Geothermal Heat Pumps 101: How and Where it Works Best!

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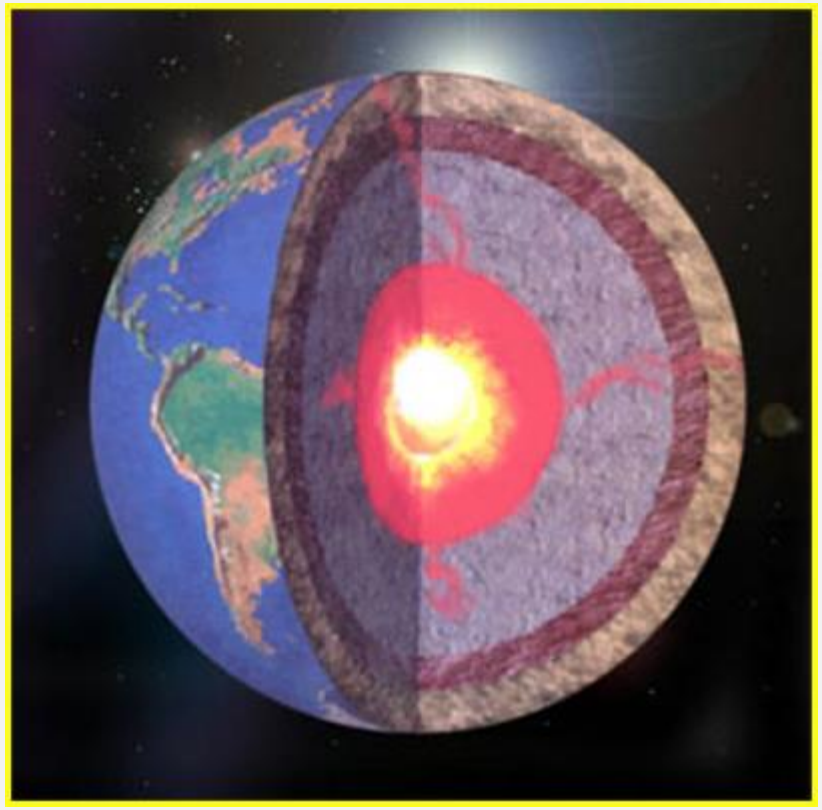
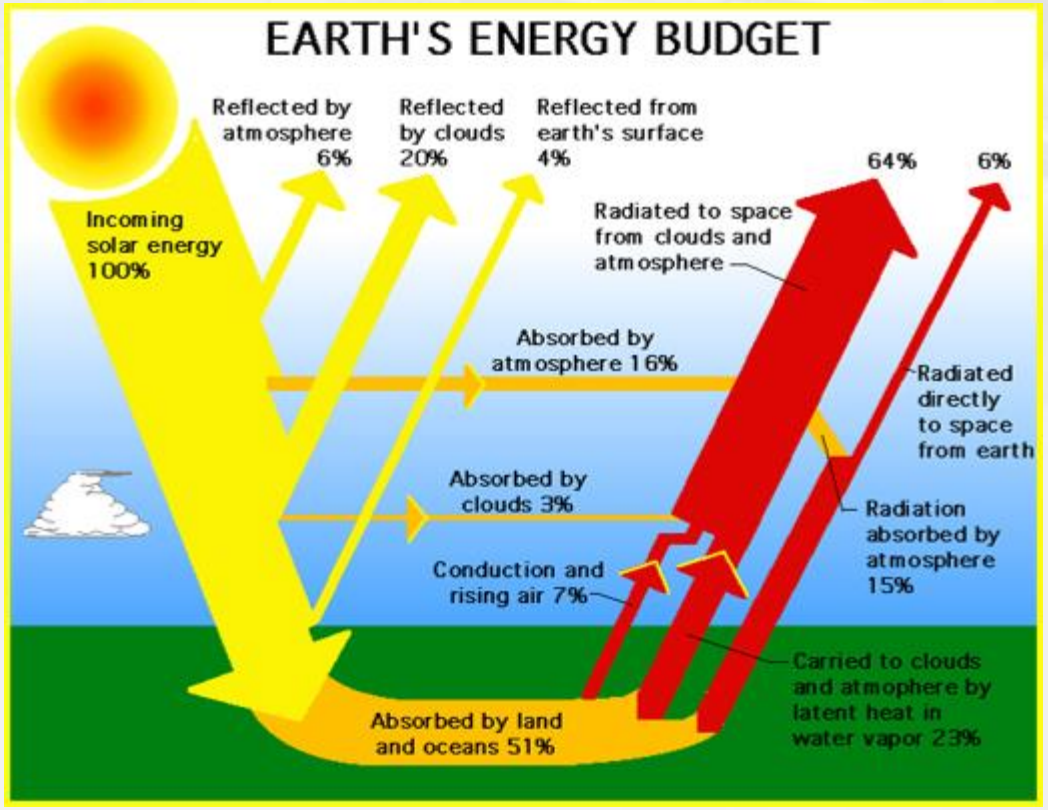
Tuesday, October 22 • 11:30–12:30 PM • Salon E

BRIEF HISTORY OF GEO HEAT PUMPS

- The first recorded geothermal system was a 1912 Swiss patent
- Open loop geothermal systems have been used successfully since the 1930s
- The Edison Electric Institute (EEI) sponsored closed loop research in the 1940s and 1950s, but the lack of suitable piping materials slowed interest.
- Swedish researchers began investigating geothermal closed loop systems in the 1970s with the advent of plastic pipe.

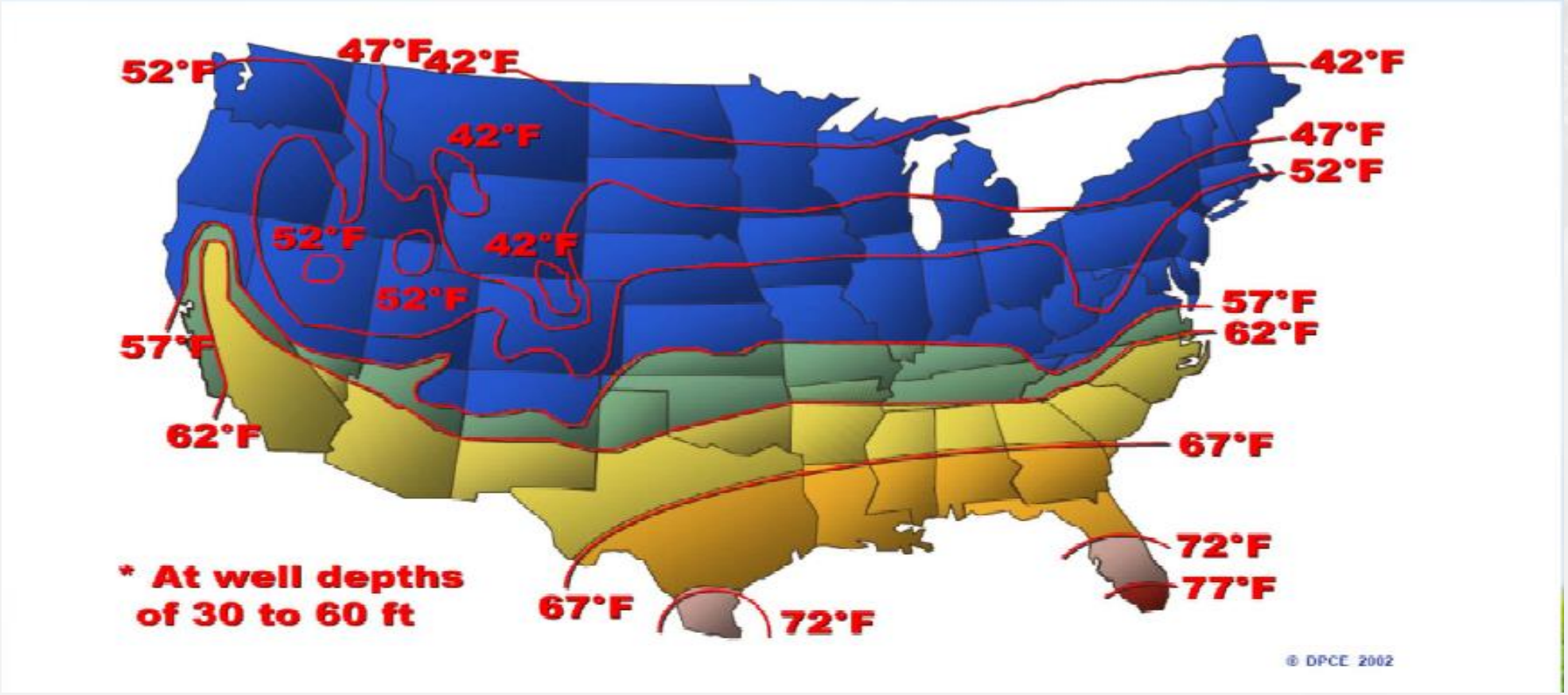
GEOTHERMAL 101





Dictionary definition: ***Relating to the internal heat of the earth***

GEOTHERMAL 101



Average underground temperatures across the US at 30-60’ depths

LAWS OF THERMODYNAMICS

In order to fully understand HOW a geothermal system works, you need a basic understanding of the First & Second Laws of Thermodynamics.

