Cost-Effective Code Compliance

Water Heating

Seattle City Light

Lighting Design Lab

February 9, 2021

Before we Begin…

During the Webinar

- Attendees will be muted
- Please use the chat feature in the control panel to submit questions to LDL staff
- The presenter will pause to address questions periodically.
- Please participate in the online polls.

Following the Webinar

- Please take the short survey
- A recording and the slide deck will be posted on LDL's webpage
- Reach out to LightingDesignLab@seattle.gov with comments or questions.

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2018 Construction Code Changes

- Building code
- Residential code
- Mechanical code
- **Energy code**
- Fuel gas code
- Plumbing code
- Fire code
- Electrical code
- Boiler code

2018 Seattle Energy Code

for “Commercial Buildings” – *not* single-family or low-rise multifamily

“2018” Code Timeline

- Nov 2017: IECC published
- Nov 2019: WSEC approved
- ~~July 2020: WSEC goes into effect~~
- **Feb 1, 2021: WSEC effective date**
- Jan – Sept: Seattle public meetings
- Sept – Oct: Review by CCAB
- Dec – Mayoral approval
- Jan – City Council approval
- **March 15, 2021: SEC effective date**

It's not *whether* we're going to do this, it's *how*

Washington state:
70% less building energy use by 2030

- Zero-carbon buildings
- …or by 2027?

Washington state:
45% reduction in GHG emissions by 2030

- 95% reduction by 2050

Seattle: Carbon-neutral buildings & vehicles by 2050

- …or sooner with Green New Deal?

Seattle amendments: 4 Guiding Principles

1. Envelopes meet our “2050” standard
   - We have to decide what that 2050 standard is
2. No “internal combustion buildings”
   - Electrical infrastructure for exceptions
3. Efficient use of electricity
   - Typically heat pumps for space heating & water heating
   - Highly efficient systems & controls
4. Increased on-site renewables
   - Options for off-site purchase
   - Plus “solar readiness” for bigger future system

Today:
Water
Heating

New buildings must be *capable of* meeting Seattle’s 2050 targets
(without major surgery)

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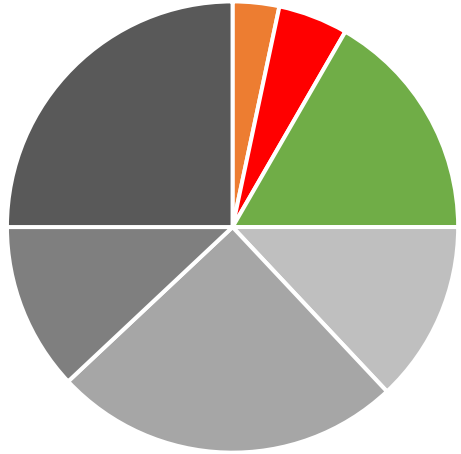
Baseline MF Building

- **DHW Temp. Maintenance**
- **DHW Primary Heating**
- Energy Savings
- Common HVAC
- Common Plugs/Lights
- Apartment HVAC
- Apartment Plugs/Lights

MF Building w/ HPWH



- **DHW Temp. Maintenance**
- **DHW Primary Heating**
- Energy Savings
- Common HVAC
- Common Plugs/Lights
- Apartment HVAC
- Apartment Plugs/Lights

Water heating equipment efficiency Table C404.2

- The performance equations look somewhat bizarre, but you can really **ignore** this whole table, because it's just parroting the minimum federal standards
- **80% *Et* (Q/800 +110√*V*SL), Btu/h**

Really big boilers (>1,000,000 btu/h)

R-1 & R-2	All other	Options
X	X	25% of hot water by renewable or site-recovered energy
X		Heat pump or electric resistance 5% better than fed standard
X	X	Or, COP at least 2.0 if not listed in fed standard
X	X	Fossil fuel: E_t at least 90%
X	X	Water heating from district heat
	X	Alteration, equipment at grade level, building 4+ stories
	X	Redundant equipment

Seattle: N/A for R-1 & R-2 (& maybe everything else) starting Jan 1, 2022

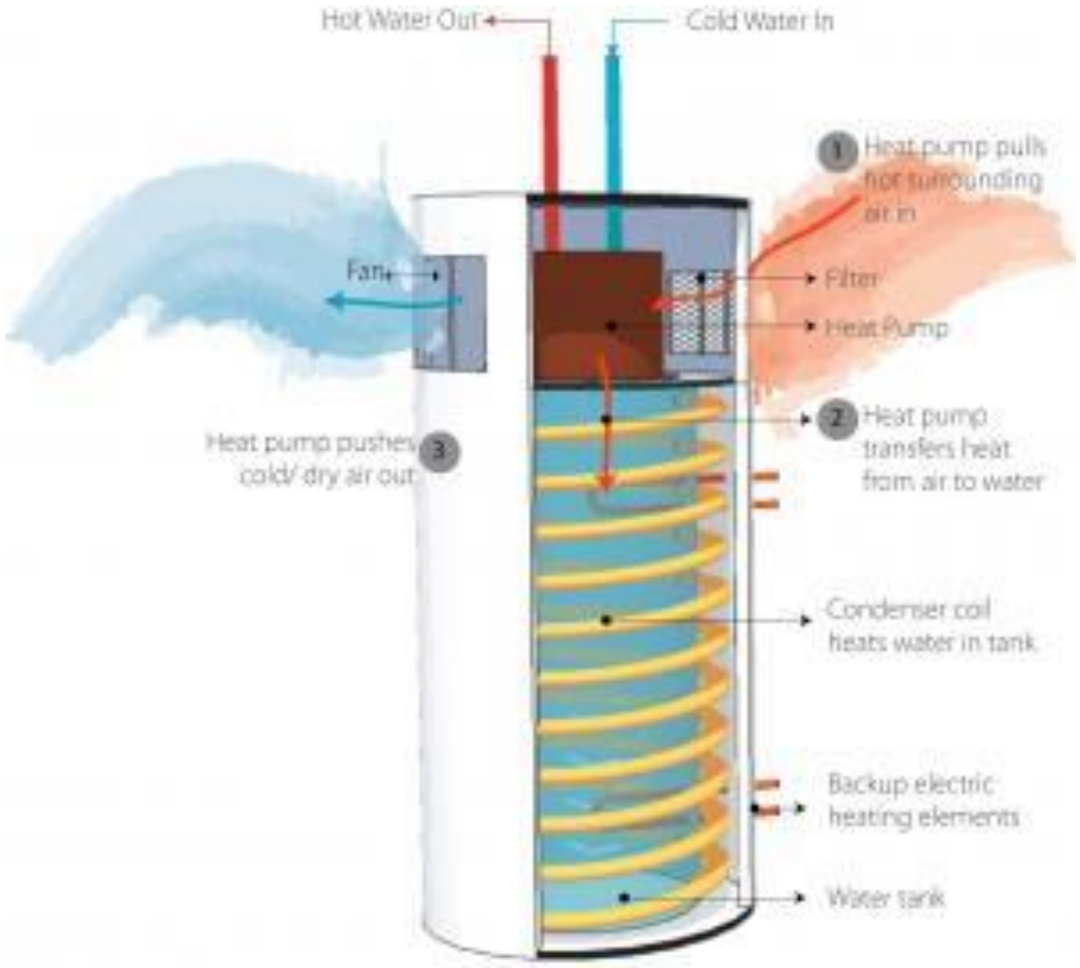
Seattle: Hotel/Multifamily Heat Pump Water Heating

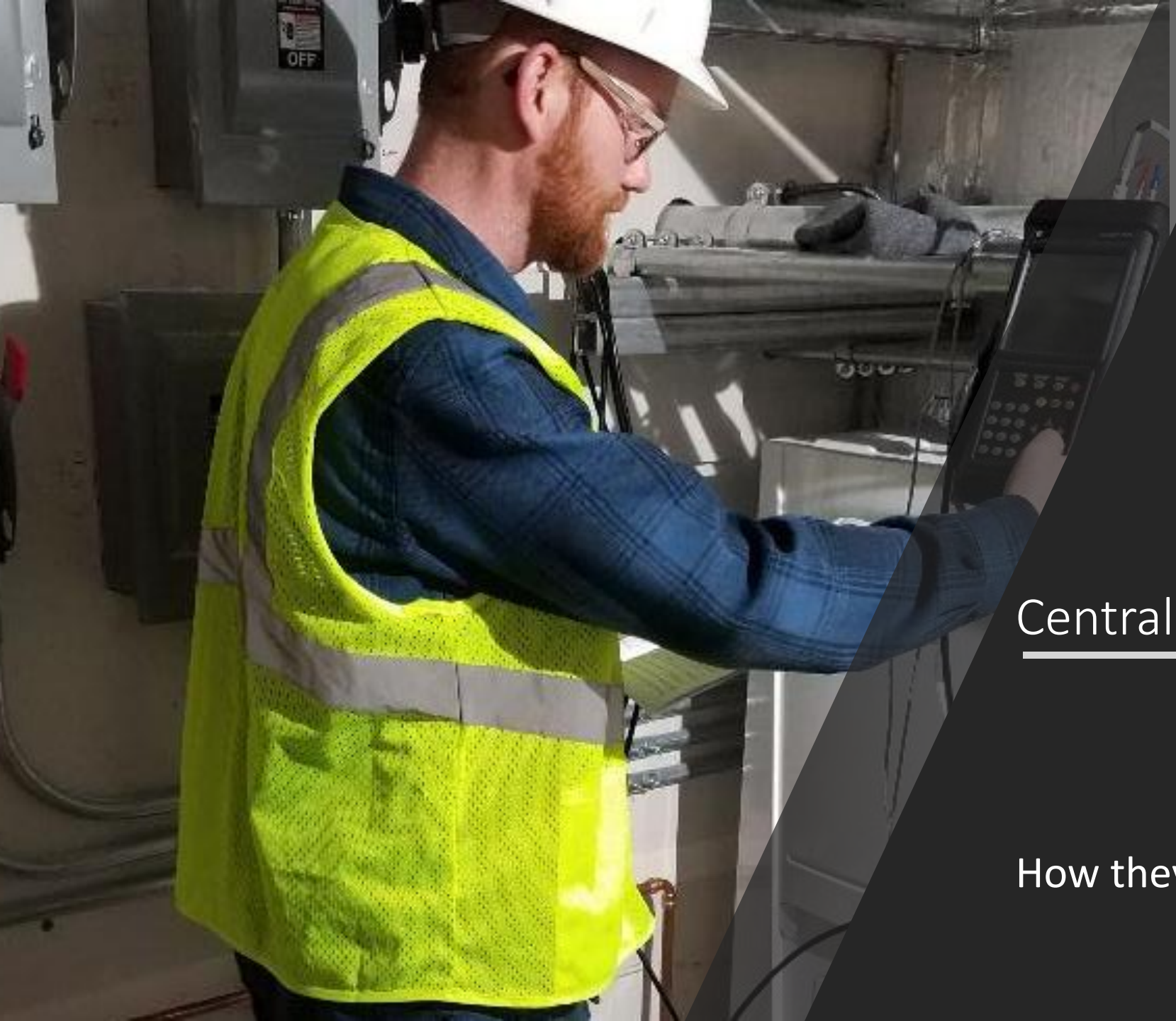
Effective <u>January 1, 2022</u>

Only for hotel & multifamily buildings with central domestic water heating:

(Or maybe *all* commercial buildings?)

