Design

Parallel Pumping

- Provides backup
- Booster pump for peak capacities
- Reduced electrical rush
- **More efficient when running in part load conditions:** matches flow to load better, which means a single large pump is not required to continually pump full flow.

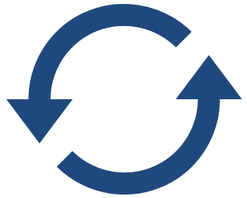
History has shown that a single pump

(supplying 75% to 85% of the design flow) maintains the flow requirements more than 95% of the time

Save Money

Reduces installation cost by reducing 2-pipes to 1-pipes without losing performance

On retrofit jobs, reduce boring thru floors and reduce required amount of fire-stop material



Smaller building loop pump HP due to lower system head (no control valves, balance valves, etc.)

See calculations later

System Simplicity

Plug and Play

Reduced installation time with integrated pumping

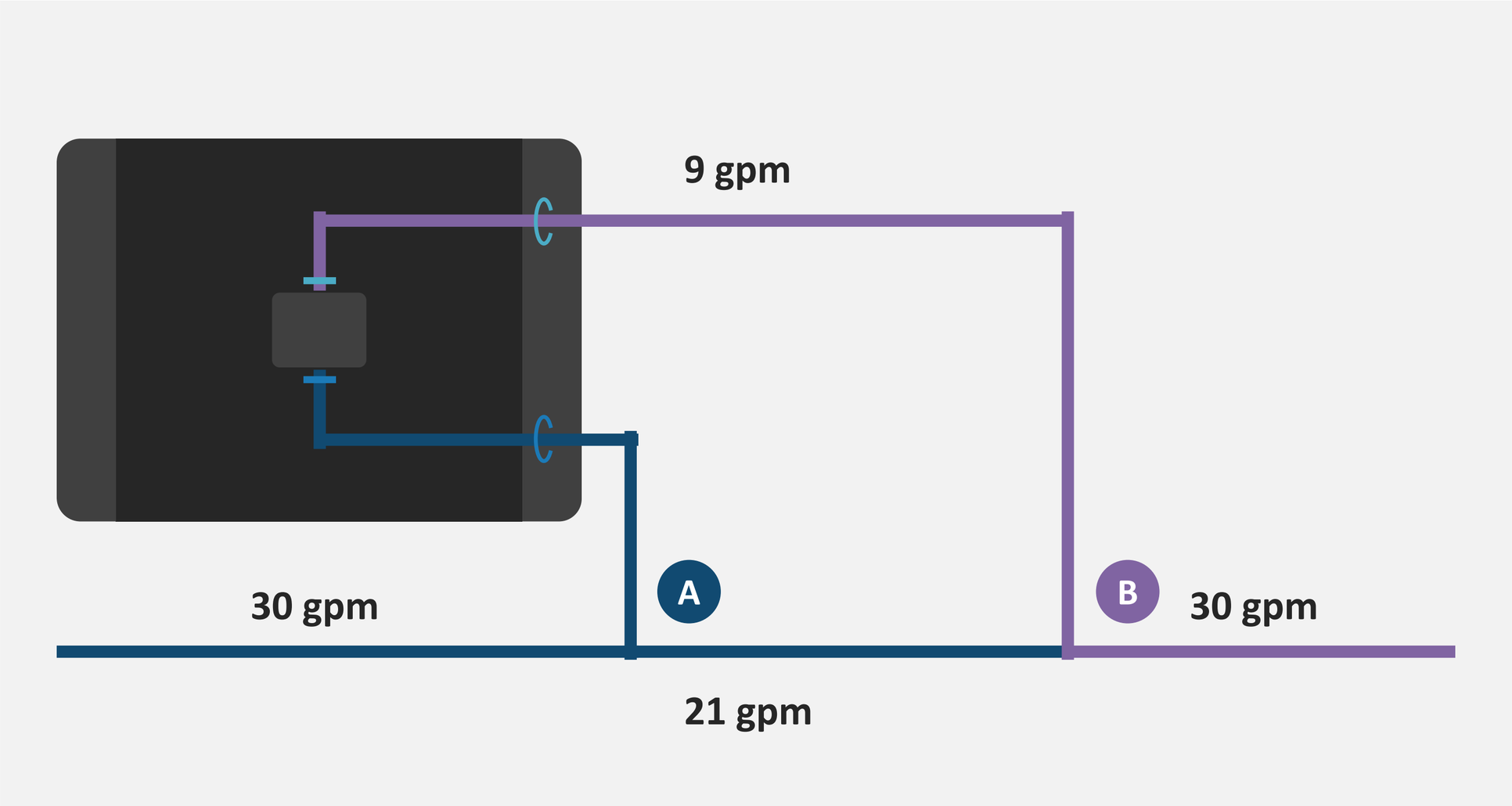
Units are self-balancing

Fewer System Components

Flow controllers, water balancing valves, and test ports are eliminated

Fewer component reduces maintenance costs

Single-Pipe Loop System



Cost Efficient Operation

Reduced System Head Allows Smaller Loop Pump HP

Assume a flow rate of 512 gpm…

2 Pipe

Pump horsepower

= 512 gpm x 66 ft. head / 3960 / .75 pump efficiency

= **11.4 hp**

1 Pipe

Pump horsepower

= 512 gpm x 44 ft. head / 3960 / .75 pump efficiency primary pump + 512 gpm x 5 ft. head / 3960 / .30 pump efficiency internal circulator