1st Law:

- Law of Conservation of Energy
  - Basically, you can't get more energy out than you put in.

2nd Law:

- Heat energy flows from an area of high heat to an area of low heat
  - You cannot stop this process, only speed it up or slow it down.

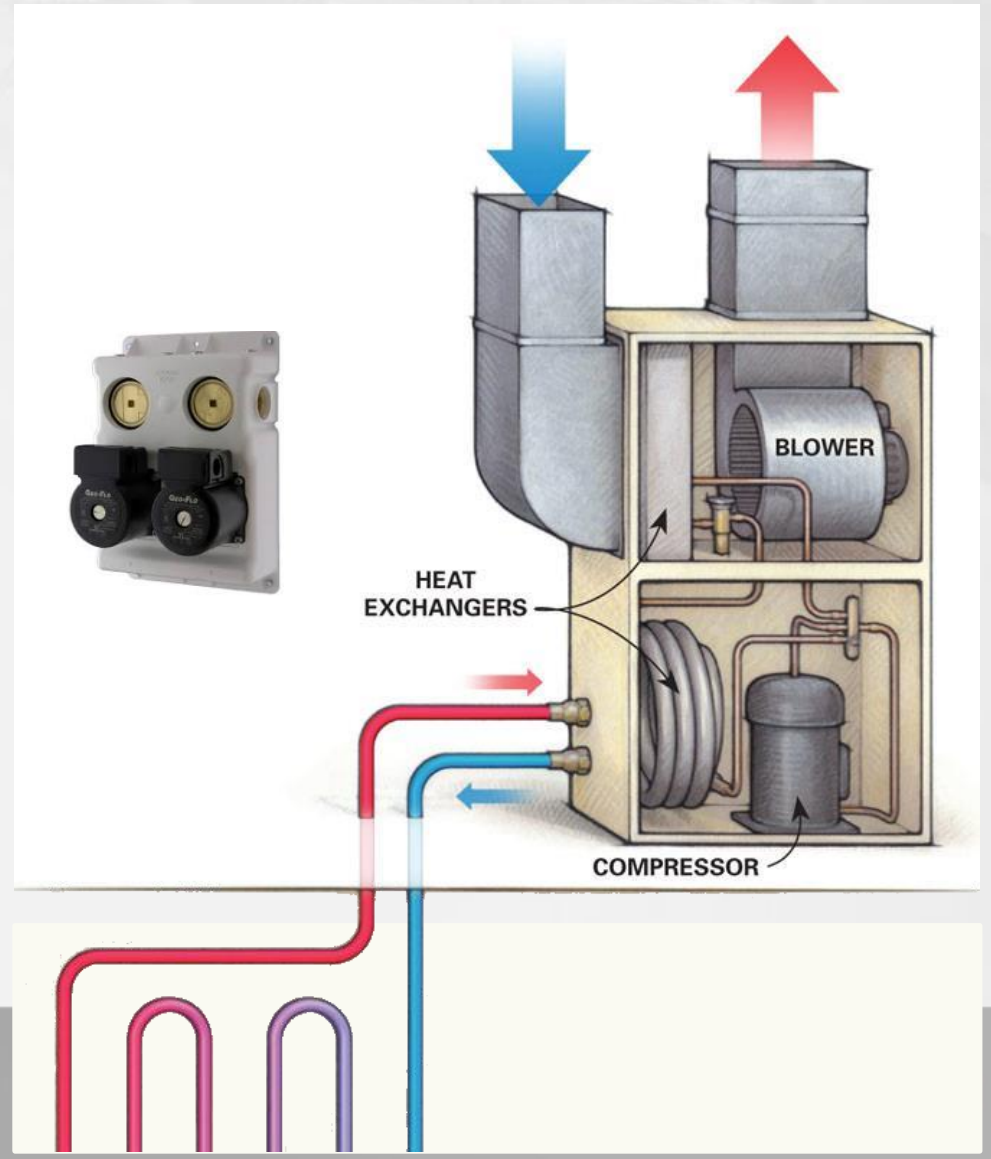
THE BASIC GSHP SYSTEM

- The earth loop is placed in the ground either horizontally or vertically, or it can be placed in a pond.
- Water and anti-freeze are circulated through the pipe, transporting heat to the heat pump during the heating mode and away from the heat pump during the cooling mode.
- The heat transfer takes place inside the heat pump in a water-to-refrigerant heat exchanger.

THE BASIC GSHP SYSTEM

3 Main Electrical Components

- Fan Motors
- Compressors
- Pumps



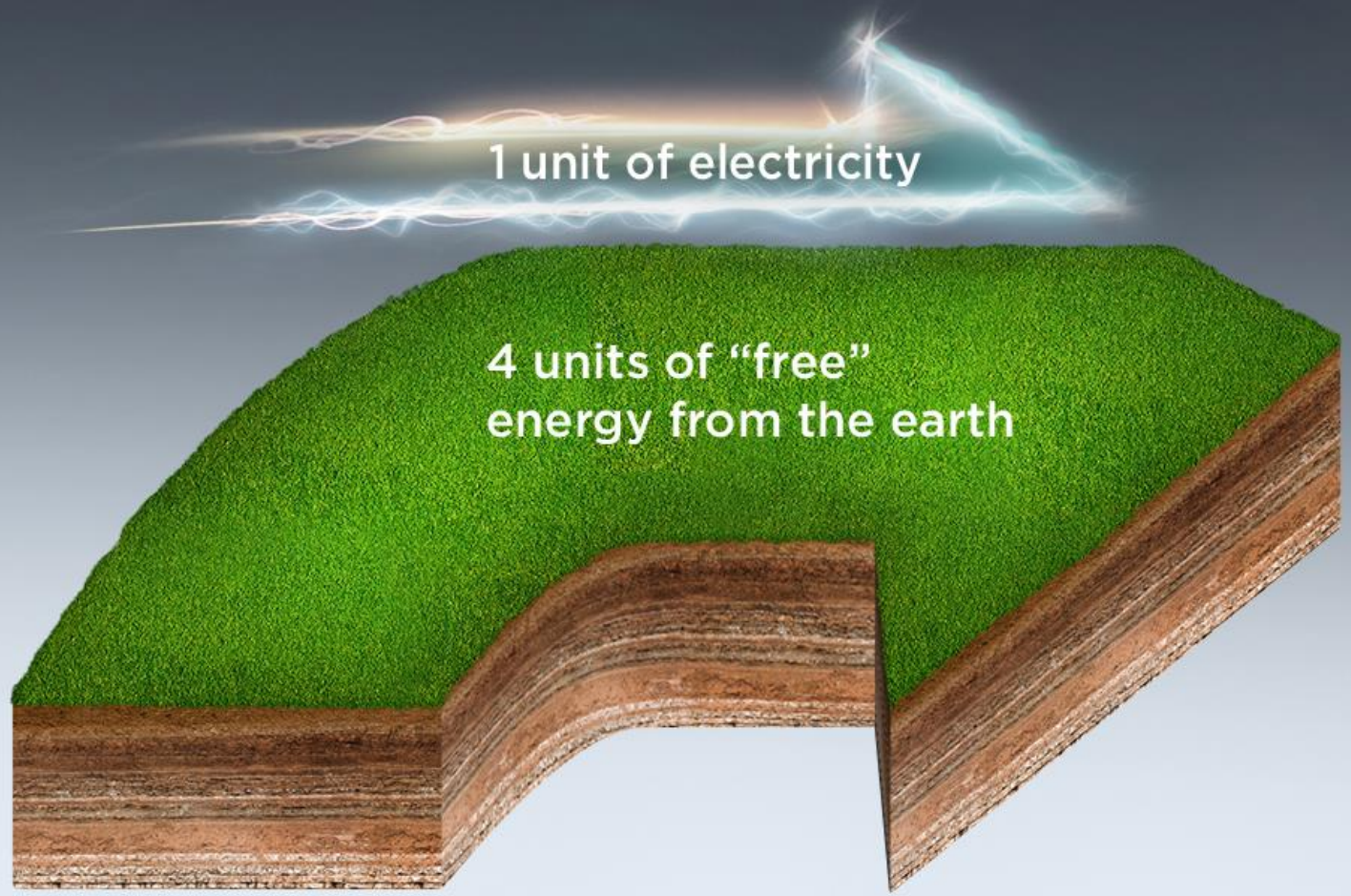
EQUIPMENT PERFORMANCE RATINGS

AHRI has designated the efficiency ratings for water-to-air/water heat pumps as:

- **Energy Efficiency Ratio (EER)**
  - EER = BTU output divided by power watt input
  - For cooling operation under steady state test conditions

- **Coefficient of Performance (COP)**
  - COP = BTU output divided by BTU input
  - For heating operation under steady state test conditions

EQUIPMENT PERFORMANCE RATINGS



5 units of heating or cooling delivered into home

EQUIPMENT PERFORMANCE RATINGS

Energy Star Rating Criteria

In order for water-source heat pumps to be Energy Star rated they must meet or exceed the minimum efficiency requirements listed below. Tier 3 represents the current minimum efficiency water source heat pumps must have in order to be Energy Start rated.