- No electric resistance or fossil fuel water heating equipment permitted.
- Air-source heat pump required
- Options: Solar thermal, recovered heat, ground-source heat pump
- "NEEA Advanced Heat Pump Water Heating Spec for Central Service"



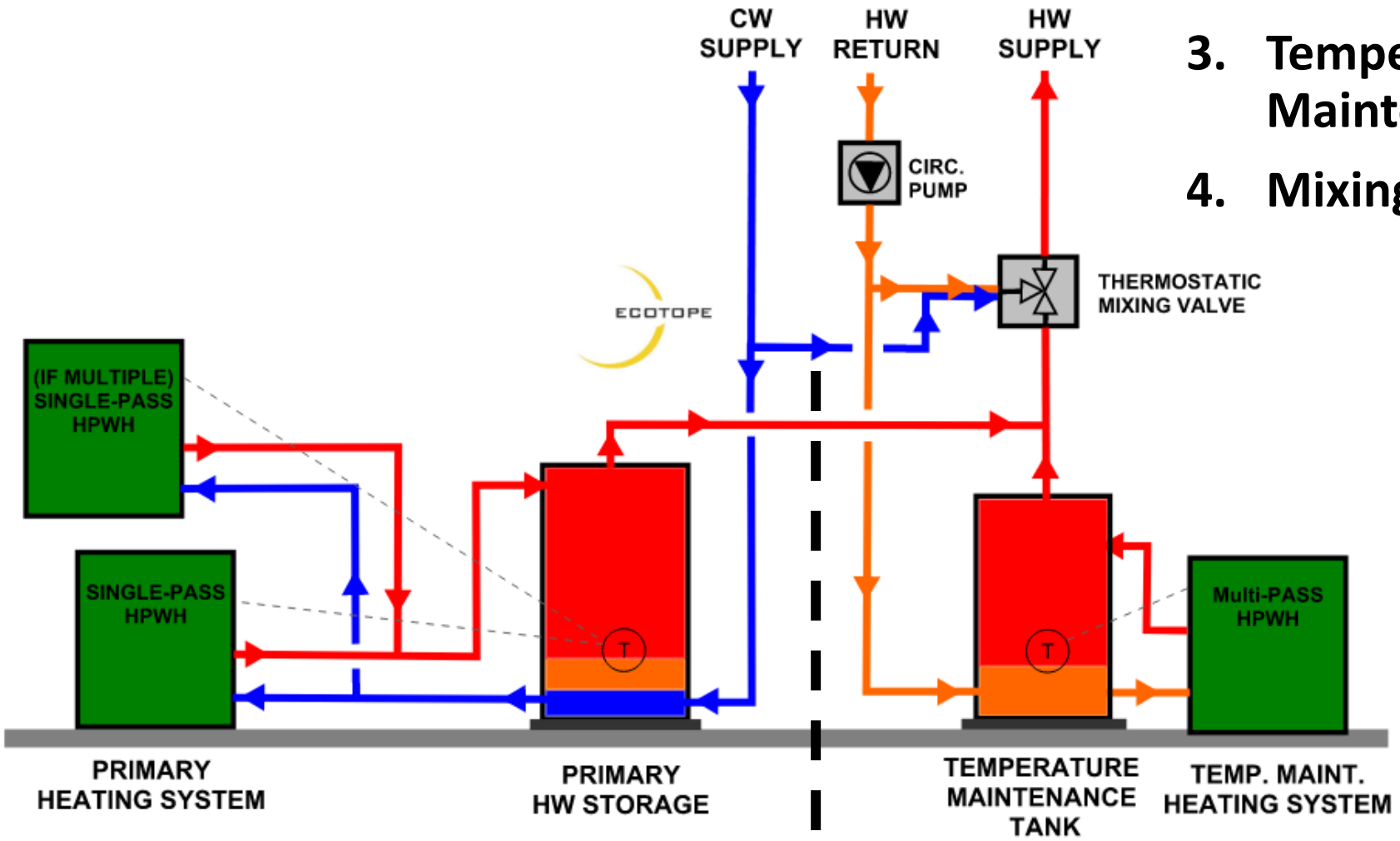


Central HPWH System Components

How they work and interact

Four HPWH System Components

1. **Heat pump**
2. **Primary storage tank**
3. **Temperature Maintenance System**
4. **Mixing valve**