= 7.6 + 2.2

= **9.7 hp**

Cost Efficient Operation

Smaller loop pump HP saves money every day

Assume a flow rate of
512 gpm and operation
8 hrs/day, 5 days/week

2 Pipe Pump horsepower
= 11.4 hp (95% efficient)

1 Pipe Pump horsepower
= 9.7 hp (95% efficient)

Annual operating cost = operating hrs * (.746*HP) / motor efficiency * energy cost

2-pipe annual operating cost

= 2080hrs * (.746*11.4) / .80 * $0.1

= **$2,206.83**

1-pipe annual operating cost

= 2080hrs * (.746*9.7) / .80 * $0.1

= **$1,889.18**

$317.65 annual savings due to reduced HP

Savings Calculations

2-pipe system **$2,206.83** **annual energy cost**	**Days:** 260 **Hour/day:** 8 **Total hrs:** 2080 **Pump motor hp:** 11.4 **Pump motor effy:** 0.8 **Electrical cost / kwh:** $0.10
1-pipe system **$1,889.18** **annual energy cost**	**Days:** 260 **Hour/day:** 8 **Total hrs:** 2080 **Pump motor hp:** 9.7 **Pump motor effy:** 0.8 **Electrical cost / kwh:** $0.10
$317.65	**Annual Savings**

Single Pipe Design Keys

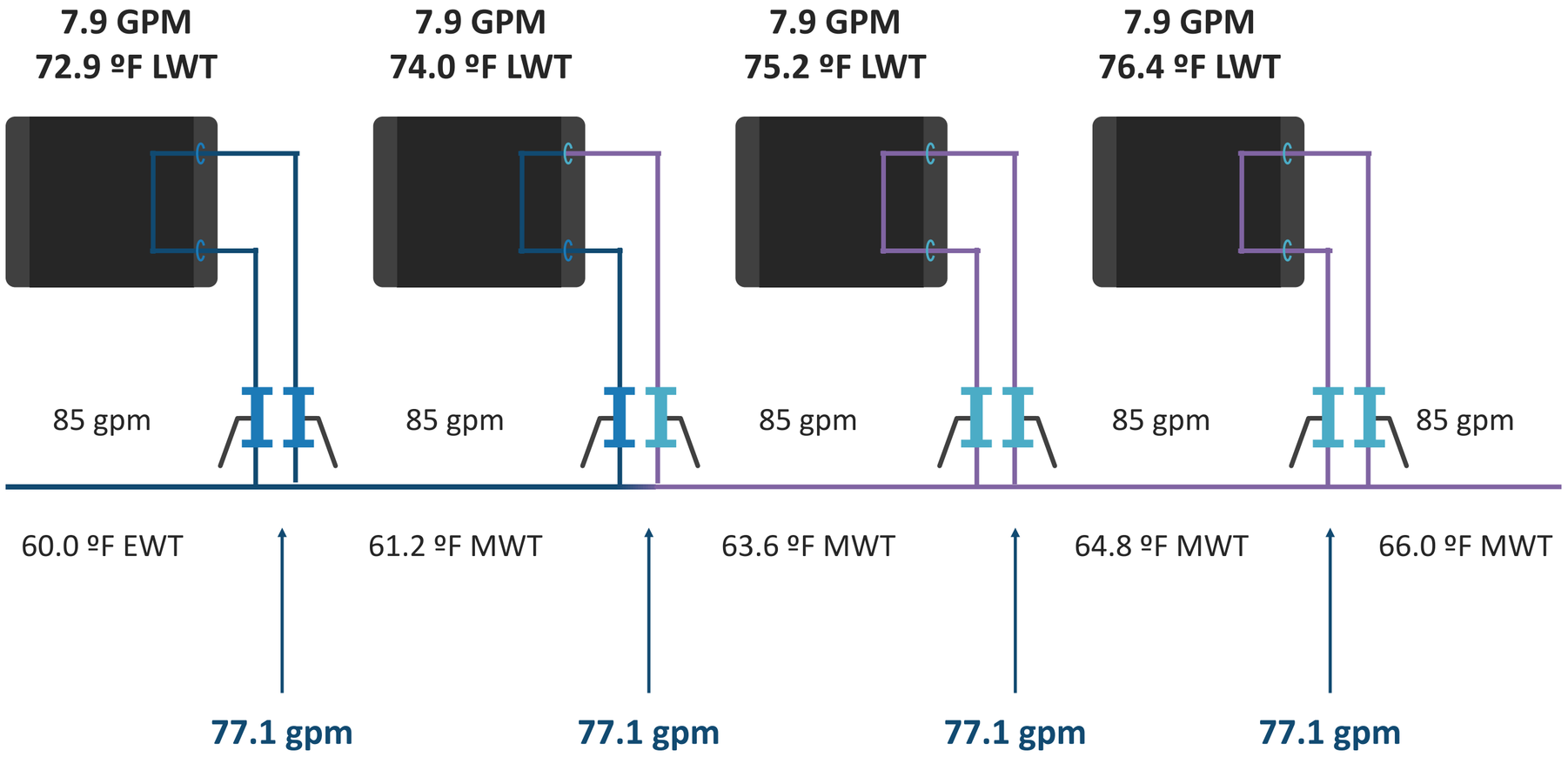
Use same common pipe size for all units on a single pipe loop (typ. 10-15 units per loop)