Tier 3: 1/1/2012 – No Effective End Date Published

	EER	COP
Water-to-Air		
Ground Loop	17.1	3.6
Ground Water	21.1	4.1
Water-to-Water		
Ground Loop	16.1	3.1
Ground Water	20.1	3.5

EnergyStar ratings only apply to residential equipment.

Eligible for 2022 Federal Tax Credit*

Certificate of Product Ratings

AHRI Certified Reference Number : 214796346 Date : 07-16-2024 Model Status : Active

Product : Water-to-Air and Brine-to-Air
Model Number : W5A(V/H)042BD12** **Brand Name : WaterFurnace**

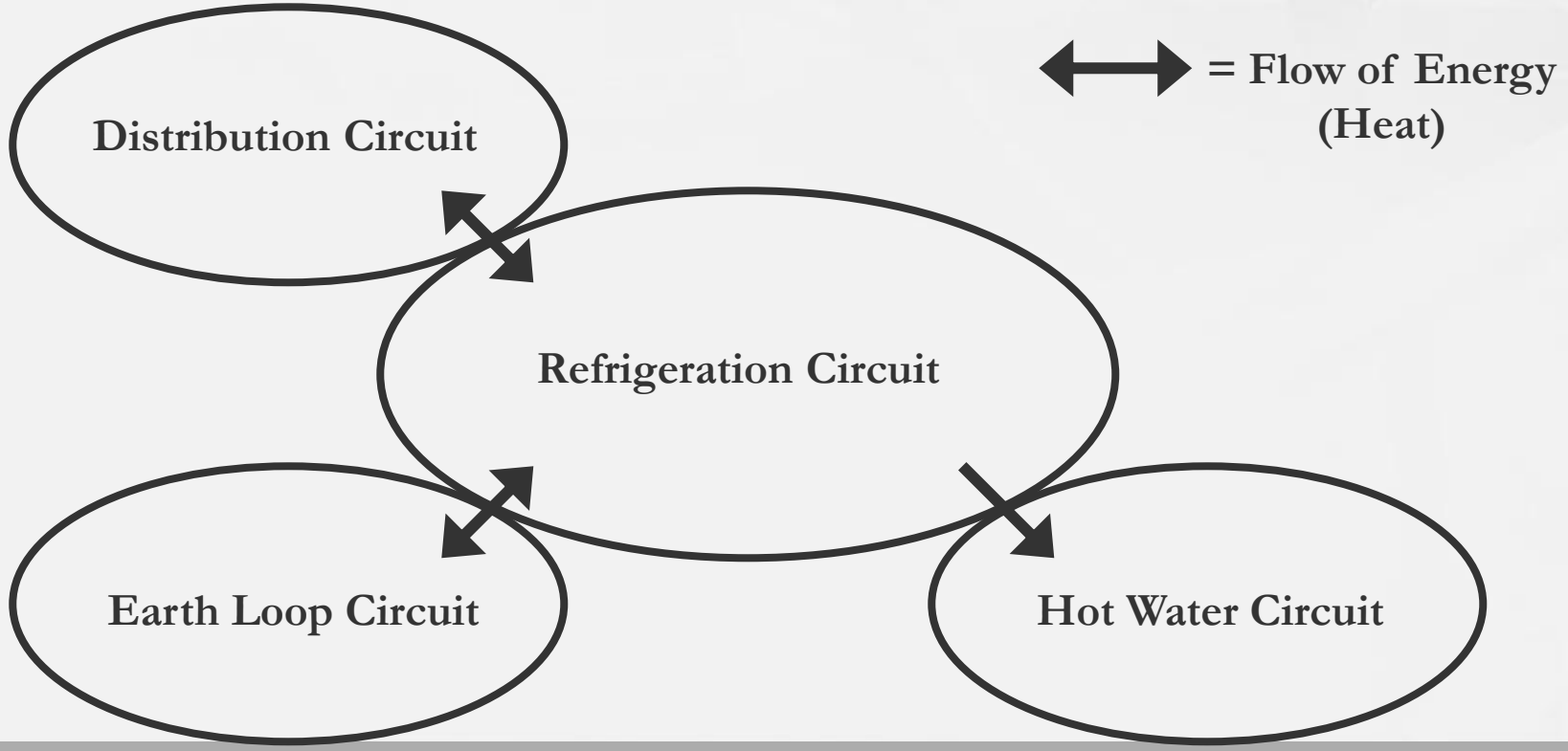
Rated as follows in accordance with ANSI/AHRI/ASHRAE/ISO Standard 13256-1: 1998 (RA 2012), Water-source heat pumps - Testing and rating for performance - Part 1: Water-to-air and brine-to-air heat pumps and subject to verification of rating accuracy by AHRI-sponsored, independent, third-party testing:

	Full Load	Part Load1	Part Load2	Part Load3
Air Flow Rate - Cooling:	1300	1200		
Air Flow Rate - Heating:		1200		
WLHP (Water-Loop Heat Pumps)				
Cooling Capacity (Btuh)	40100/40100	29300/29300		
Cooling EER Rating (Btuh/watt)	16.50/16.50	17.50/17.50		
Cooling Fluid Flow Rate (gpm)	11.00	10.00		
Heating Capacity (Btuh)	50500/50500	36500/36500		
Heating Cop (watt/watt)	5.90/5.90	6.80/6.80		
Heating Fluid Flow Rate (gpm)	11.00	10.00		
GWHP (Ground Water-Heat Pumps)				
Cooling Capacity (Btuh)	46200/46200	34400/34400		
Cooling EER Rating (Btuh/Watt)	26.60/26.60	32.70/32.70		
Cooling Fluid Flow Rate (gpm)	11.00	10.00		
Heating Capacity (Btuh)	41700/41700	29700/29700		
Heating COP (watt/watt)	5.20/5.20	5.50/5.50		
Heating Fluid Flow Rate (gpm)	11.00	10.00		
GLHP (Ground -Loop Heat Pumps)				
Cooling Capacity (Btuh)	41700/41700	33100/33100		
Cooling EER Rating (Btuh/Watt)	19.20/19.20	26.90/26.90		
Cooling Fluid Flow Rate (gpm)	11.00	10.00		
Heating Capacity (Btuh)	33700/33700	26600/26600		
Heating COP (watt/watt)	4.40/4.40	4.90/4.90		
Heating Fluid Flow Rate (gpm)	11.00	10.00		

Indoor Blower Motor Fan Type : ECM **Sold In? : USA, Canada**

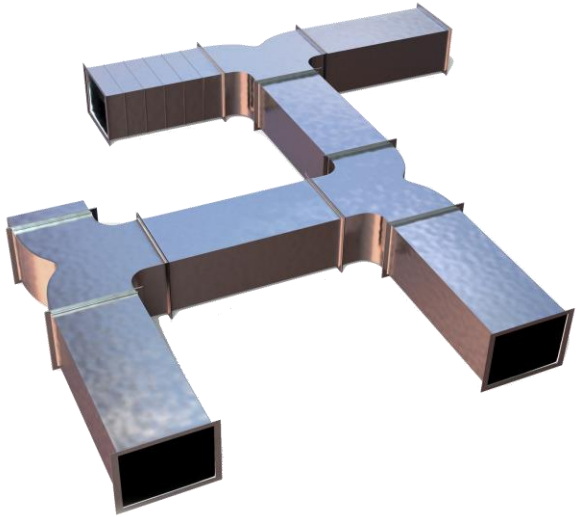
GEOTHERMAL 101

A typical geothermal heat pump system is comprised of up to four independent circuits:



DISTRIBUTION CIRCUITS

Forced Air



Low Temp Radiators

Radiant Floors

REFRIGERATION CIRCUIT

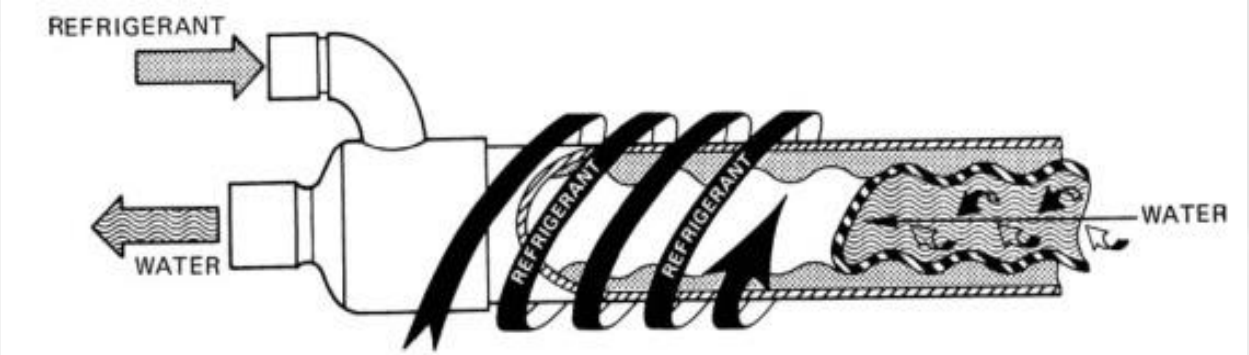
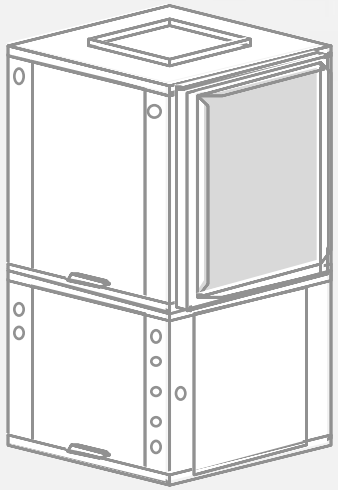
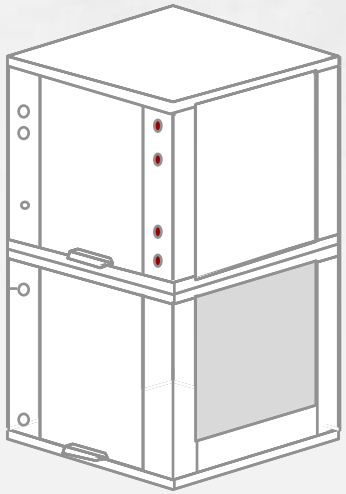


Fig. 8-6 *A typical counter-flow path inside a coaxial water-cooled condenser.* (Packless)

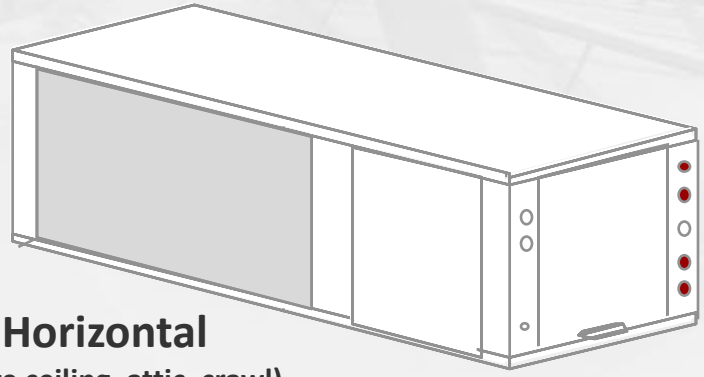
REFRIGERATION CIRCUIT



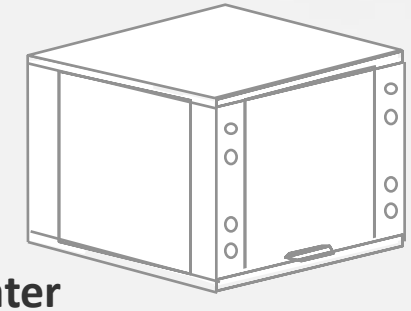
Vertical Upflow
(basement, mechanical room)



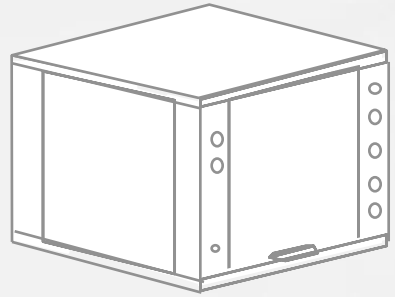
Vertical Bottomflow
(mechanical room above crawl, slab)



Horizontal
(above ceiling, attic, crawl)

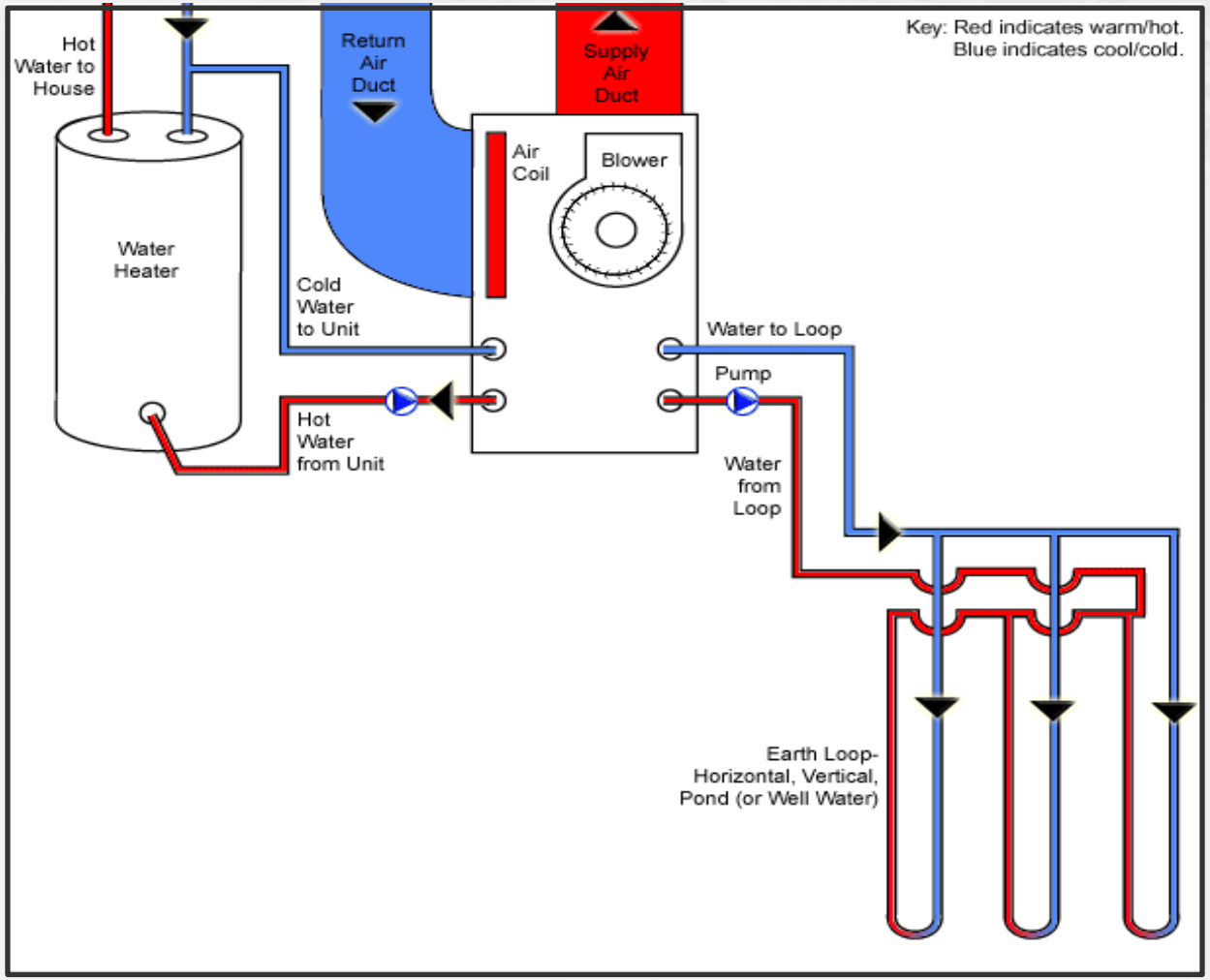


Water-to-Water
(radiant heating, fan coils, pool heating)