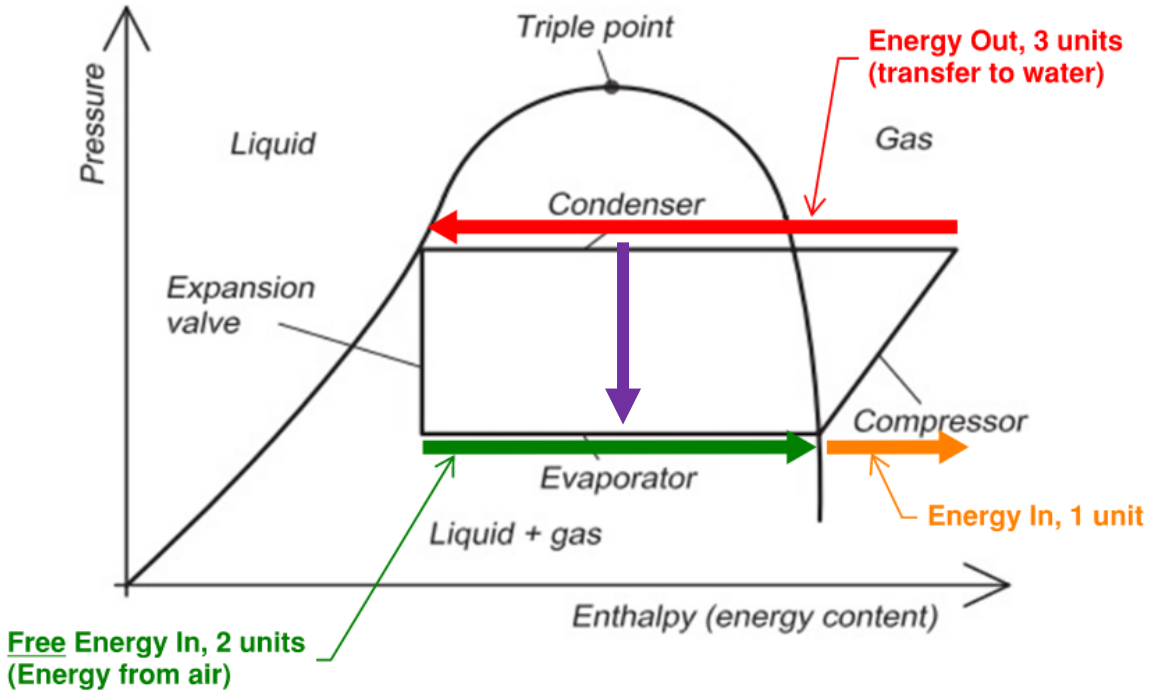


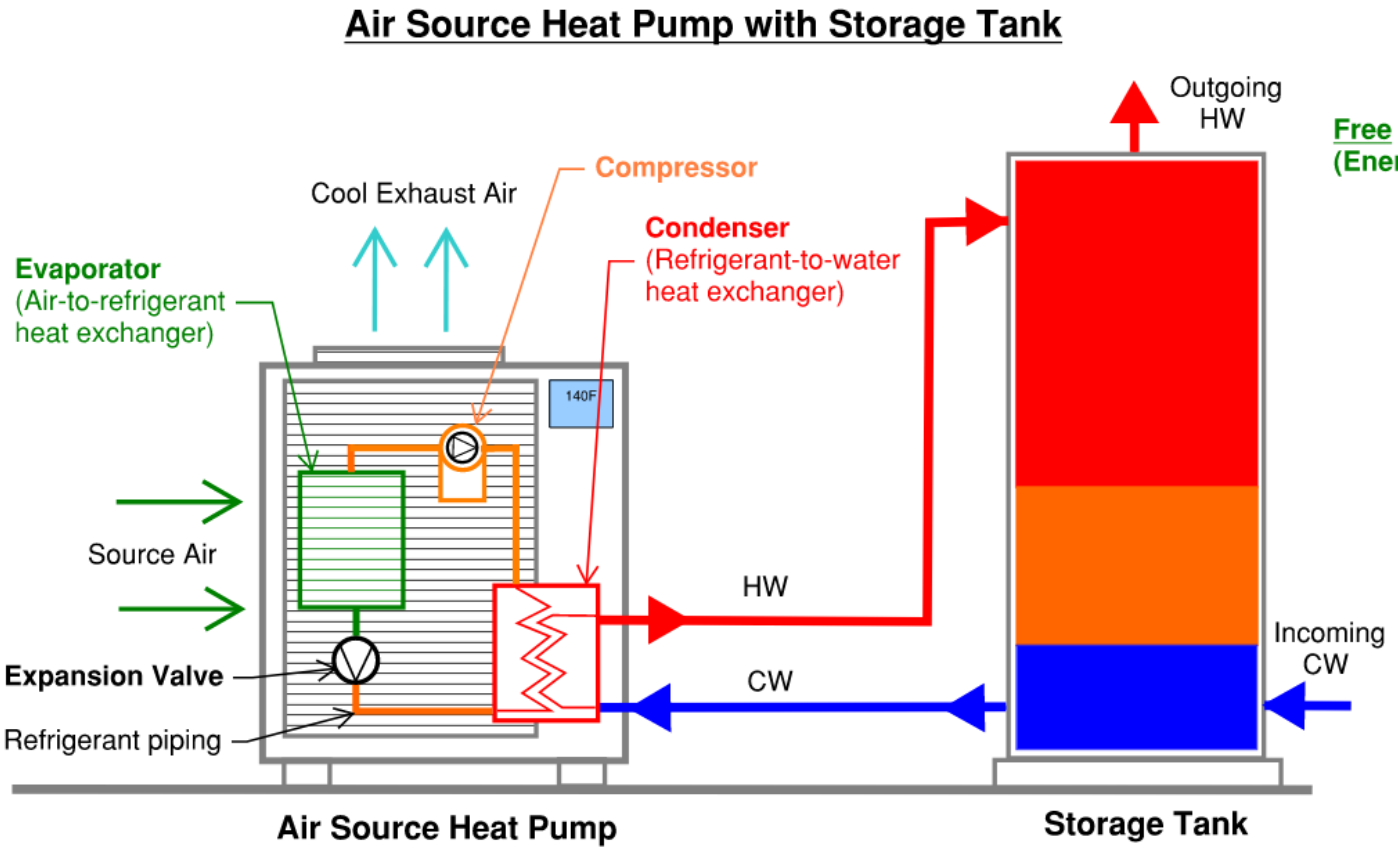
1. Heat Pump Water Heater

The engine

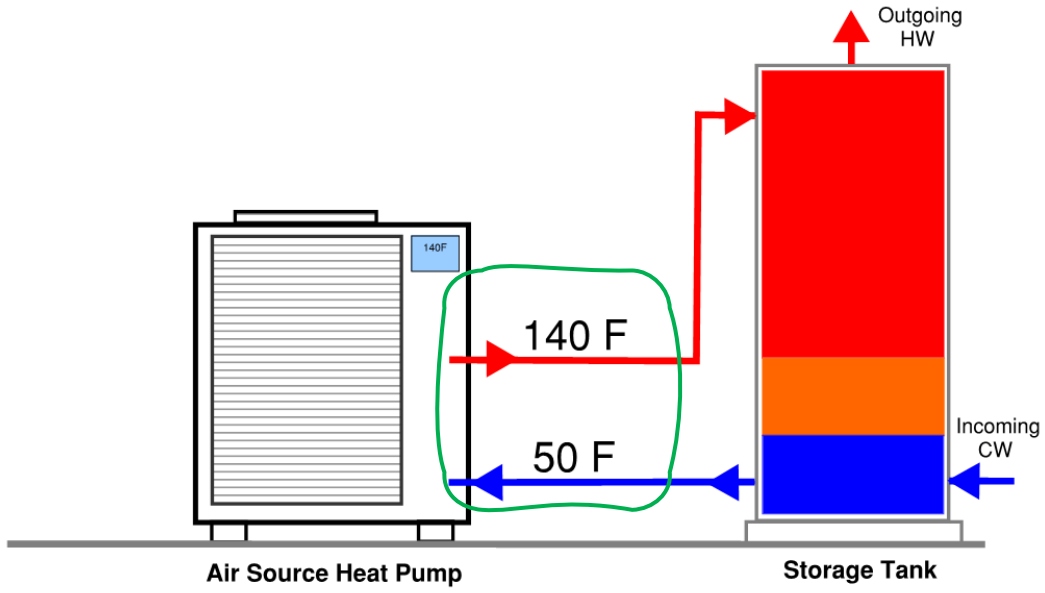
Not a boiler

How Heat Pumps Work



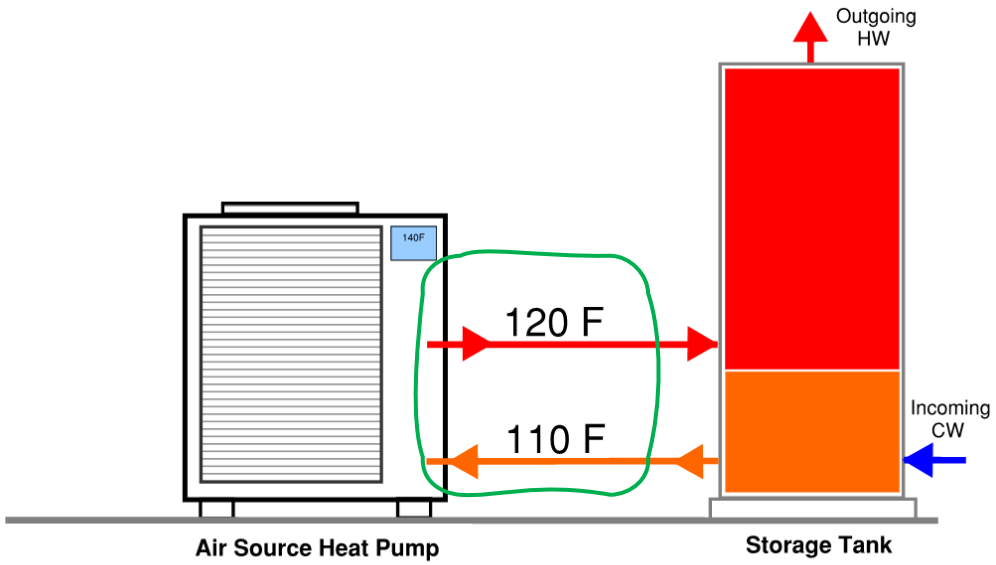


Two types of heating cycles



Single-Pass

Heats water to working temp in single pass

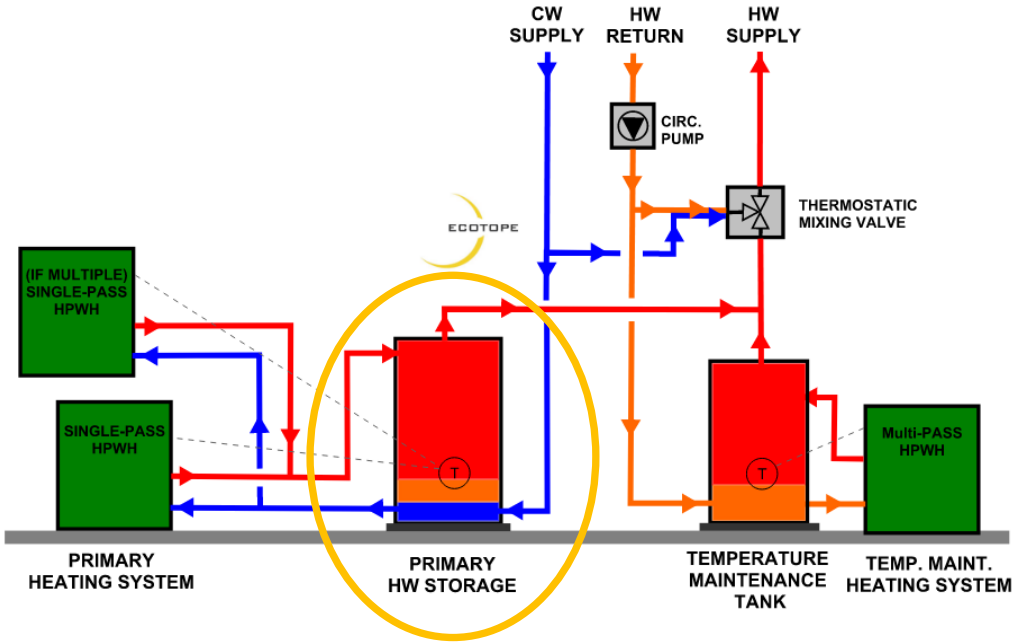


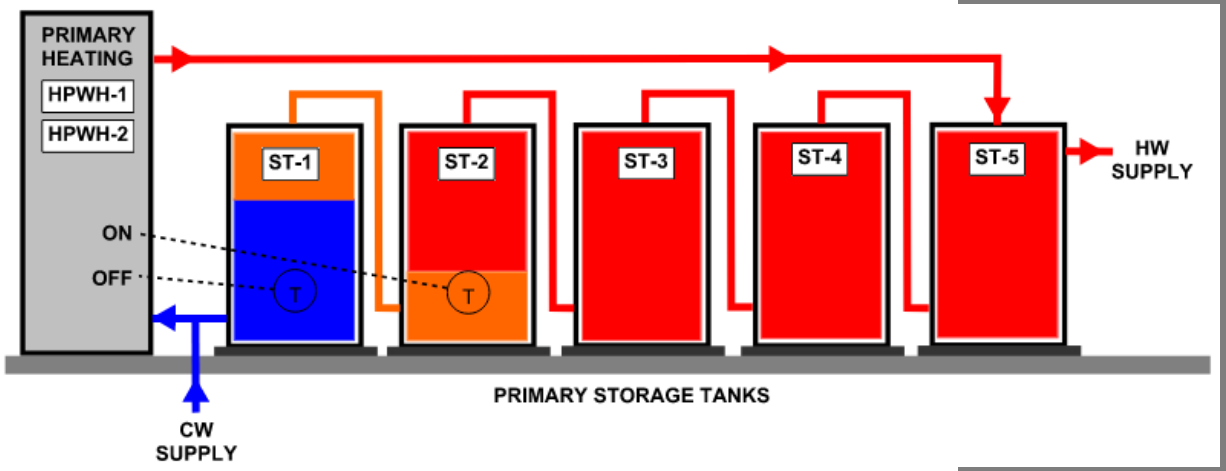
Multi-Pass

Heats water to working temp in multiple passes

2. Primary Storage Tank(s)

The battery bank



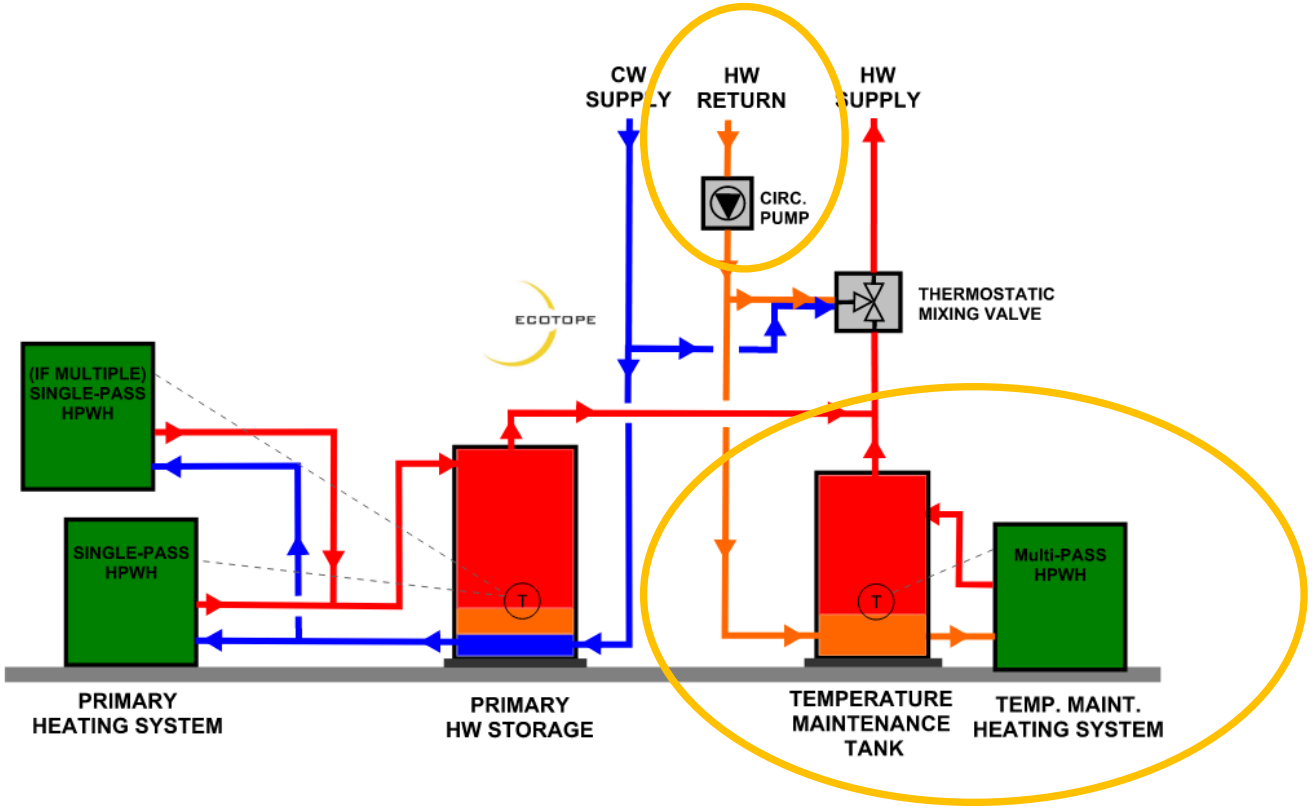


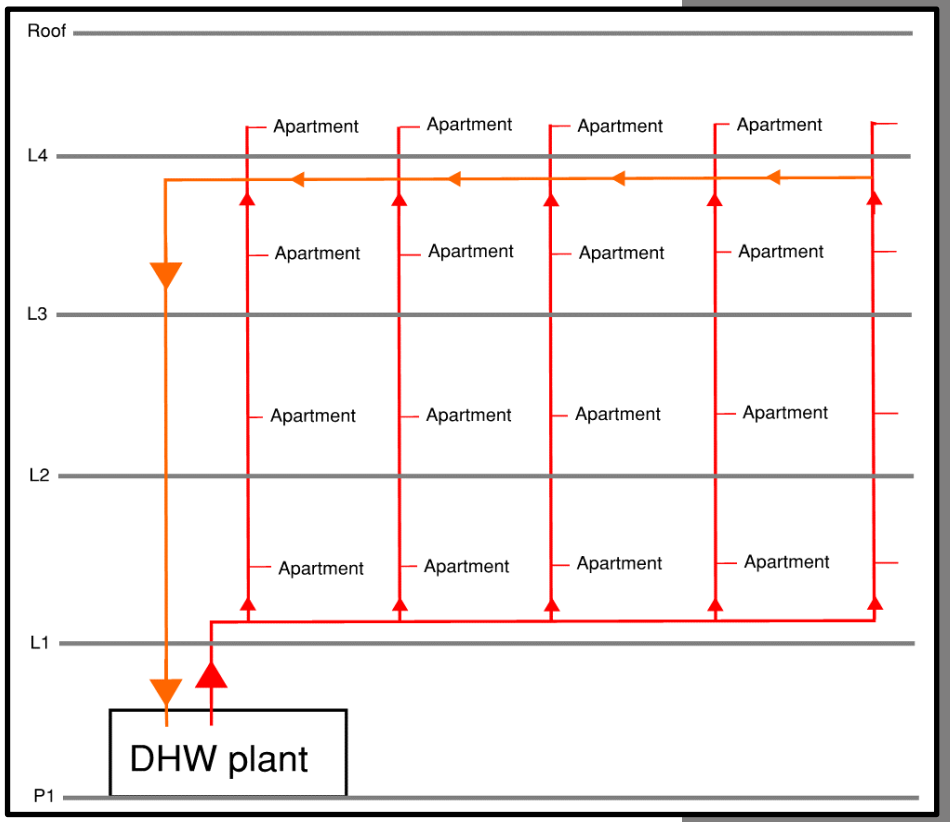
Tank insulation

C404.6.1 Storage tank insulation. Unfired storage tanks used to store service hot water at temperatures above 130°F shall be wrapped with an insulating product, installed in accordance with the insulation manufacturer's instructions and providing a **minimum of R-2 additional insulation for every 10°F increase in stored water temperature above 130°F**. Such additional insulation is also permitted to be integral to the tank. The insulation is permitted to be discontinuous at structural supports.

3. Temperature Maintenance System

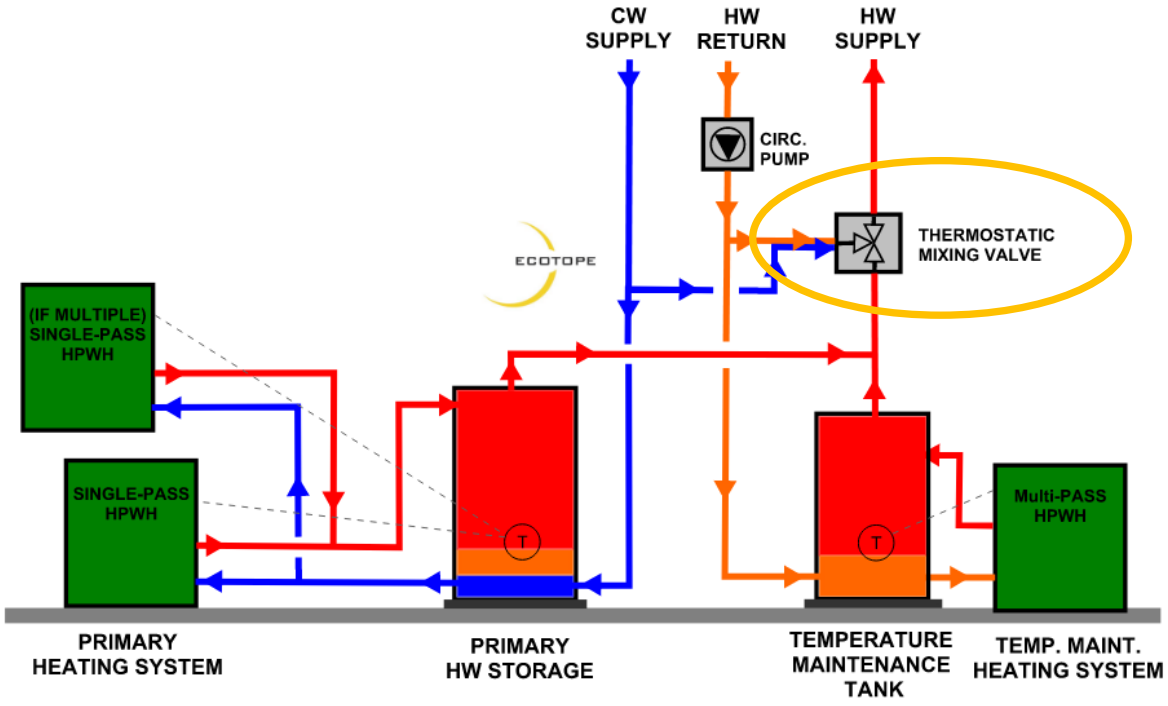
Keeping the water in the distribution system hot





4. Thermostatic Mixing Valve

HW delivery temperature control



Circulation controls

C404.7.1.1 Single riser systems. (One hot water riser or zone)

1. Pump turns off when water in loop hits supply temp, turns back on at 10°F below supply temp or
2. Automatic time switch turns off pump during unoccupied hours and
3. Manual switch to turn off the pump during extended periods when hot water is not required.