Size single pipe dia. for cumulative gpm of all units on single pipe loop

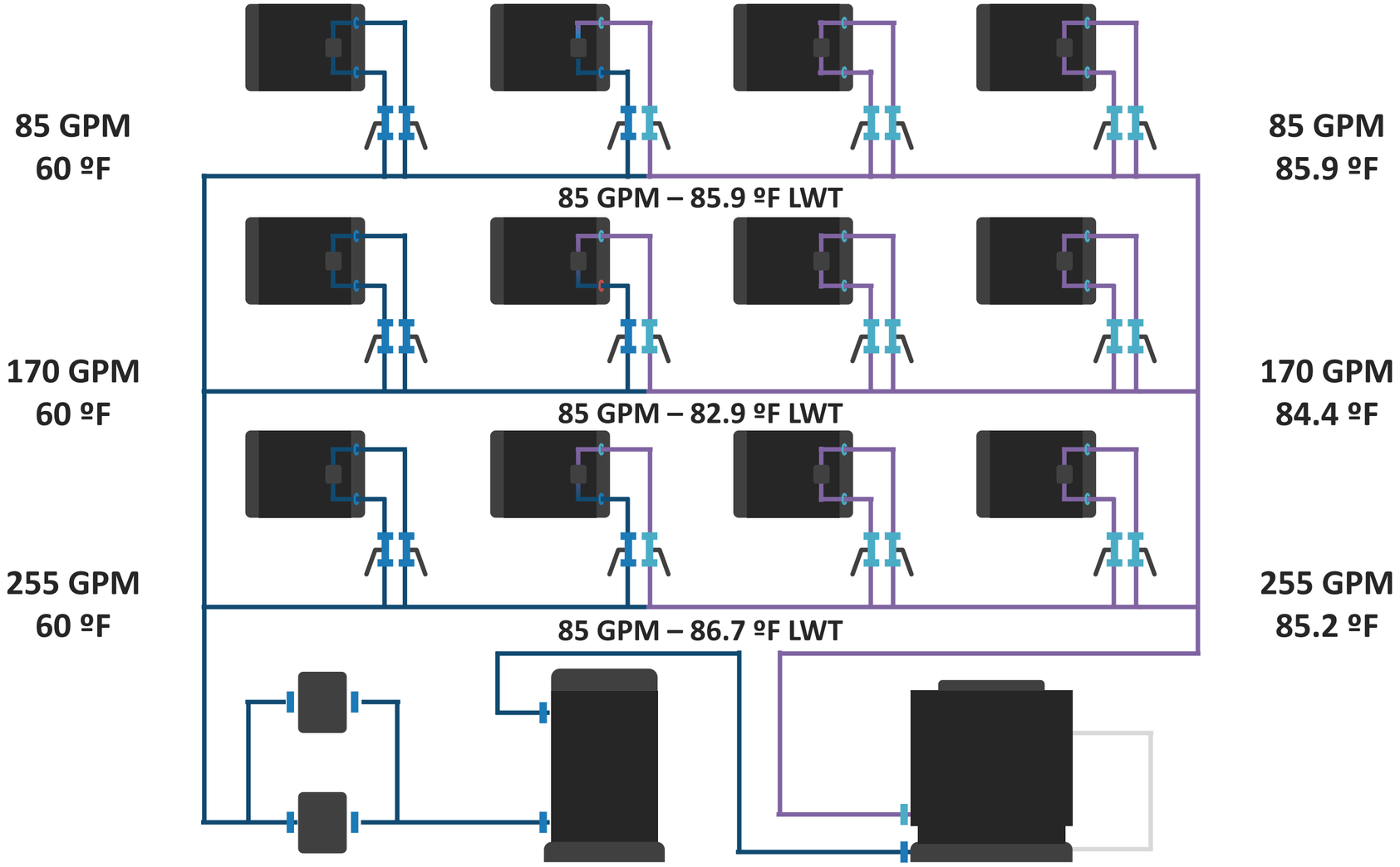
Temperature rise of single pipe loop will largely depend on loop flow