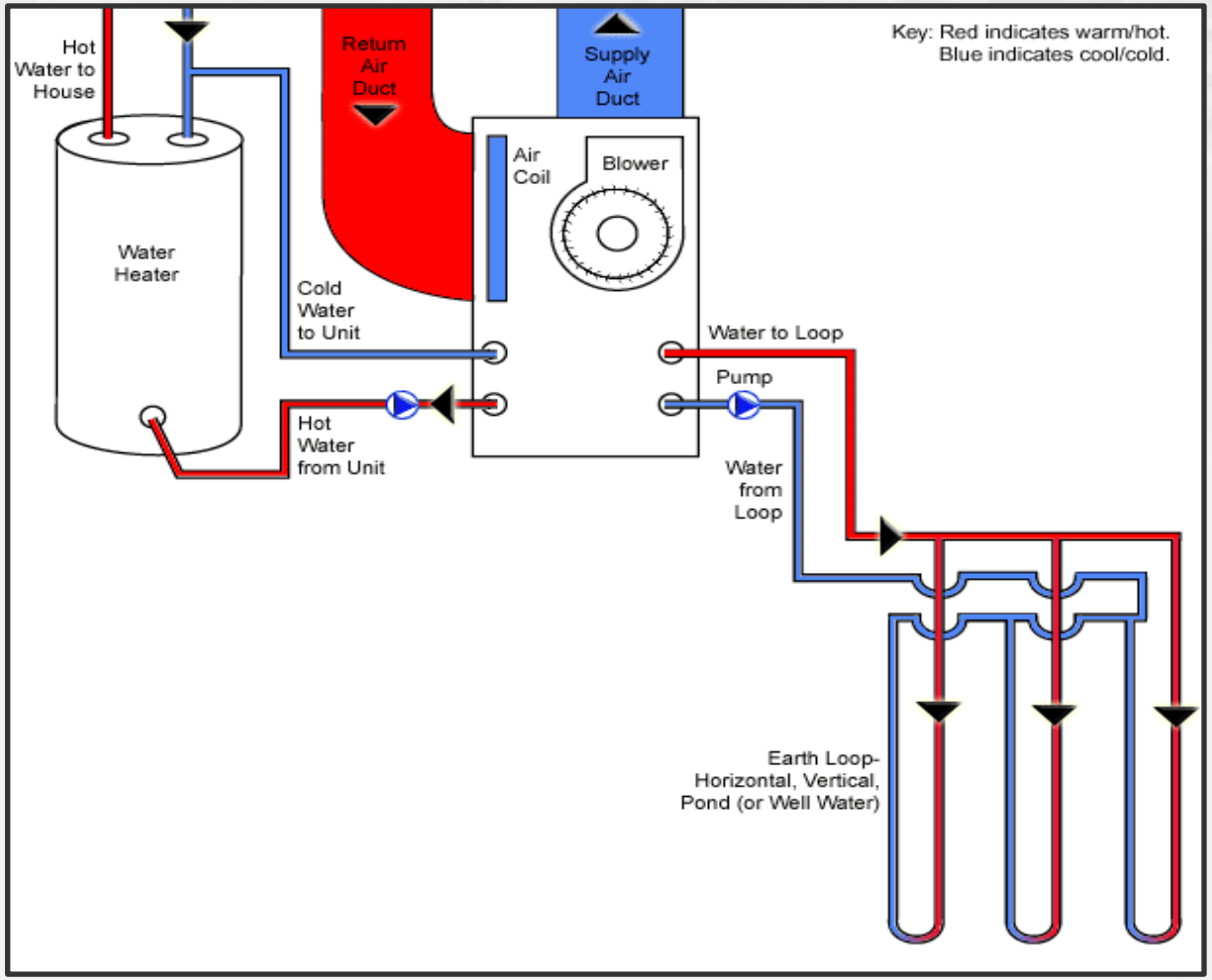


Split System
(various applications)