C404.7.1.2 Multiple riser systems. (Multiple hot water risers or zones)

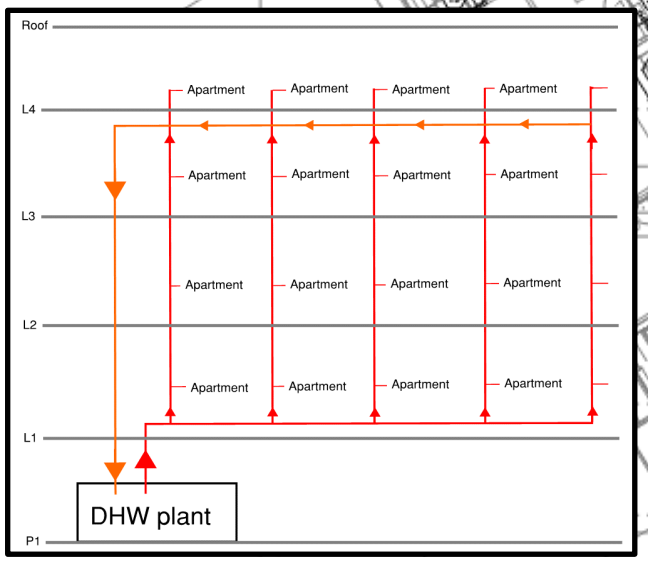
1. Pump turns off during extended periods when hot water is not required.
2. Means for balancing the flow rate through each supply riser or piping zone
3. (Seattle) Self-actuating thermostatic balancing valve for systems with multiple risers and variable flow pump

Mixing valve (Seattle)

C404.7.1.3 Electronic thermostatic mixing valve (TMV). Where a heated water circulation system utilizes an electronic TMV to control the temperature of hot water supplied to the building, the TMV shall be configured so that it either **reverts closed (fully COLD)** or **maintains its current valve position** upon power failure or cessation of circulation flow.

Key Design Considerations

1. Building Hot water distribution systems and the impact on thermal stratification
2. How to Size a HPWH system: Ecosizer (https://ecosizer.ecotope.com)
3. Refrigerant and Equipment Selection
4. Alarms, Notifications and Maintenance



1. Building Hot Water Distribution Systems & Temperature Maintenance

Temp. maintenance: single-pass or multi-pass?

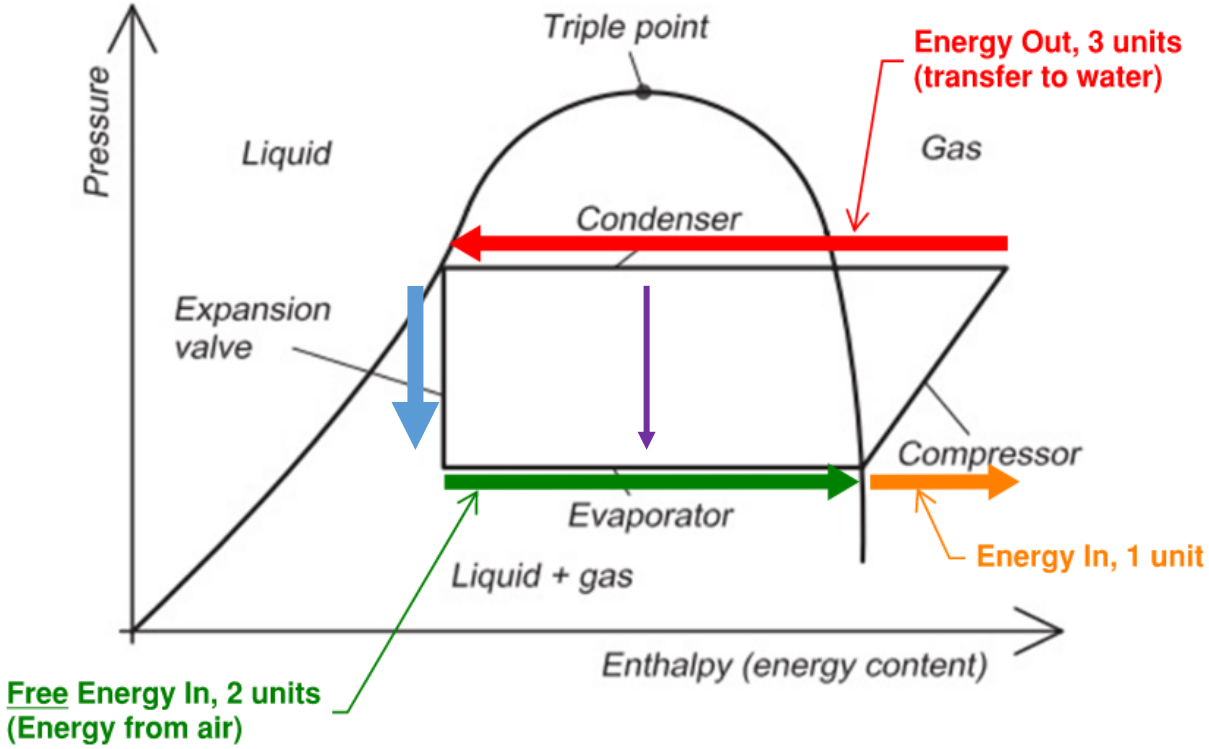
C404.2.3.3. System Design. The service water heating system shall be configured to conform to one of the following provisions.

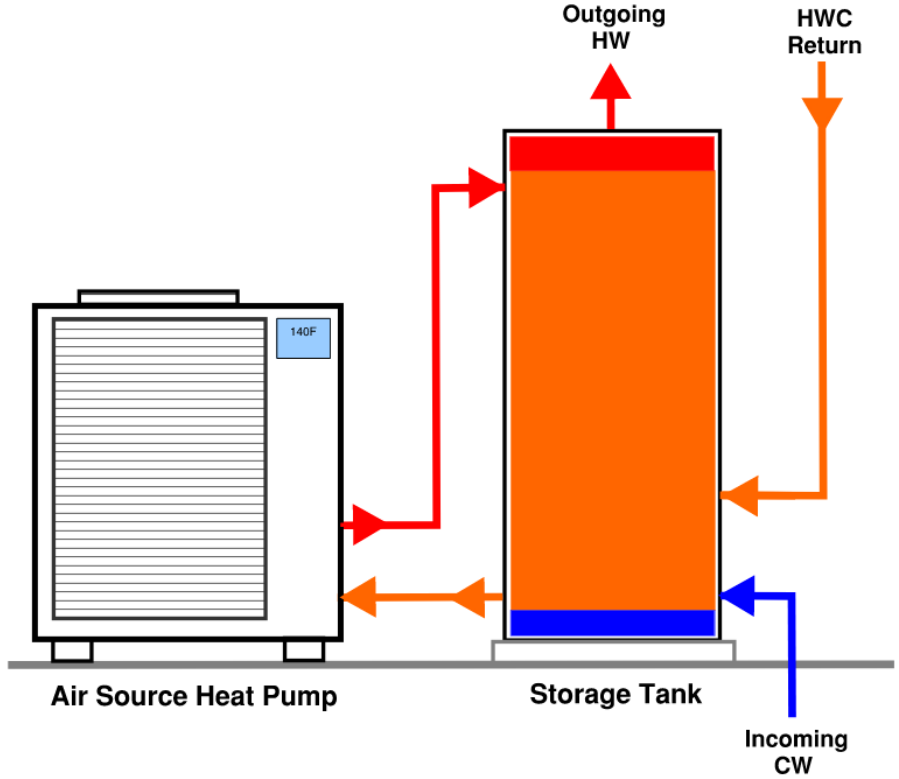
For *single-pass* HPWHs, *temperature maintenance* heating provided for reheating return water from the building's heated water circulation system shall be physically decoupled from the primary service water heating system storage tank(s) in a manner that prevents destratification of the primary system storage tanks. *Temperature maintenance* heating is permitted to be provided by electric resistance or a separate dedicated heat pump system.

For multi-pass HPWHs, recirculated *temperature maintenance* water is permitted to be returned to the primary water storage tanks for reheating.

HW Distribution System

Impact on Thermal Stratification



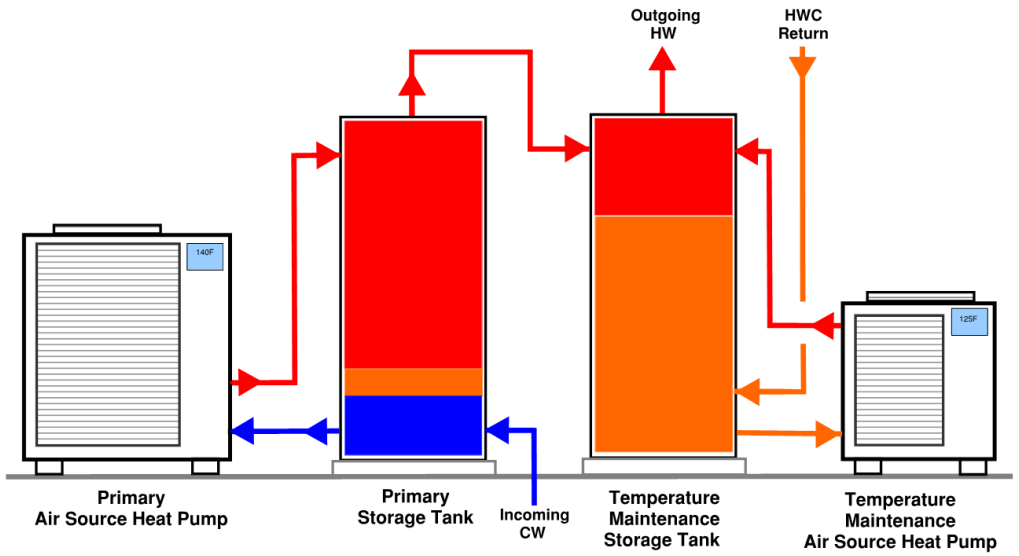


HWC Return to Primary Storage Tanks

- Mixed tank
- No (low) stratification
- Low effective storage volume <60%
- Lower HPWH efficiency

Thermal Stratification and System Performance

Single-pass HPWH = Dedicated Systems

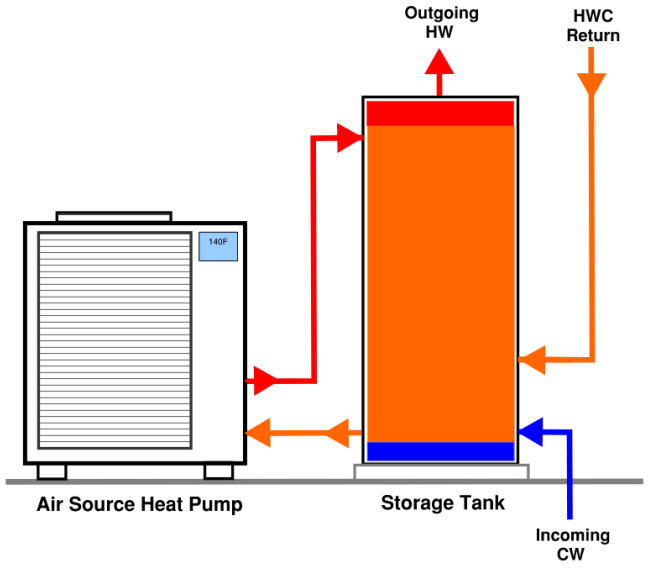


Primary and Temperature maintenance heaters tuned to load HPWHs that are tuned to the load

Advantages:

- Better equipment reliability
- high effective storage volume >80%
- Higher HPWH COP
- Higher system COP
- Redundancy

Multi-pass HPWH = "All eggs in one basket"

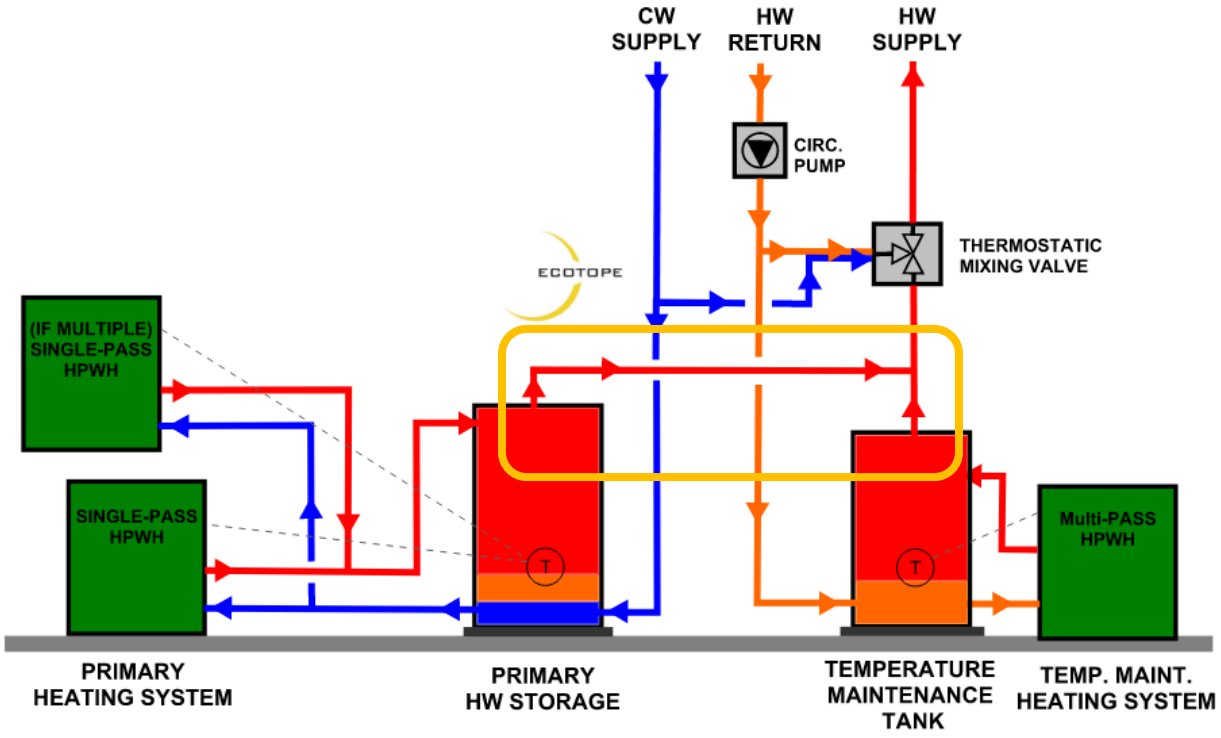


Primary and temperature maintenance loads heated by a HPWH(s)