Not all units on at the same time, so diversity occurs

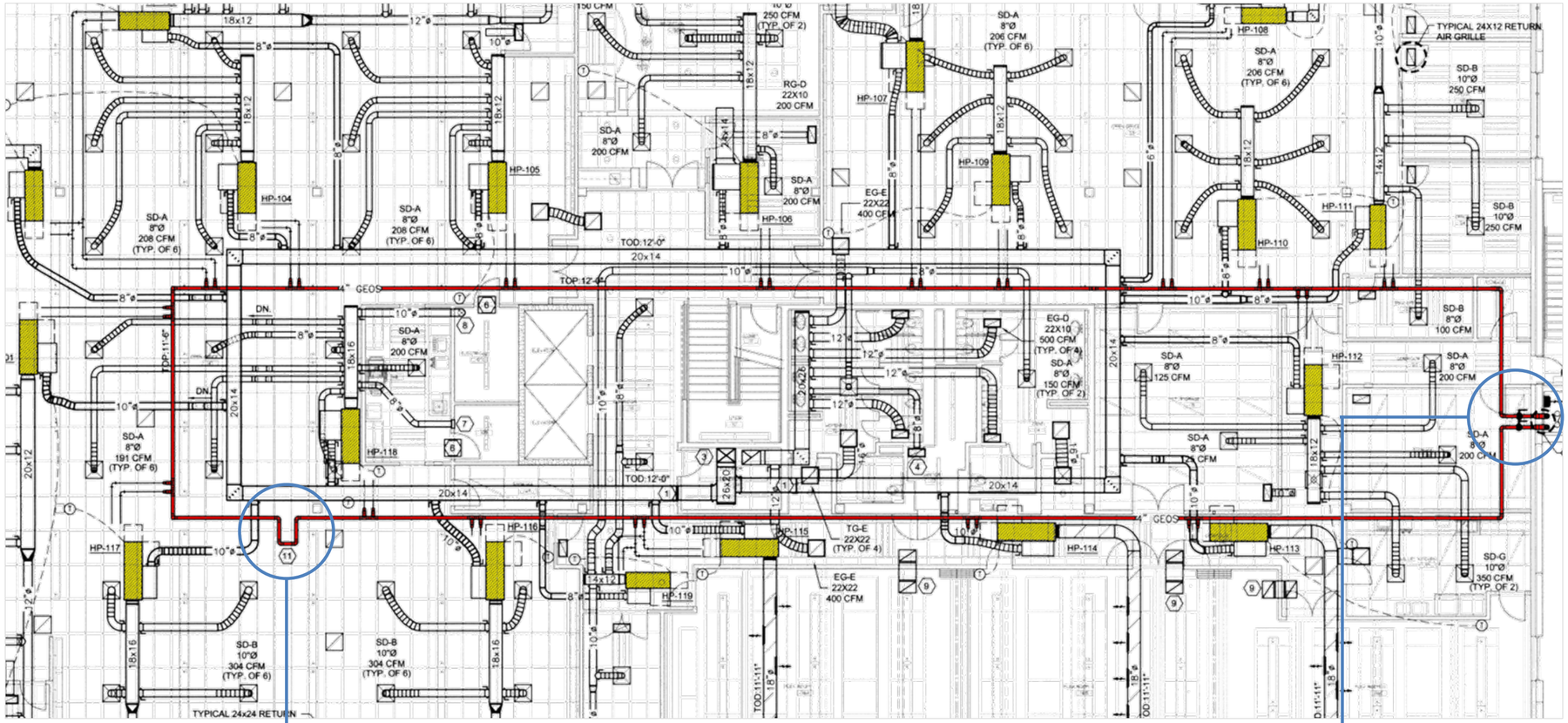
Loop Calculations



Loop Calculations



Loop Layout


Expansion Loop
To Mechanical Room
TYPICAL 24X12 RETURN AIR GRILLE
TYPICAL 24x24 RETURN
HP-104
HP-105
HP-106
HP-107
HP-108
HP-109
HP-110
HP-111
HP-112
HP-113
HP-114
HP-115
HP-116
HP-117
HP-118
HP-119
SD-A 8"Ø 208 CFM (TYP. OF 6)
SD-A 8"Ø 206 CFM (TYP. OF 6)
SD-A 8"Ø 200 CFM
SD-A 8"Ø 191 CFM (TYP. OF 6)
SD-A 8"Ø 125 CFM
SD-A 8"Ø 150 CFM (TYP. OF 2)
SD-B 10"Ø 250 CFM
SD-B 8"Ø 100 CFM
SD-B 10"Ø 304 CFM (TYP. OF 6)
SD-G 10"Ø 350 CFM (TYP. OF 2)
RG-D 22X10 200 CFM
EG-E 22X22 400 CFM
EG-D 22X10 500 CFM (TYP. OF 4)
TG-E 22X22 (TYP. OF 4)
TOD:12'-0"
TOP:12'-6"
TOD:11'-11"
4" GEOS
DN.