HEATING MODE OPERATION

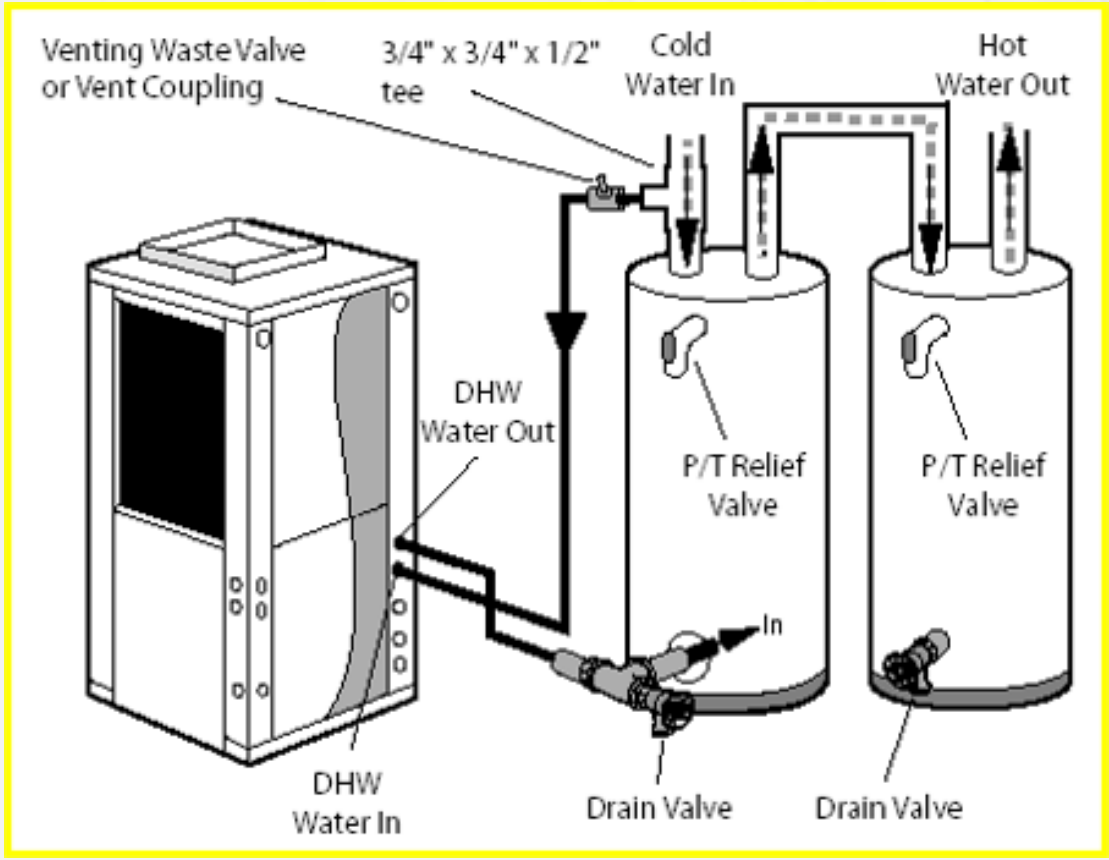


COOLING MODE OPERATION



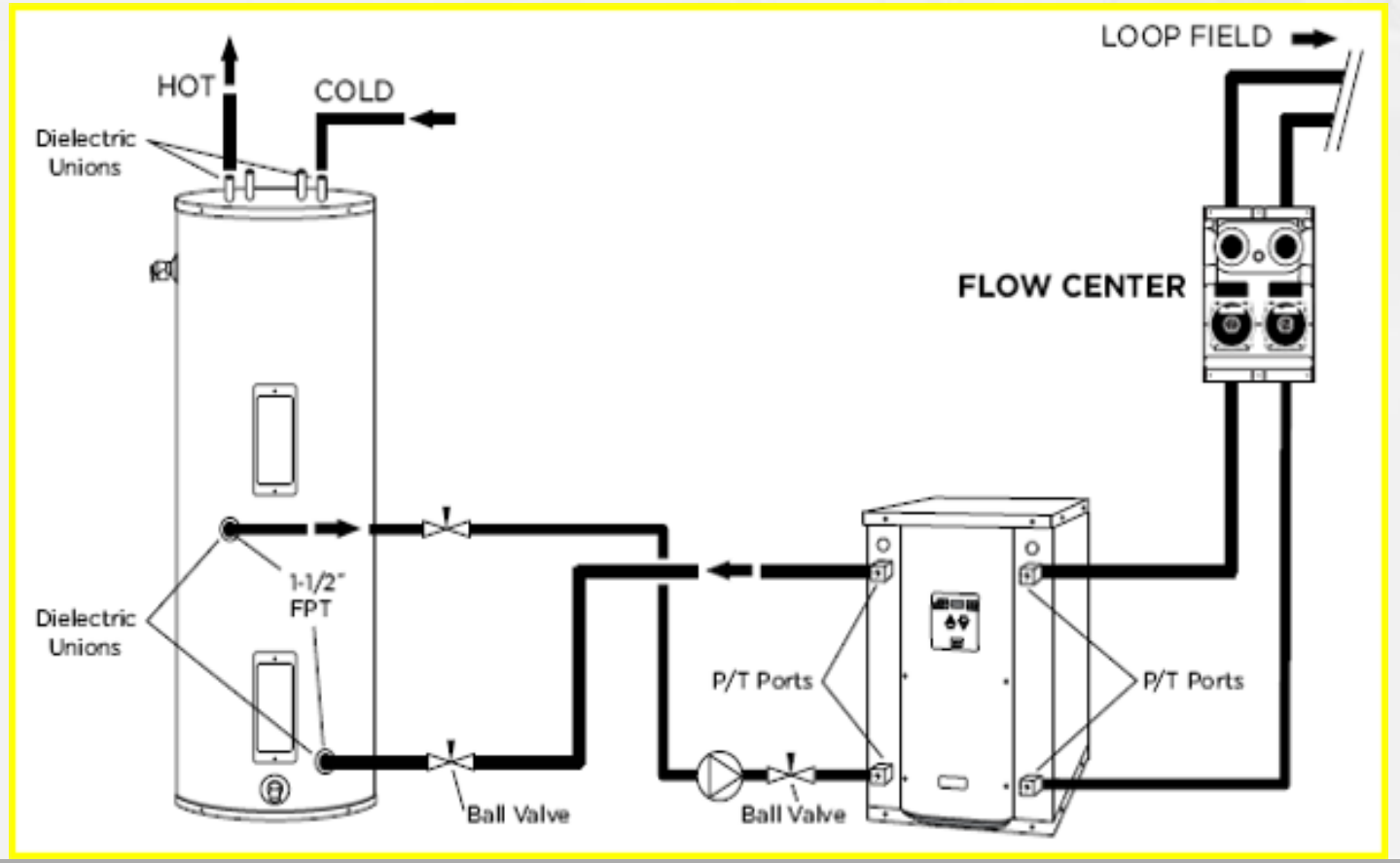
HOT WATER CIRCUIT

Desuperheater Hot Water Assist



HOT WATER CIRCUIT

100% Dedicated Hot Water



EARTH LOOP CIRCUIT

PIPING MATERIAL

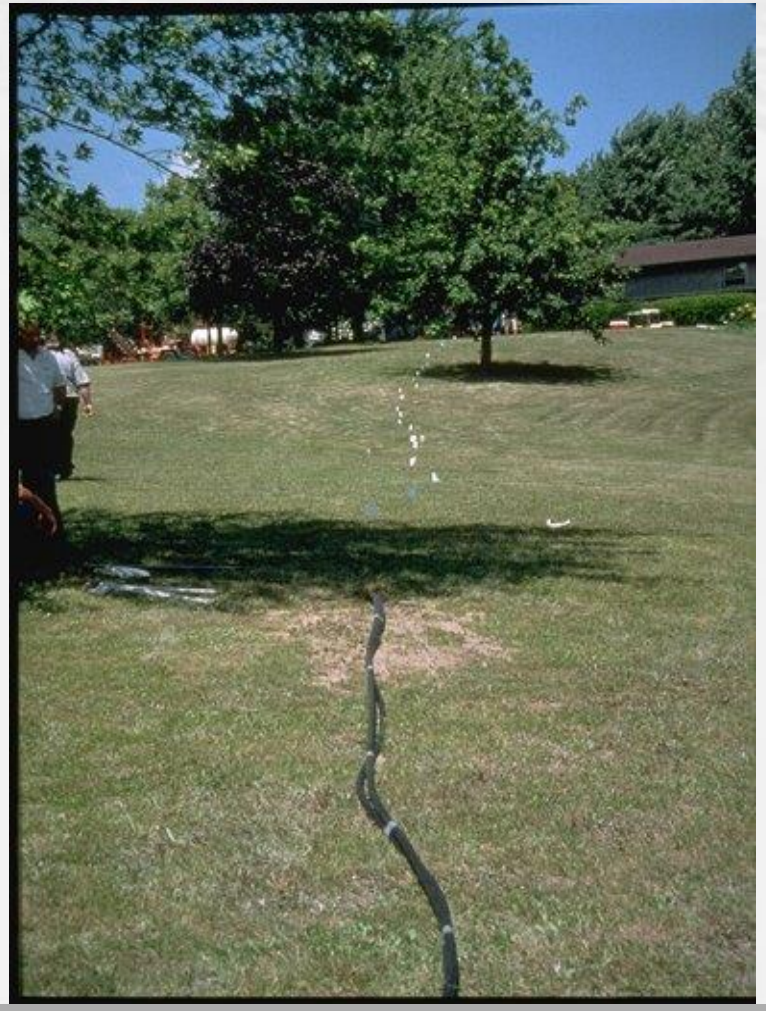
Geothermal earth loops are constructed using pipe with the following characteristics:

- Polyethylene—designated as High Density PE3408.
- SDR-11; IPS sizes ¾” diameter and larger
- All connections done using heat fusion at 500°F.
- Highest rating available for stress crack resistance.
- Carbon black provides UV protection from sun
- Elongation of 6 times original length before failure.