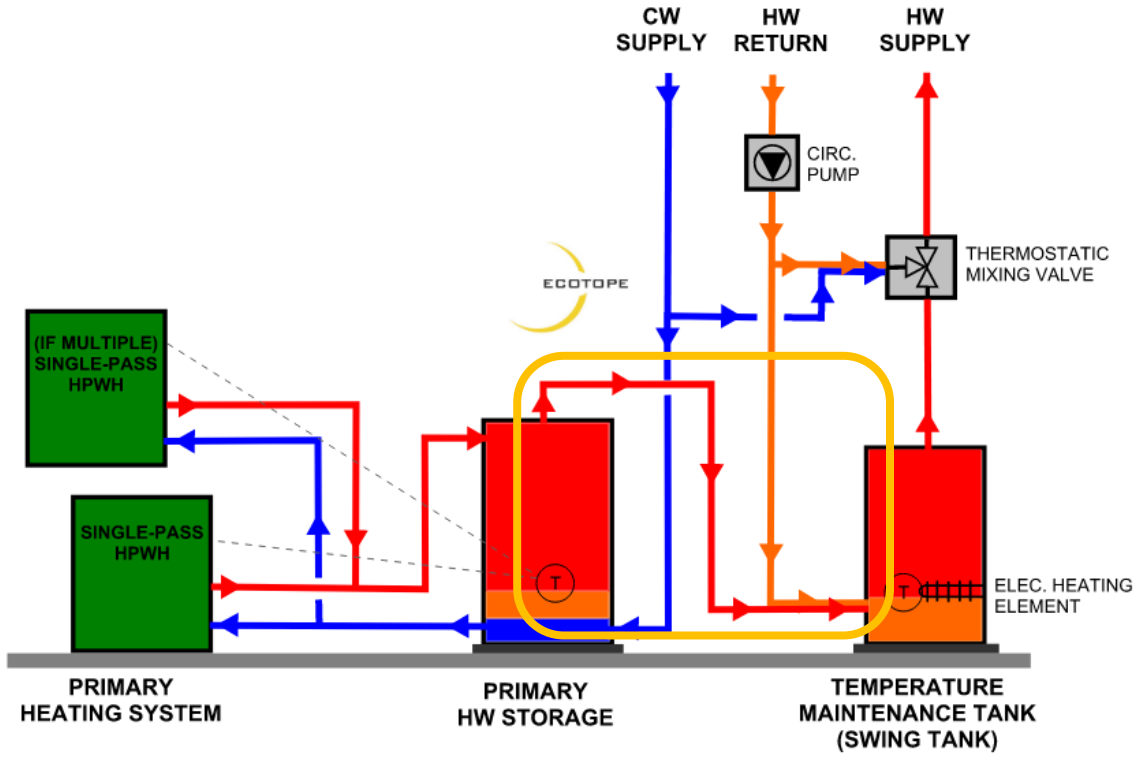
Challenges:

- Cycling issues
- Sizing issues (HW load and HWC load scale difference)
- Cycling issues
- Low effective storage volume <60%
- Low HPWH COP
- A functioning system is technology and control dependent

Two Options for Temperature Maintenance



SINGLE-PASS PRIMARY HPWH SYSTEM WITH PARALLEL LOOP TANK



SINGLE-PASS PRIMARY HPWH SYSTEM WITH SWING TANK

55 Tons
1,000 Gallons

5 Tons
520 Gallons

2. Central HPWH System Sizing

System sizing: 100%@40°F…50%@24°F
(exception for system in UG garage)

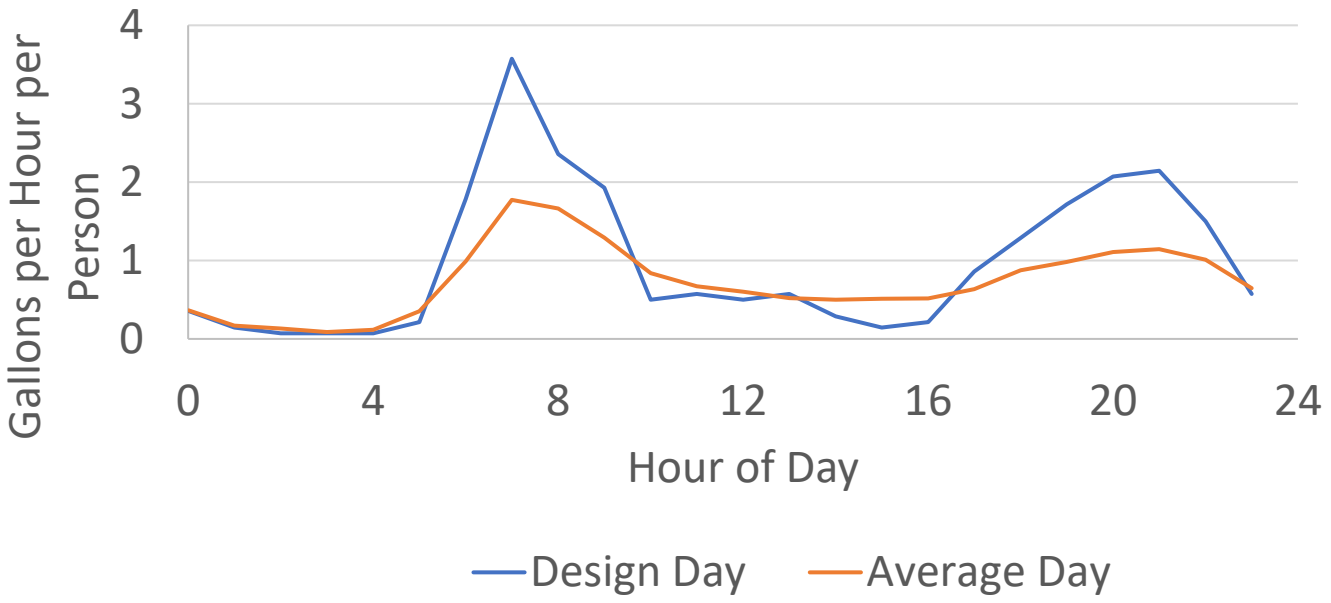
C404.2.3.1 Primary heat pump system sizing. The system shall include a primary service minimum output **at 40°F outdoor air temperature** that provides sufficient hot water for R-1 and/or R-2 occupancy uses as calculated using the equipment manufacturer's selection criteria or another *approved* methodology. Air source heat pumps shall be sized to deliver no less than **50 percent** of the calculated demand for hot water production during the peak demand period when entering air temperature is **24°F**.

Exception. 50 percent sizing at 24°F is not required for heat pumps located in a below-grade enclosed parking structure or other ventilated and unconditioned space that is not anticipated to fall below 40°F at any time.

Supplemental electric resistance heat allowed:

- Temp maintenance for circulation system
- Defrost
- Heat trace
- Backup or low-ambient, where:
  - No greater than heat pump output at 40°F
  - Entering air temp is below 40°F
  - Heat pump compressor operates down to 17°F
  - Compressor heat can’t satisfy demand
- Downstream from multi-pass system
- Single water heaters not served by central syste

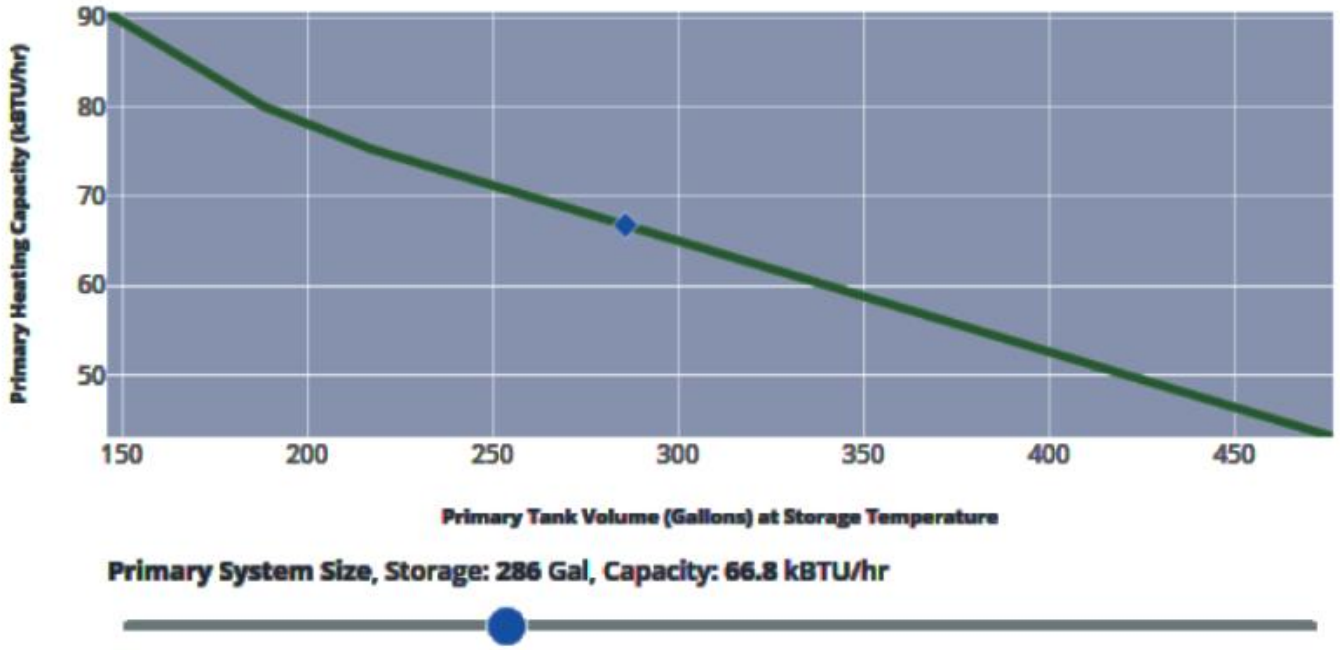
Domestic Hot Water Load



- **Hot water load defined by:**
  - the number of occupants
  - how much hot water they use
- At the Design Conditions (cool air and water temperatures)