Typical Single-Pipe Mechanical Room

Thank you for your time!!

CLIMATEMASTER®

NY-GEO 2024

October 22 -23 | BROOKLYN, NY

The Dandelion Geo heat pump

dandelion

Dandelion has developed expertise on Northeast geothermal retrofits

~3,000

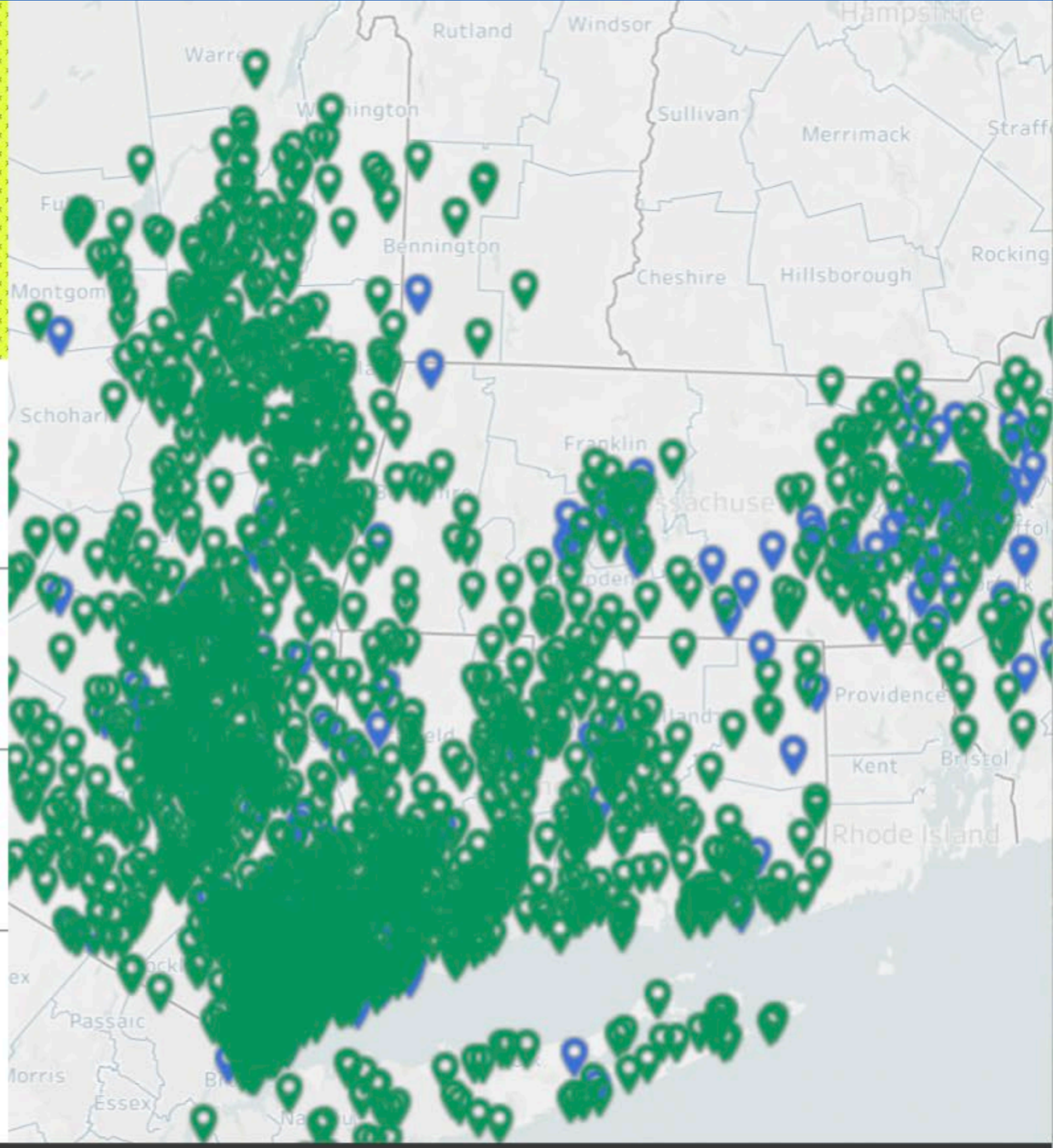
Geothermal heat pumps installed

NY, CT, MA

Dandelion's service territory

7

Years of installation experience



Barriers to geo adoption

In 2023, we did a study that found that only 7.5% of projects in Con Edison territory DID NOT require additional products (beyond the geothermal system) to electrify their heating.