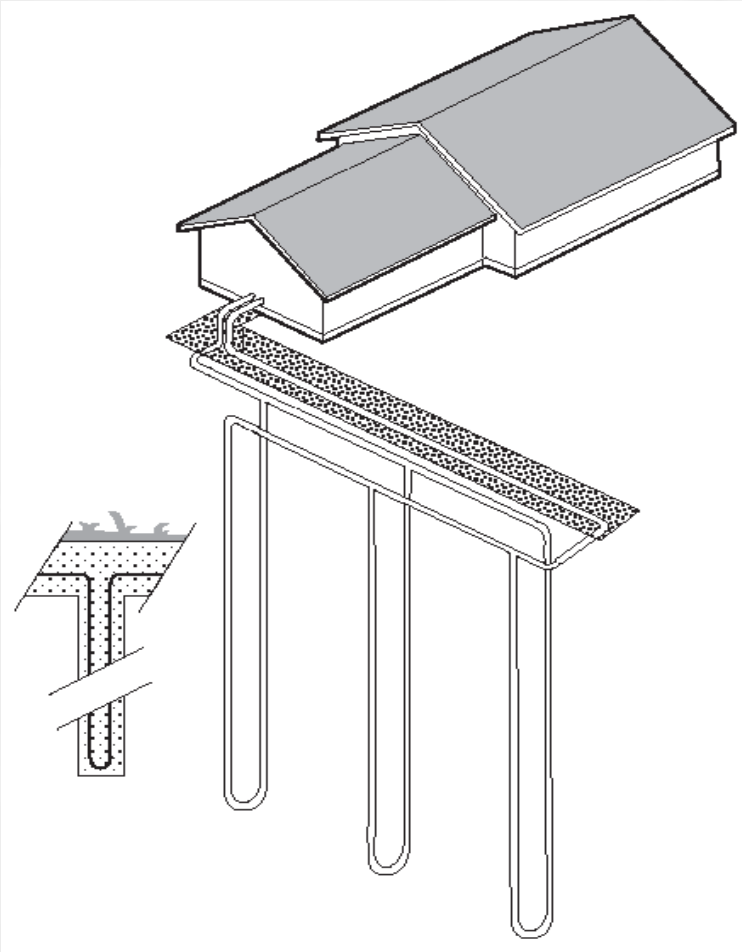
TYPICAL EARTH LOOP FEATURES

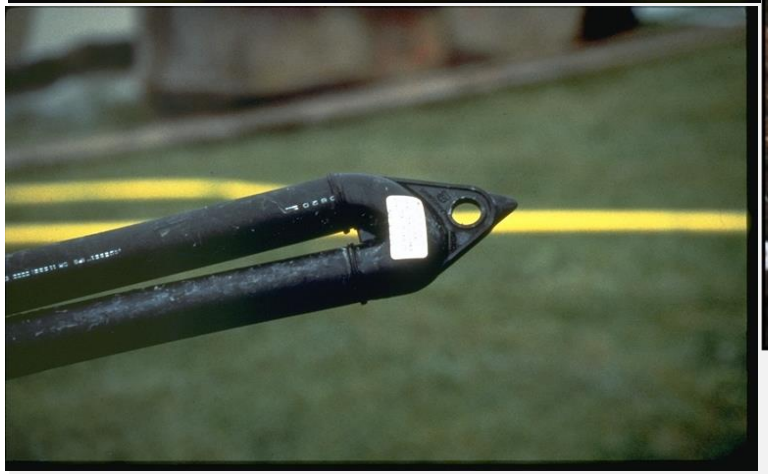
HORIZONTAL SLINKY LOOP

HORIZONTAL BORE LOOPS

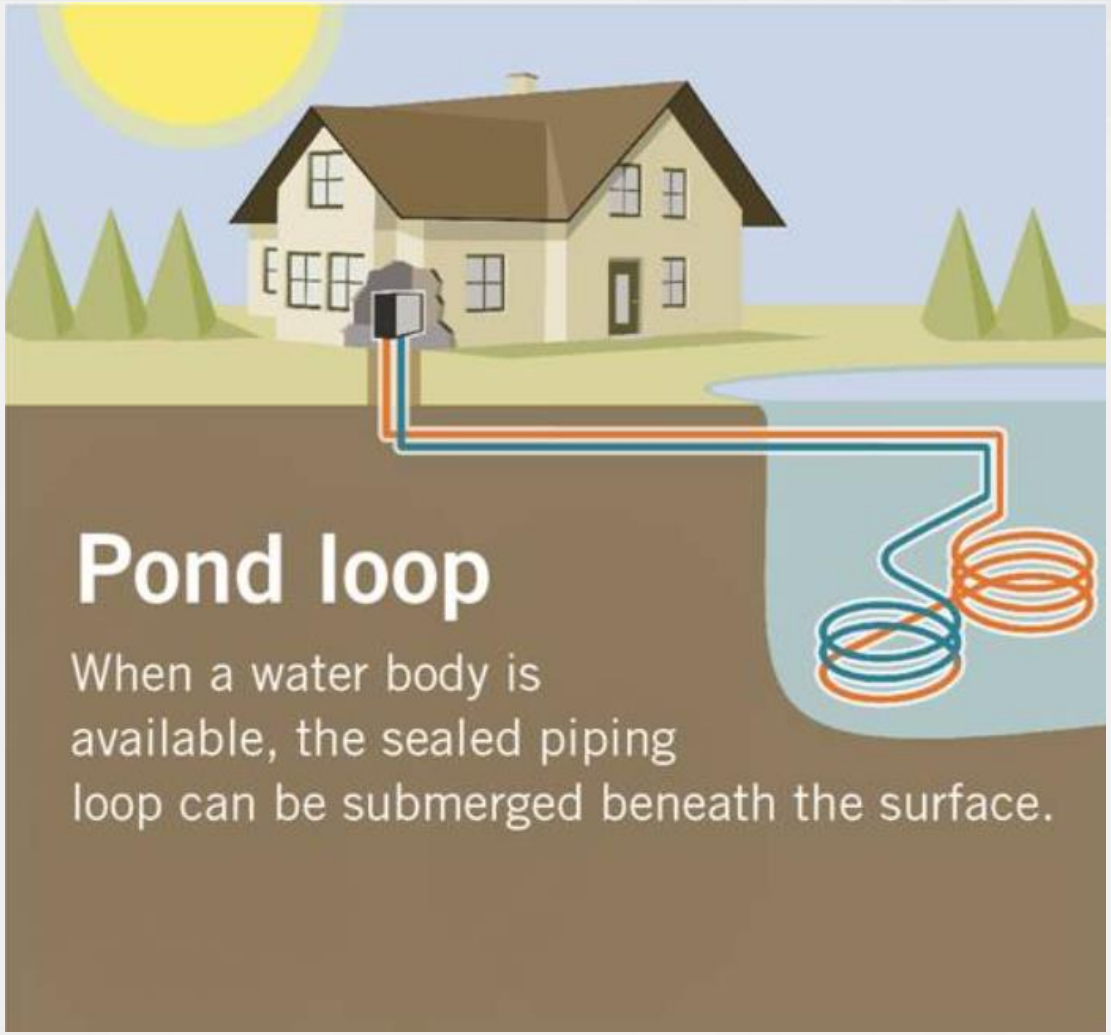


VERTICAL LOOPS

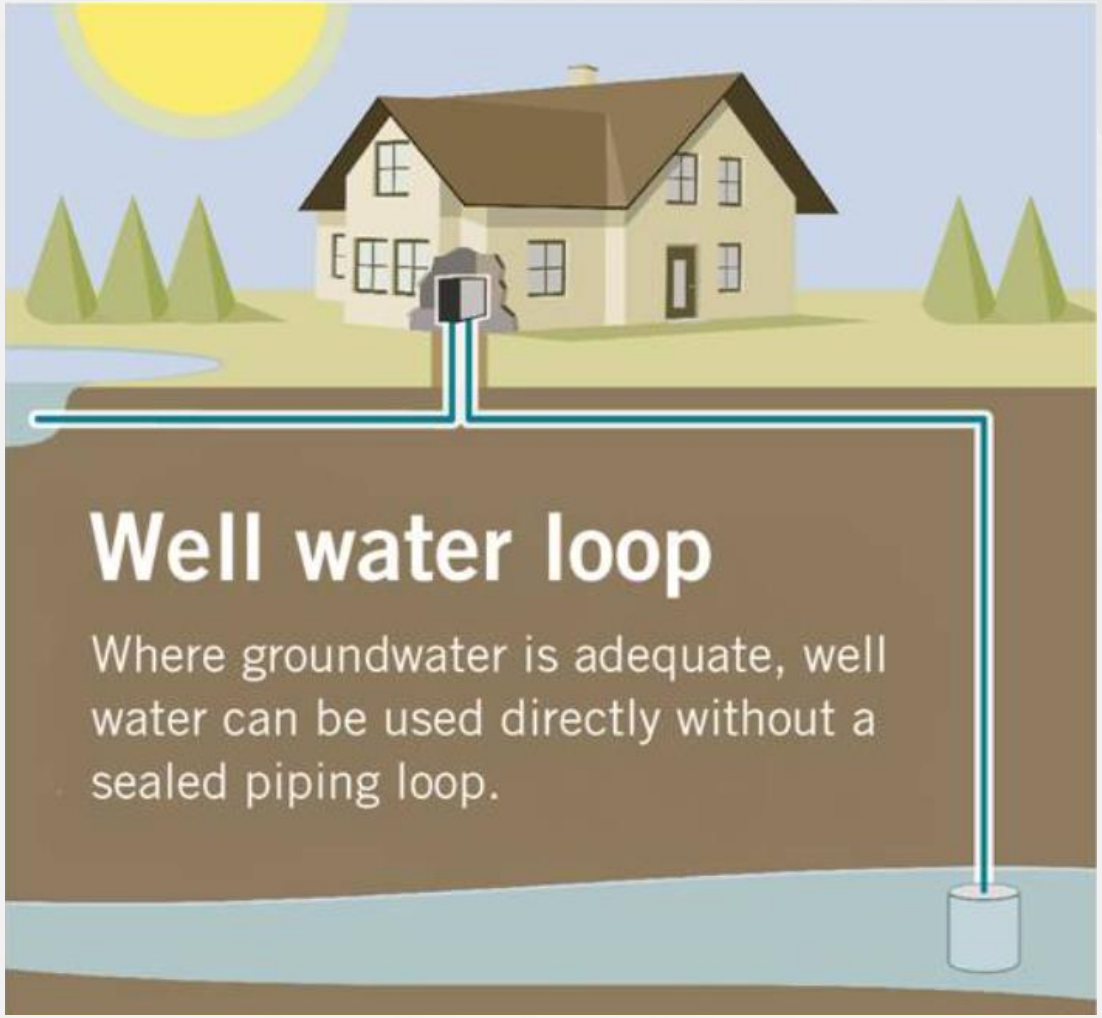




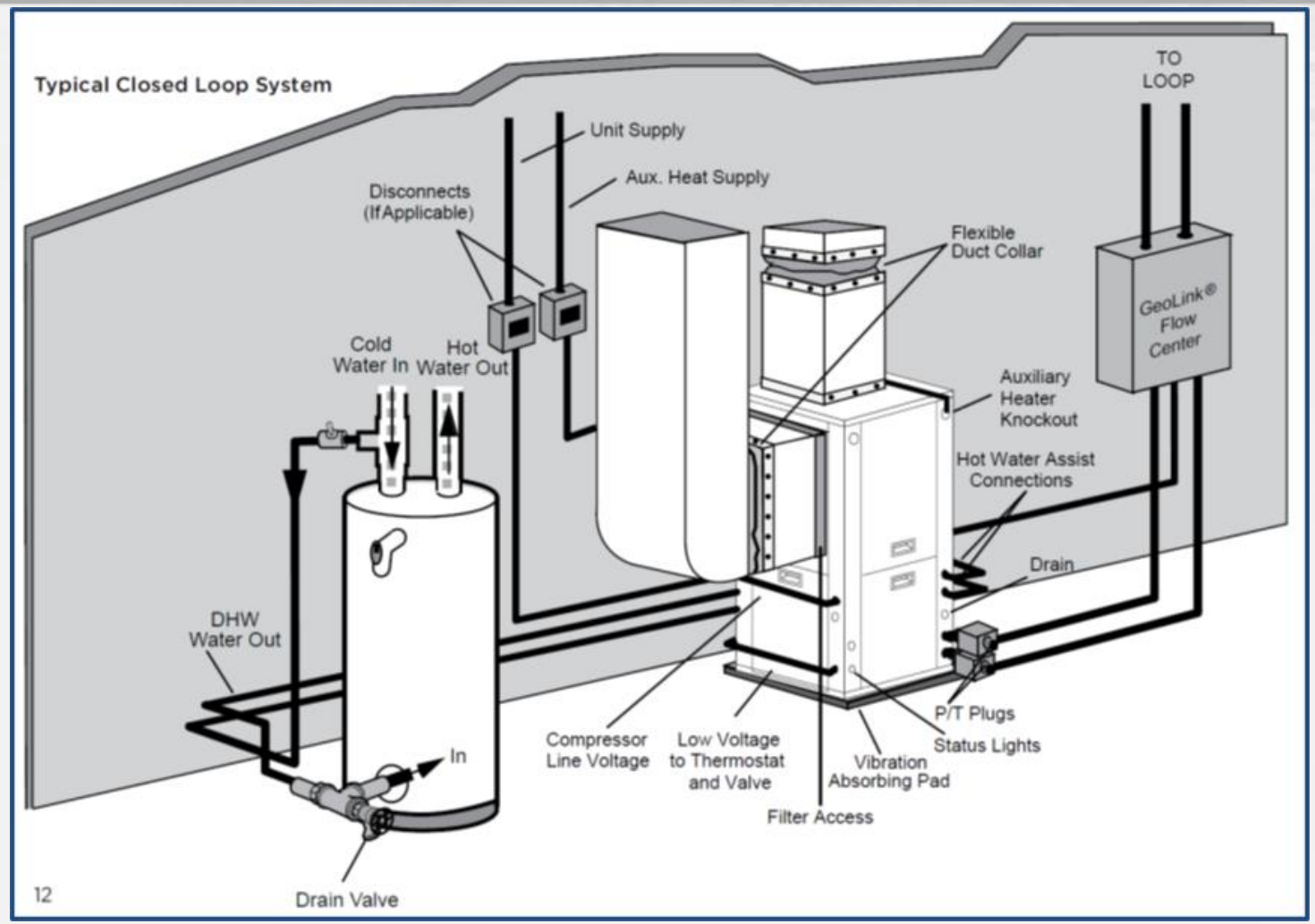
POND LOOPS


Pond loop
When a water body is available, the sealed piping loop can be submerged beneath the surface.

OPEN LOOPS


Well water loop
Where groundwater is adequate, well water can be used directly without a sealed piping loop.

TYPICAL CLOSED LOOP SYSTEMS



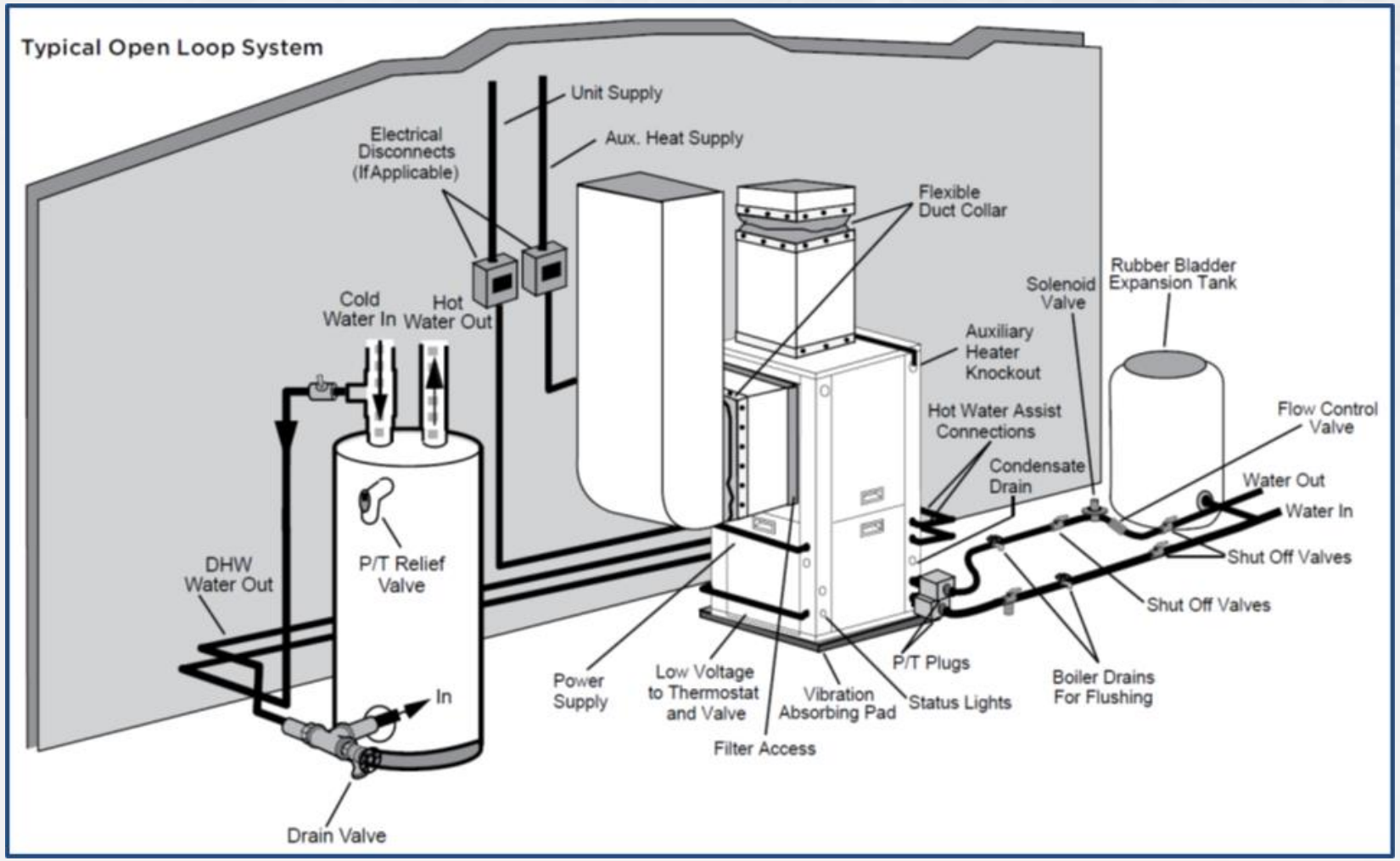
CLOSED LOOP FREEZE PROTECTION

In climates with moderate to dominant heating loads, anti-freeze is used for freeze protection.

Various types and concentrations of antifreezes are used.

- Environol
- Methanol
- Propylene glycol

TYPICAL OPEN LOOP SYSTEMS



OTHER APPLICATIONS

- Commercial applications (offices, retail, hotels, apartments/condos, resorts)
- Institutional applications (schools, hospitals, nursing homes)
- Industrial applications (process water heating & cooling, manufacturing plants)
- Pools and spas
- Snow melt / ice melt
- Radiant floor heating

WHO'S INVOLVED IN GEOTHERMAL?

Contractors

Engineers

Heat Pump Manufacturers

Plastic pipe Manufacturers

Fusion Equipment Manufacturers

Trenching & Drilling Manufacturers

GEO Consortium and IGSHPA

Electric Utilities

KEY BENEFITS OF GEOTHERMAL SYSTEMS

- Energy savings for heating, cooling and DHW
- Quiet operation
- No outdoor condensing unit required
- Less maintenance
- Long life
- Safe and clean-- No flames, fumes, flues
- Environmentally Friendly
- Decreases peak demands for electricity
- US made products

THANK YOU!!

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