Ecosizer

ecosizer.Ecotope.com



THIS SYSTEM WAS SIZED FOR

Occupancy
60.0 People

Apartments
30.0 Units

Daily Hot Water Usage
25.0 Gallons per Day per Person

Total Hot Water
1500 Gallons per Day

Tank Volume
285 Gallons

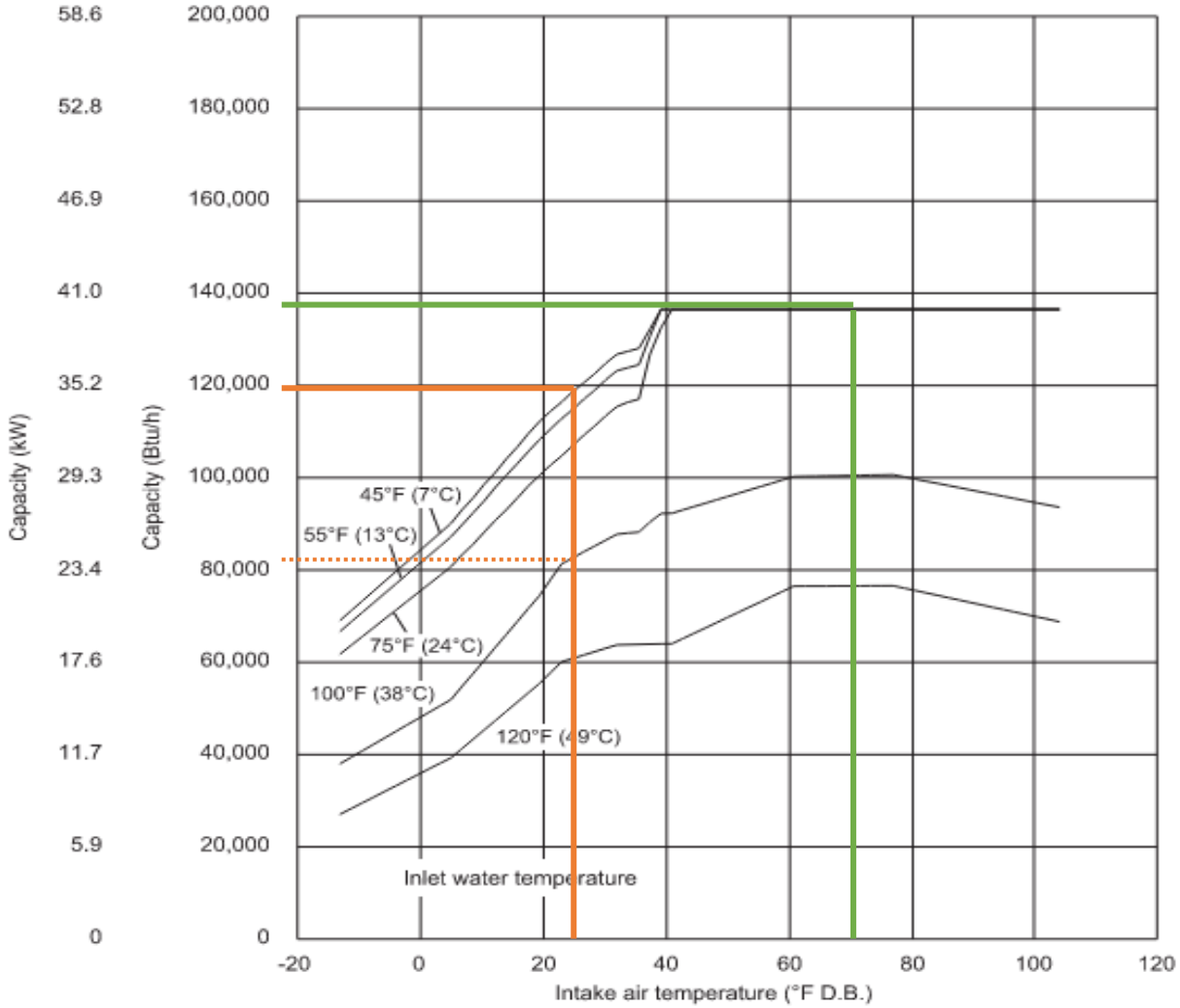
Heating Capacity
66.8 kBTU/hr

Swing Tank Volume
80 Gallons

Swing Resistance Element
4.7 kW · **15.9** kBTU/hr

Central HPHW System Sizing

Don’t forget about defrost!



Manufacturer's nominal heat capacity

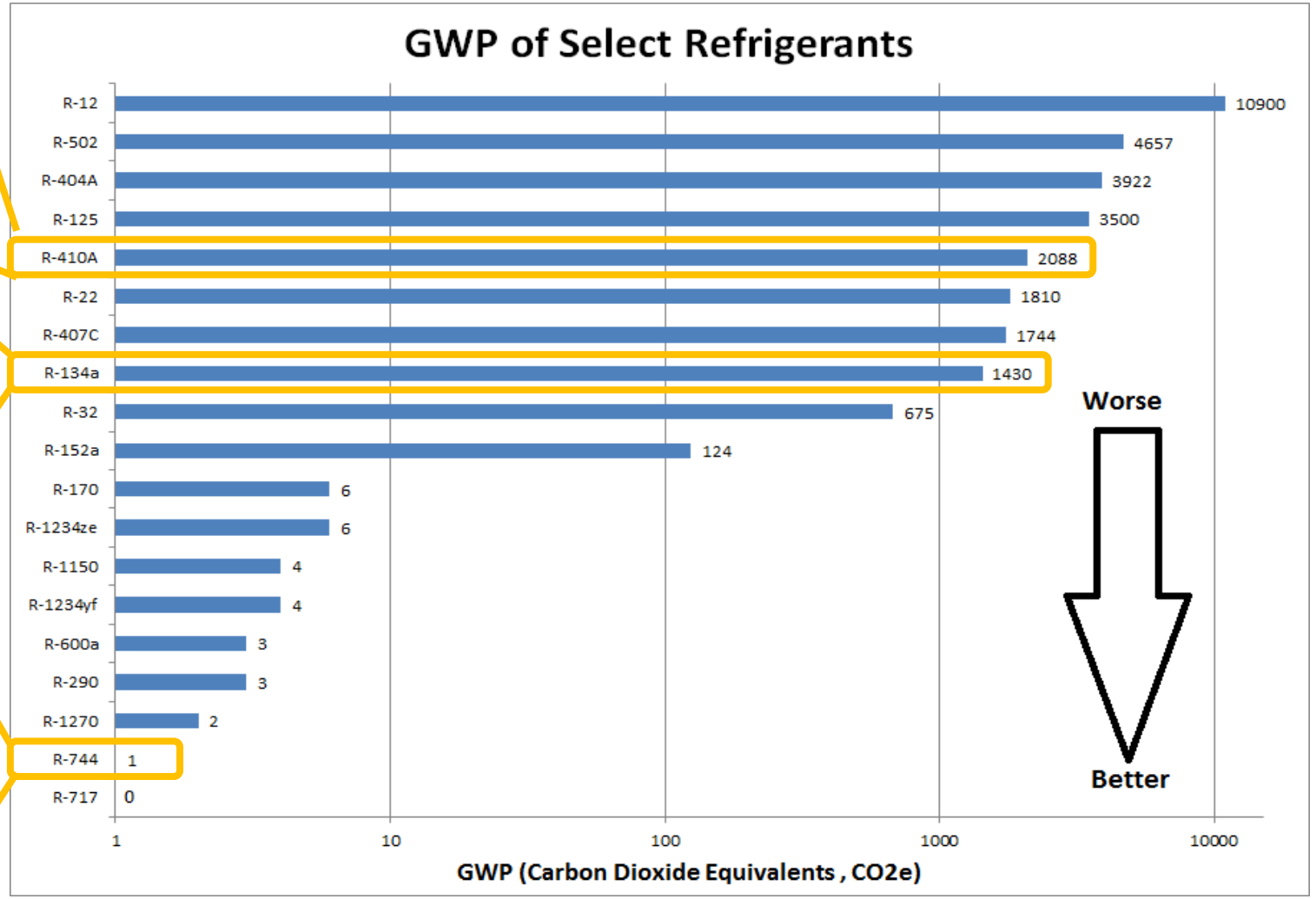
vs.

Heat capacity at design air conditions

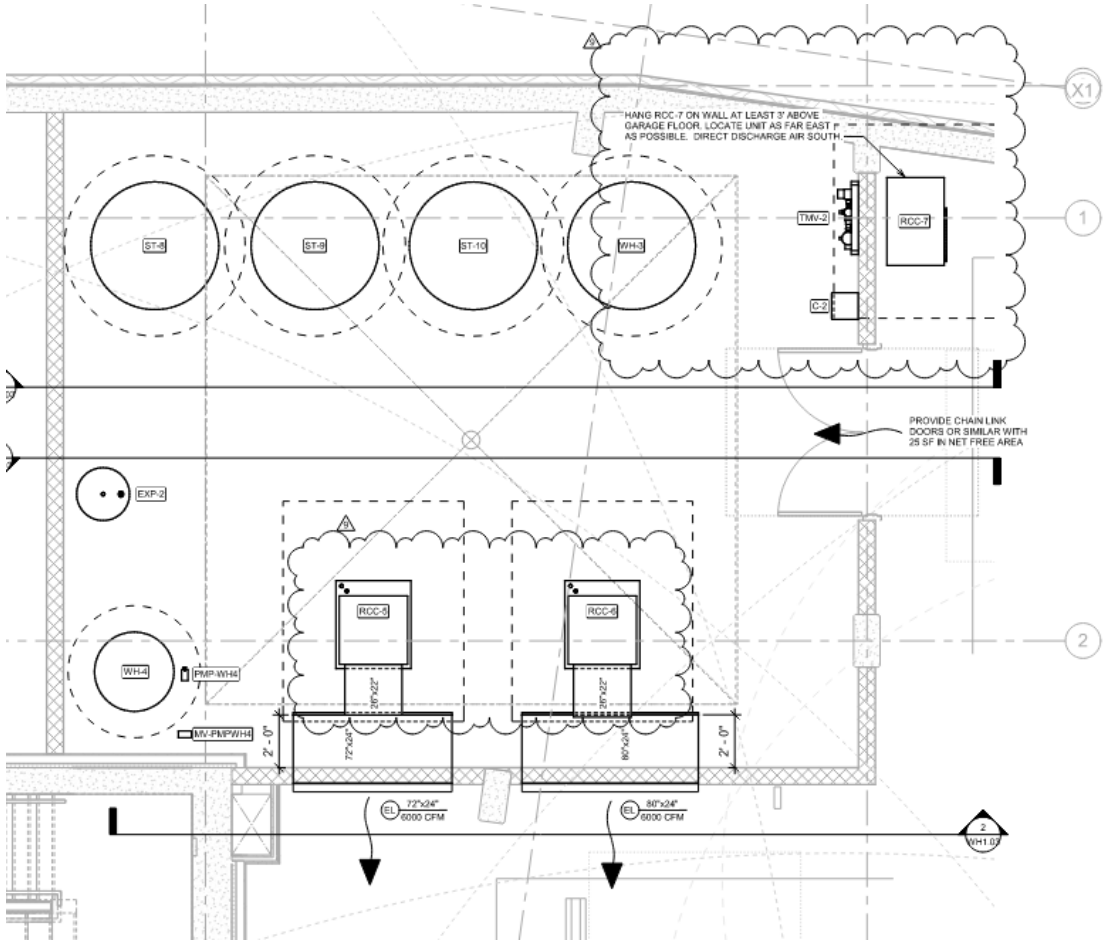
3. Refrigerant & Equipment Selection

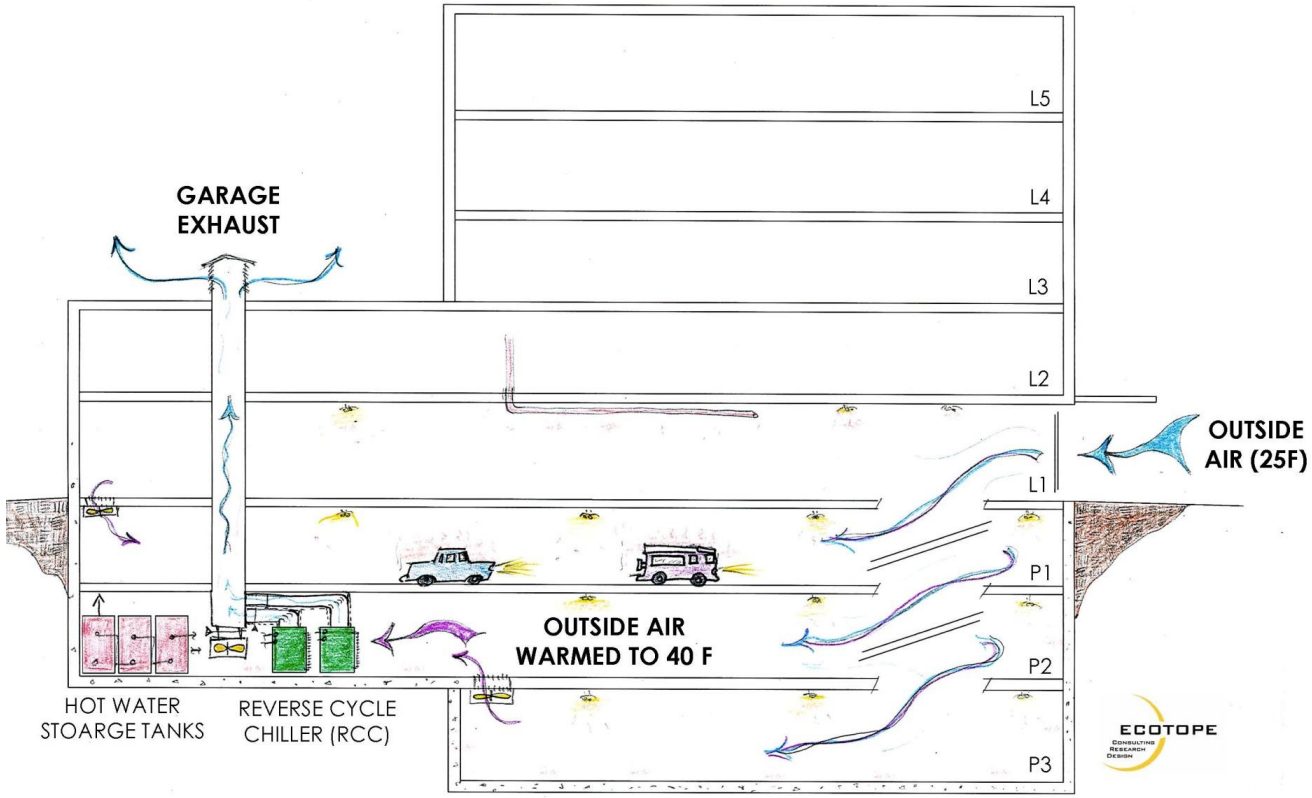
Refrigerant Types

	Refrigerant		
	R-134a	R-410a	R-744 (CO2)
COP (average Seattle annual)	2.7	2.5	3.2
Low ambient air temperature	35 F	-5 F	-25 F
Maximum discharge water temperature	160 F	120 F	190 F