It is often not the geo system itself that is too expensive; it is everything else that is required along with it.

	% of contracts that include	Price	Comments
Ductwork modification	21%	$2,500 - $20,000+	Note: we include some duct modification in our base price. This represents customers who need more than that base amount.
Aeroseal	44%	~$3,000	Decreases home's heating load. Can allow for a lower tonnage heat pump that's more compatible with the home's ducts.
Main panel upgrade	16%	$5,750 - $9,750	In addition to added cost, a main panel upgrade can result in project delays.
Heat pump water heater	24%	~$5,000	Required to remove oil tank or boiler.
Oil tank removal	15%	~$5,000	Regulatory requirements have increased costs.
Boiler removal	13%	$1,750	Regulatory requirements have increased costs

We made the Dandelion Geo to address these barriers

Optimized for heating

- The Dandelion Geo has a significantly higher heating capacity than other units of its kind, expanding the number of homes that can be served with one unit.

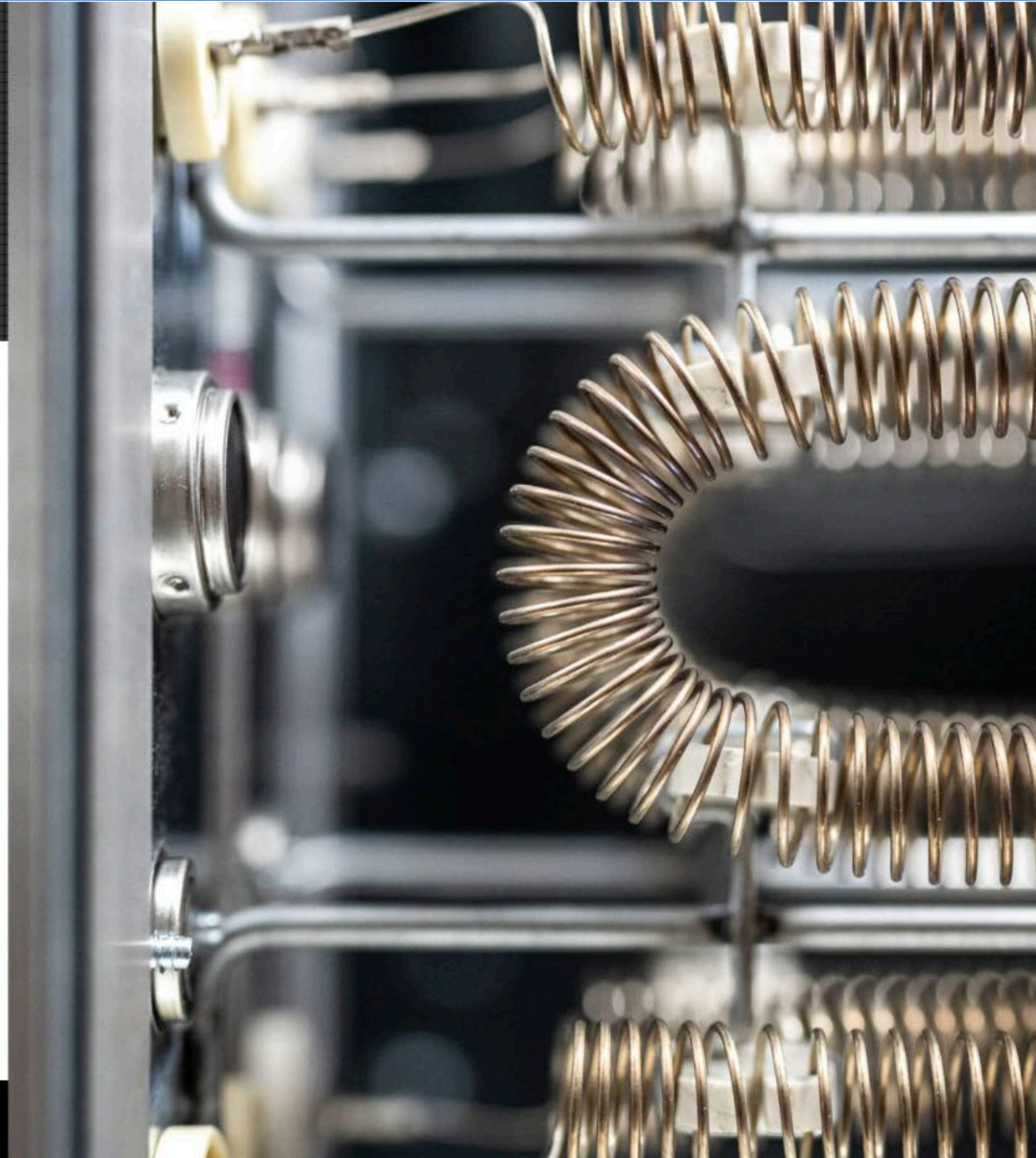
- This high heating capacity can be delivered at low airflow, making the Dandelion Geo more compatible with ducts that previously served a furnace [more on this soon].