Air buffer zones



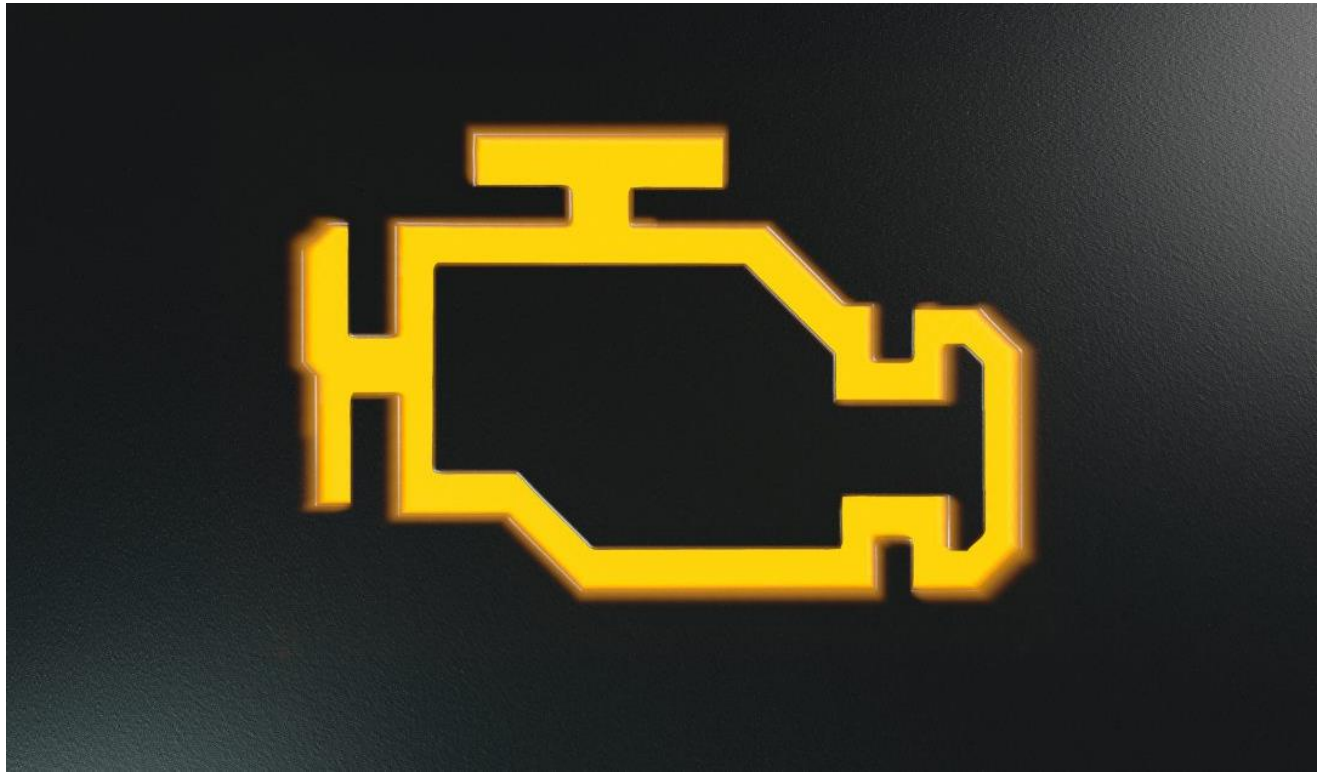


Alarms required

- Equipment faults
- Low leaving temp from primary tanks
- Low hot water delivery temp to distribution system

- Q: Who sees these alarms?
- Will they result in something getting fixed?

4. Alarms, Notifications & Maintenance



Impacts to system efficiency and performance

- Notify building owners/maintenance team back up system engaged
- Prompt remediation necessary for system longevity
- Maintenance procedure is often simple but critical for reliability

Break Time!

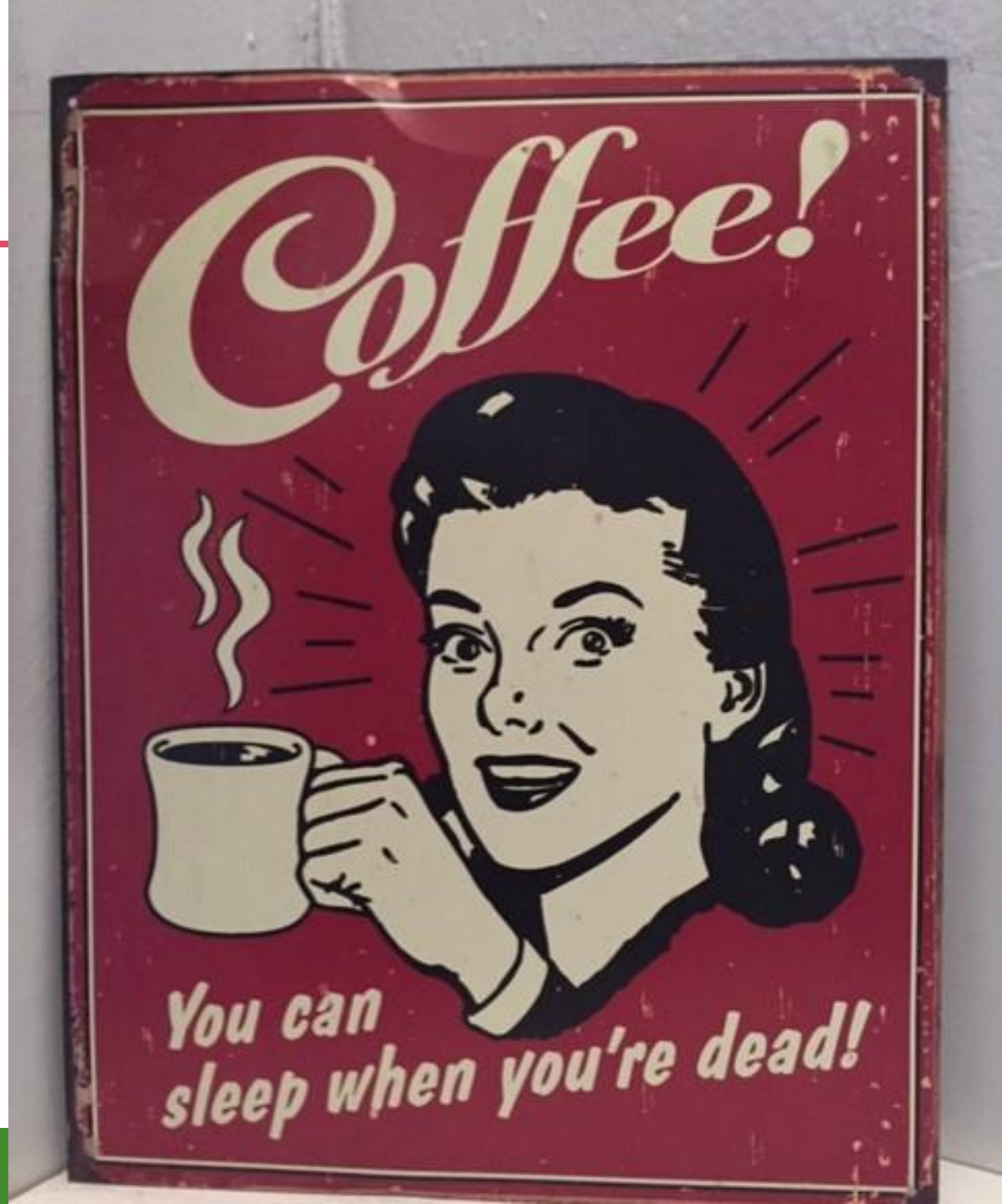


TABLE C404.3.1
PIPING VOLUME AND MAXIMUM PIPING LENGTHS

NOMINAL PIPE SIZE (inches)	VOLUME (liquid ounces per foot length)	MAXIMUM PIPING LENGTH (feet)	
		Public lavatory faucets	Other fixtures and appliances
1/4	0.33	6	50
5/16	0.5	4	50
3/8	0.75	3	50
1/2	1.5	((~~2~~)) 8	43
5/8	2	((~~1~~)) 8	32
3/4	3	0.5	21
7/8	4	0.5	16
1	5	0.5	13
11/4	8	0.5	8
11/2	11	0.5	6
2 or larger	18	0.5	4

WA plumbing fixture standards – 2019

- **Shower heads 1.8 GPM**
  - 1.5 & 1.25 GPM heads also on market
- **Kitchen and lavatory faucets 1.8 GPM**
- **Toilets 1.28 GPF**
- **Urinals 0.125 GPF**
  - (1 pint per flush)

Appendix M:
Seattle/King Co Plumbing Code

103.4 Appendices. Provisions in the Uniform Plumbing Code appendices do not apply except Appendices A, B, ((~~and~~)) I and M, which are specifically adopted.

Appendix M: Peak Water Demand Calculator for single-family & multifamily dwellings with water-conserving fixtures **= smaller pipes**.

[W] 610.4 Sizing Water Supply and Distribution Systems. Systems within the range of Table 610.4 shall be permitted to be sized from that table or by the method in accordance with Section 610.5. Appendix M is permitted to be used for sizing piping and systems for single-family and multifamily dwellings using water-conserving fixtures.

Pipe insulation – One-way vs. circulating pipe

C404.6 Pipe insulation. Per Table C403.10.3 (100°F - 140°F):

- Up to 1-1/2” = 1” insulation
- Over 1-1/2” = 1-1/2” insulation
- Continuous through hangars

Exceptions:

- Valves, pumps, strainers and threaded unions in piping <1 inch
- Surrounded by R-3 building insul
- Final run from circ pipe to fixture

C404.7.3.1 Pipe insulation. For heated water circulation systems, both supply and return pipe insulation shall be at minimum 1.0 inch thicker than that required by Table C403.10.3.

Exception. Where piping is centered within a wall, ceiling, or floor framing cavity with a depth at least 4” greater than the diameter of the pipe and that is completely filled with batt or blown-in insulation, additional pipe insulation is not required.

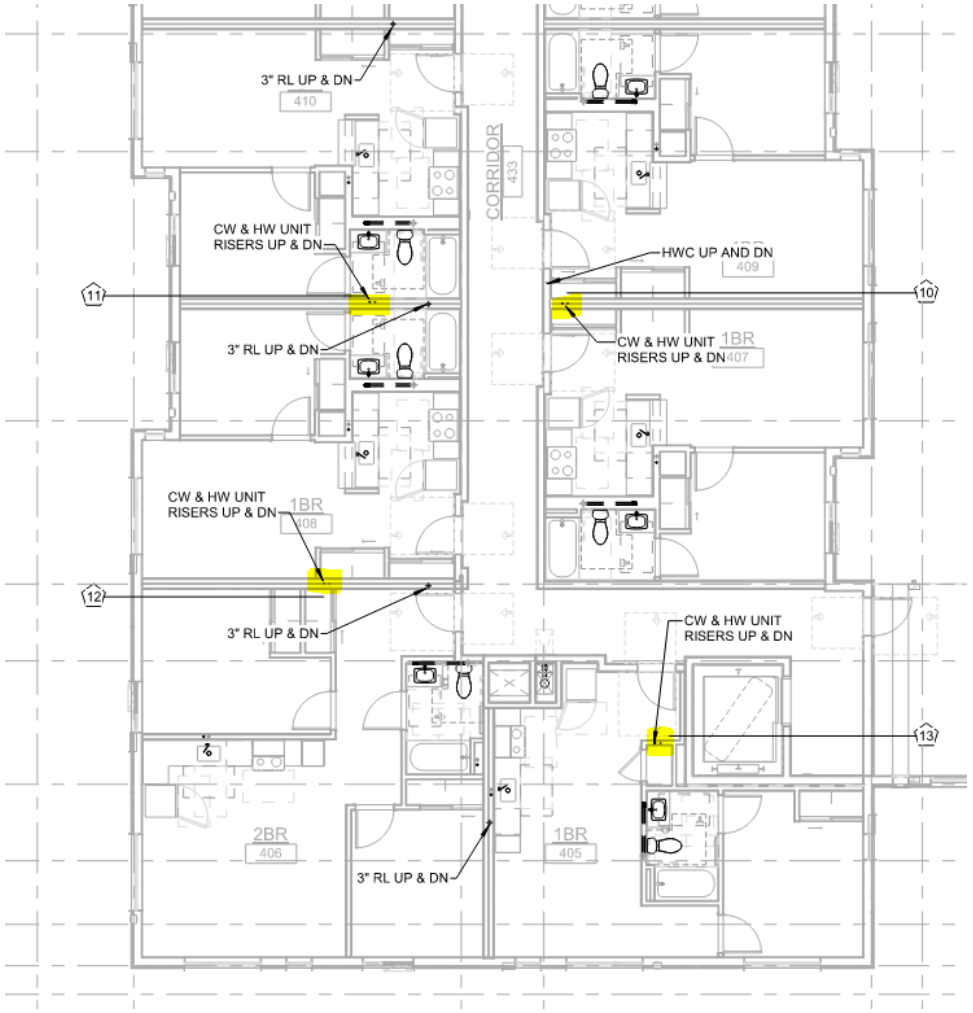
Efficient HW distribution Systems

Appendix M sizing

114-unit Seattle area MF building: (assumes booster pump, due to low entering water pressure

- 96 1bed/1bath
- 18 2bed/2bathbathroom

Sizing Method	Flowrate (GPM)	CW main	Notes
Appendix A	260	4"	Top end of 4” range – at about 280 gpm we are pushed up to a 6” connection
Appendix A + C	205	3.5"	Likely requieres a 4” connection from city
Appendix M	**54**	**2"**	**2018 UPC**



Refrigerant piping insulation - Seattle

C403.10.3 Piping insulation. All piping, other than refrigerant piping, serving as part of a heating or cooling system shall be thermally insulated in accordance with Table C403.10.3.