	Dandelion Geo - R410a		Dandelion Geo - R454b	
	Heating Capacity	COP	Heating Capacity	COP
6T	61,000	4.45	63,370	4.35
5T	53,000	4.5	54,570	4.75
4T	41,500	4.65	42,300	4.95
3T	31,000	4.85	32,692	5.2

Note: a typical 6T geothermal heat pump has a heating capacity around 57,000 btu/hr

Designed for an easy electrical installation

- Each tonnage comes with built-in auxiliary heat, but only requires a single electrical connection:
  - 6T: 60A
  - 5T: 50A
  - 4T: 40A
  - 3T: 40A
- This minimizes the need for main panel upgrades.
- The unit has a built-in electrical disconnect.



Low airflow? No problem.

Lack of heat pump-ready ductwork in retrofit homes has been one of our biggest challenges. This unit is designed to work with furnace ductwork.

	Min airflow heating (CFM)	Min airflow cooling (CFM)	
	Stages 1 & 2	Stage 1	Stage 2
6T	1,380	1,420	1,900
5T	1,150	1,175	1,600
4T	920	940	1,400
3T	690	720	1,210

Internal pumps that auto-optimize flow rate

- Each unit comes with built in variable speed pumps, reducing installation time.
- These built-in pumps automatically optimize flow rate, reducing installation complexity.

The frontier: What's next in the quest for geo simplicity?

While we're happy with what we've achieved with the Dandelion Geo, there is much still to be done. Here are some of the things we're thinking about:

- Simplifying thermostat wiring in retrofits.
- A better solution for water heating with geo.
- High capacity with colder entering water.
- Simpler, less expensive interior piping methods.

If you have ideas for other things we should be exploring, let's talk!

NY-GEO 2024

UK Legislation, Standards & Testing of Ground Source Heat Loops

22-23 October 2024

Presented by Geoff Ellison

GSHPA
GROUND SOURCE HEAT PUMP ASSOCIATION

ENVIROHIRE

DRAGON
RENEWABLE ENERGY

DRAGON
DRILLING

My Background

Government Research Scientist

Former Technical Director of National Waste Management Company

Current Companies: Plant Hire, Renewable Energy & Drilling

British Drilling Association, Technical & Standards Committee

Ground Source Heat Pump Association (GSHPA)

Standards Group
Drillers Action Group

UK Environmental Legislation

Environment Agency consider heat is a pollutant.

From the 2nd October 2023 the Environmental Permitting Regulations were extended to include closed loop heat exchangers for heating and cooling. Statutory Instrument 2023 No. 651.

Environmental Permit required for environmental protection.

Closed loop heat exchanger pipework systems are **exempt** from requiring a permit, provided that there is compliance with named standards.

Named Standards

Three named GSHPA Standards

Vertical Borehole Standard

Shallow Ground Source Standard

Thermal Pile Standard

Applies to the entire project, design, materials, components, their installation and testing of the system.

GSHPA Standards

Polyethylene pipe has visco-elastic stress behaviour.

Expands under pressure which affects accuracy of pressure readings.

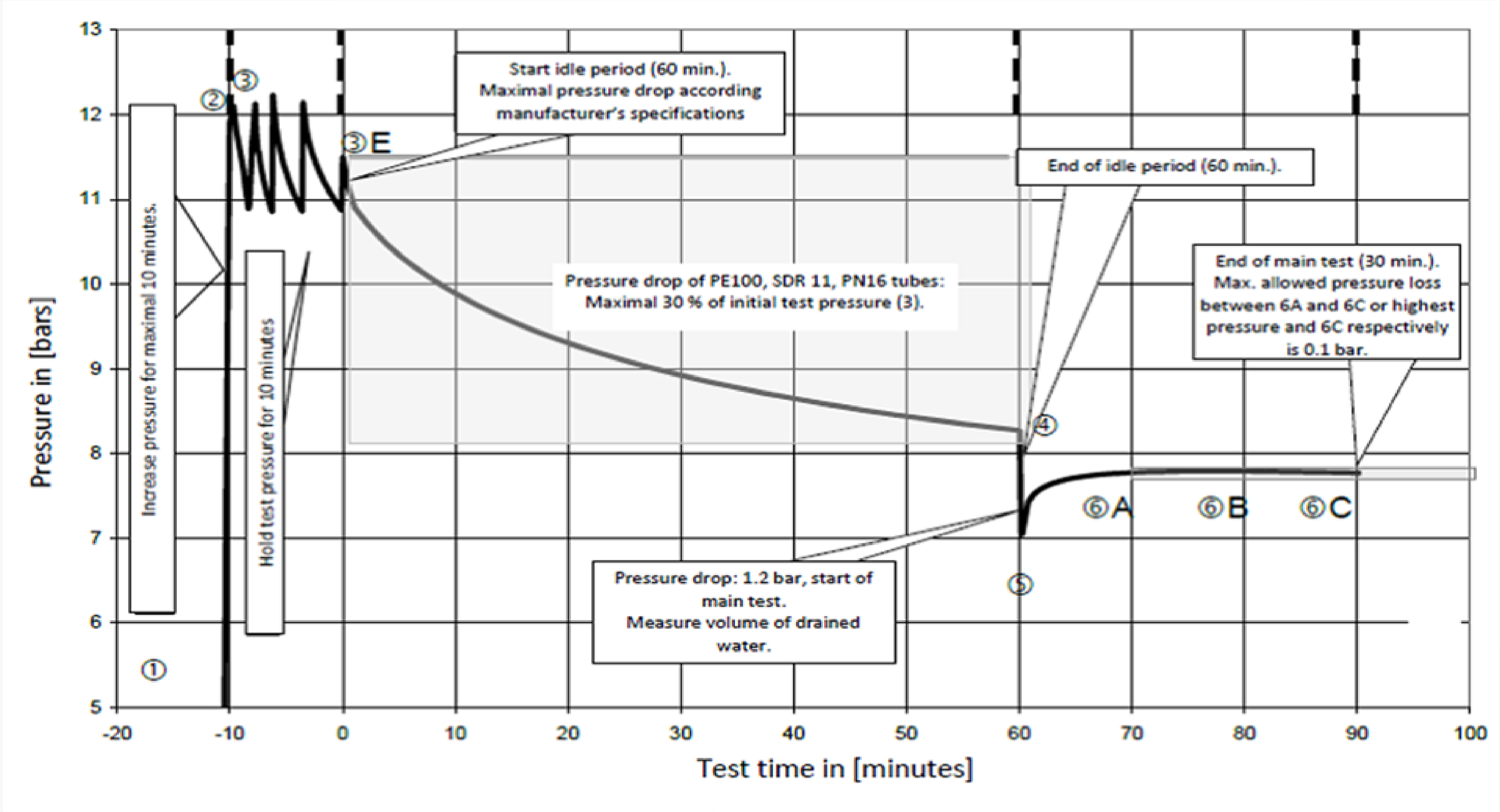
Pressure Drop Test (BS EN 805:2000)

Raise the pipe to the test pressure.

Controlled, rapid reduction in pressure. (10%).

Test the pressure as the pipe contracts.

BS EN 805:2000



GSHPA Standards

All three GSHPA standards test pressure in accordance with BS EN 805:2000.

Specific Requirements:-

Use potable water

Remove all air

Test flow in both directions, without disconnecting

Loop Test Apparatus

Automated test system working to GSHPA standards.

Features:-

Filters test fluid and sterilises using ultra-violet light.

Twin de-gassing tanks to remove air.

Undertakes pressure drop test in line with BS EN 805:2000

Carries out flow test in both directions without disconnecting.

Records results electronically for storage and export.

Records the loop position by GPS.

Camera supervision, in unit & loop connection point.

Prototype Unit

Prototype Unit

System Benefits

Fully automated.
Robust.
Does not interrupt drilling operations.
Calibrated apparatus.
Accurate.
Consistent.
Repeatable.
Electronic data collection, storage & export. No malicious adjustments.
GPS for loop location.
Verification of loop connection by camera.
Fingerprint access by trained operator.
Qualifies for loop warranties and guarantees.

Objectives

1. Raise the quality of ground source heat pump installations, to cover the entire project.

2. Maintain & increase confidence in the sector by having, and working to, published standards.

3. Generate and maintain an accurate and reliable data base for loop installations.

4. Confirm protection of the environment.

5. Continue development work on the test apparatus to include loop depth and verticality.

Thank you and Questions

Geoff Ellison

www.dragondrilling.co.uk

www.dragonrenewableenergy.co.uk

www.gshpa.org.uk

Four Technologies That Could Disrupt the GHP Marketplace

Moderator: Mitch DeWein – *CHA Consulting, Inc.*

Speakers:

Matt Desmarais – *Energy Catalyst; Double Hybrid Heat Pump*

Robert Manning – *Climate Control Group; Single Pipe Risers*

Darren Jones – *Dandelion Energy; Dandelion Geo Heat Pump*

Geoff Ellison – *Envirohire Ltd; Loop Integrity Tester*