…

C403.10.4 Insulation of refrigerant piping. Refrigerant piping, other than piping factory installed in HVAC equipment, shall have minimum 1/2-inch insulation within conditioned spaces and 1-inch insulation outside of conditioned spaces, at a conductivity rating of 0.21 to 0.26 Btu x in/(h x ft^2 x °F) with a mean temperature rating of 75°F.

Hot Water Metering

C404.9 Domestic hot water meters. Each individual *dwelling unit* in a Group R-2 occupancy with central service domestic hot water systems shall be provided with a domestic hot water meter to allow for domestic hot water billing based on actual domestic hot water usage.

Exception: *Dwelling unit*s in **other than Group R-2 multi-family and live/work units** are not required to provide domestic hot water metering at each *dwelling unit* where domestic hot water is metered separately for each of the following building end uses:

1. *Dwelling unit*s.
2. Sleeping units.
3. Commercial kitchens.
4. Central laundries.

This has caused difficulties for plumbing replacement in existing buildings, when the team didn't know it was required!

C409.3.2 Service water heating energy use. This category shall include all energy used for heating of domestic and service hot water, but not energy used for space heating.

Exception: Service water heating energy use less than 50 kVA does not require end-use metering.

C406 Efficiency Package Credits

- WA: 6 credits required
  - 3 credits for low-energy occupancies
- **Seattle: 8 credits required**
- Seattle: Gas equip doesn't qualify

	R1	R2	B	E	M	Other
1. More efficient HVAC performance in accordance with Section C406.2	**2.0**	**3.0**	**3.0**	**2.0**	**1.0**	**2.0**
2. Reduced lighting power: Option 1 in accordance with Section C406.3.1	**1.0**	**1.0**	**2.0**	**2.0**	**3.0**	**2.0**
3. Reduced lighting power: Option 2 in accordance with Section C406.3.2[a]	**2.0**	**3.0**	**4.0**	**4.0**	**6.0**	**4.0**

SEATTLE: Table C406.1 Efficiency Package Credits

Code Section	Commercial Building Occupancy					
	Group R-1	**Group R-2**	Group B	Group E	Group M	**All Other**
	Additional Efficiency Credits					
1. More efficient HVAC performance in accordance with Section C406.2	2.0	3.0	3.0	2.0	1.0	2.0
2. High performance dedicated outdoor air system in accordance with Section C406.7	4.0	4.0	4.0	4.0	4.0	4.0
8. High-efficiency service water heating in accordance with Sections C406.8.1 and C406.8.2	**4.0** NA after 1/1/2022	**5.0** NA after 1/1/2022	NA	NA	NA	**8.0**
9. High performance service water heating in ((~~multi-family~~)) R-1 and R-2 buildings in accordance with Section C406.9	**7.0 prior to 1/1/2022 5.0 after 1/1/2022**	**8.0 prior to 1/1/2022 5.0 after 1/1/2022**	NA	NA	NA	NA
10. Enhanced envelope performance in accordance with Section C406.10[c]	3.0	6.0	3.0	3.0	3.0	4.0

?

Best options for apartments?
One engineer's ranking

Best

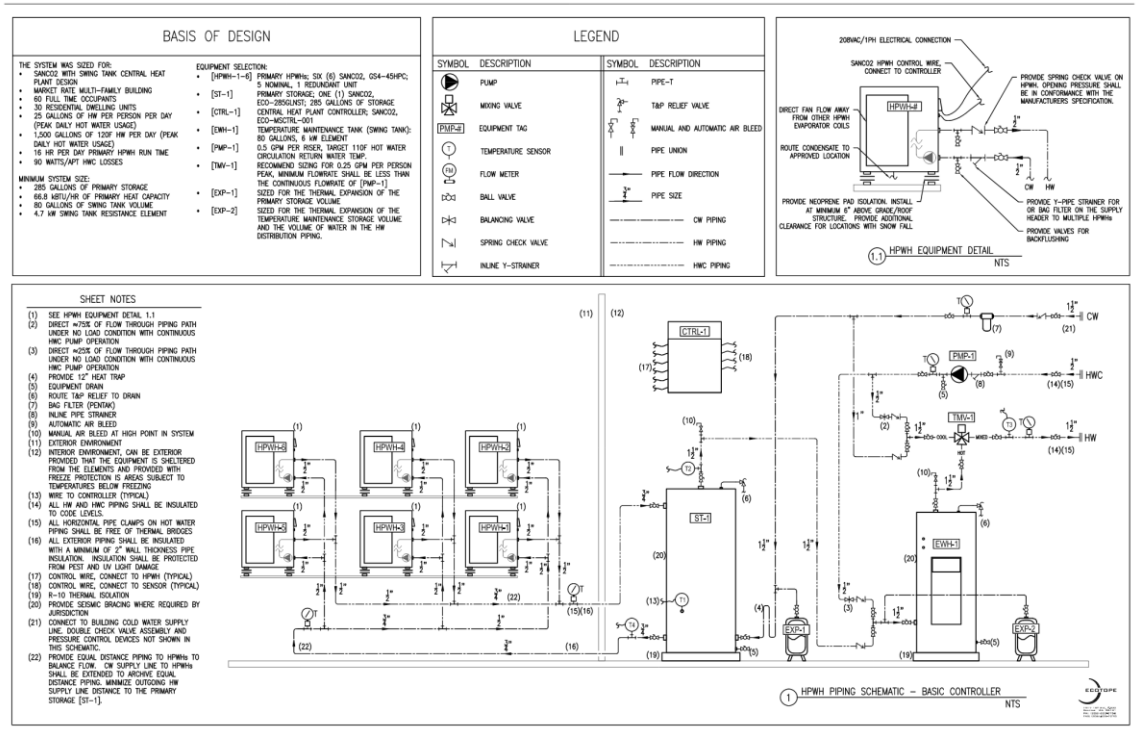
- #2 (1 credit) Reduced lighting
- #9 (8 credits before 1/1/22)
  Advanced Heat Pump Water Heater
  - **(5 credits after 1/1/22)**

Second Best

- #5 (3 credits, max) Rooftop solar
- #6 (2 credits) DOAS – Dedicated Outdoor Air System (double-dip)
- #7 (4 credits) High-perform DOAS
- #11 (2 credits) Reduced air leakage

Getting to 8 Credits (after 1/1/22)		
No.	**Credits**	**Description**
#2	1	Lighting
#9	5	Advanced HPWH
#6	2	DOAS
	8	Total

CO2 Central HPWH system



BASIS OF DESIGN

THE SYSTEM WAS SIZED FOR:
- SANCO2 WITH SWING TANK CENTRAL HEAT PLANT DESIGN
- MARKET RATE MULTI-FAMILY BUILDING
- 60 FULL TIME OCCUPANTS
- 30 RESIDENTIAL DWELLING UNITS
- 25 GALLONS OF HW PER PERSON PER DAY (PEAK DAILY HOT WATER USAGE)
- 1,500 GALLONS OF 120F HW PER DAY (PEAK DAILY HOT WATER USAGE)
- 16 HR PER DAY PRIMARY HPWH RUN TIME
- 90 WATTS/APT HWC LOSSES

MINIMUM SYSTEM SIZE:
- 285 GALLONS OF PRIMARY STORAGE
- 66.8 kBTU/HR OF PRIMARY HEAT CAPACITY
- 80 GALLONS OF SWING TANK VOLUME
- 4.7 kW SWING TANK RESISTANCE ELEMENT

EQUIPMENT SELECTION:
- [HPWH-1~6] PRIMARY HPWHs; SIX (6) SANCO2, GS4-45HPC; 5 NOMINAL, 1 REDUNDANT UNIT
- [ST-1] PRIMARY STORAGE; ONE (1) SANCO2, ECO-285GLNST; 285 GALLONS OF STORAGE
- [CTRL-1] CENTRAL HEAT PLANT CONTROLLER; SANCO2, ECO-MSCTRL-001
- [EWH-1] TEMPERATURE MAINTENANCE TANK (SWING TANK): 80 GALLONS, 6 kW ELEMENT
- [PMP-1] 0.5 GPM PER RISER, TARGET 110F HOT WATER CIRCULATION RETURN WATER TEMP. RECOMMEND SIZING FOR 0.25 GPM PER PERSON PEAK, MINIMUM FLOWRATE SHALL BE LESS THAN THE CONTINUOUS FLOWRATE OF [PMP-1]
- [TMV-1] SIZED FOR THE THERMAL EXPANSION OF THE PRIMARY STORAGE VOLUME.
- [EXP-1] SIZED FOR THE THERMAL EXPANSION OF THE TEMPERATURE MAINTENANCE STORAGE VOLUME AND THE VOLUME OF WATER IN THE HW DISTRIBUTION PIPING.
- [EXP-2]

LEGEND

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
	PUMP		PIPE-T
	MIXING VALVE		T&P RELIEF VALVE
PMP-#	EQUIPMENT TAG		MANUAL AND AUTOMATIC AIR BLEED
T	TEMPERATURE SENSOR		PIPE UNION
FM	FLOW METER		PIPE FLOW DIRECTION
	BALL VALVE	3/4"	PIPE SIZE
	BALANCING VALVE		CW PIPING
	SPRING CHECK VALVE		HW PIPING
	INLINE Y-STRAINER		HWC PIPING

SHEET NOTES

(1) SEE HPWH EQUIPMENT DETAIL 1.1
(2) DIRECT ≈75% OF FLOW THROUGH PIPING PATH UNDER NO LOAD CONDITION WITH CONTINUOUS HWC PUMP OPERATION
(3) DIRECT ≈25% OF FLOW THROUGH PIPING PATH UNDER NO LOAD CONDITION WITH CONTINUOUS HWC PUMP OPERATION
(4) PROVIDE 12" HEAT TRAP
(5) EQUIPMENT DRAIN
(6) ROUTE T&P RELIEF TO DRAIN
(7) BAG FILTER (PENTAIR)
(8) INLINE PIPE STRAINER
(9) AUTOMATIC AIR BLEED
(10) MANUAL AIR BLEED AT HIGH POINT IN SYSTEM
(11) EXTERIOR ENVIRONMENT
(12) INTERIOR ENVIRONMENT, CAN BE EXTERIOR PROVIDED THAT THE EQUIPMENT IS SHELTERED FROM THE ELEMENTS AND PROVIDED WITH FREEZE PROTECTION IS AREAS SUBJECT TO TEMPERATURES BELOW FREEZING
(13) WIRE TO CONTROLLER (TYPICAL)
(14) ALL HW AND HWC PIPING SHALL BE INSULATED TO CODE LEVELS.
(15) ALL HORIZONTAL PIPE CLAMPS ON HOT WATER PIPING SHALL BE FREE OF THERMAL BRIDGES
(16) ALL EXTERIOR PIPING SHALL BE INSULATED WITH A MINIMUM OF 2" WALL THICKNESS PIPE INSULATION. INSULATION SHALL BE PROTECTED FROM PEST AND UV LIGHT DAMAGE
(17) CONTROL WIRE, CONNECT TO HPWH (TYPICAL)
(18) CONTROL WIRE, CONNECT TO SENSOR (TYPICAL)
(19) R-10 THERMAL ISOLATION
(20) PROVIDE SEISMIC BRACING WHERE REQUIRED BY JURISDICTION
(21) CONNECT TO BUILDING COLD WATER SUPPLY LINE. DOUBLE CHECK VALVE ASSEMBLY AND PRESSURE CONTROL DEVICES NOT SHOWN IN THIS SCHEMATIC.
(22) PROVIDE EQUAL DISTANCE PIPING TO HPWHs TO BALANCE FLOW. CW SUPPLY LINE TO HPWHs SHALL BE EXTENDED TO ARCHIVE EQUAL DISTANCE PIPING. MINIMIZE OUTDOING HW SUPPLY LINE DISTANCE TO THE PRIMARY STORAGE [ST-1].

1 HPWH PIPING SCHEMATIC – BASIC CONTROLLER
NTS

Existing Buildings

- **Legally-built existing can remain forever**
- **Repairs can be like-for-like**
- **Historic fabric of Landmarks protected**
- **All new work usually has to meet code**

C503.5 Service hot water systems. New service hot water systems that are part of the *alteration* shall comply with Section C404.

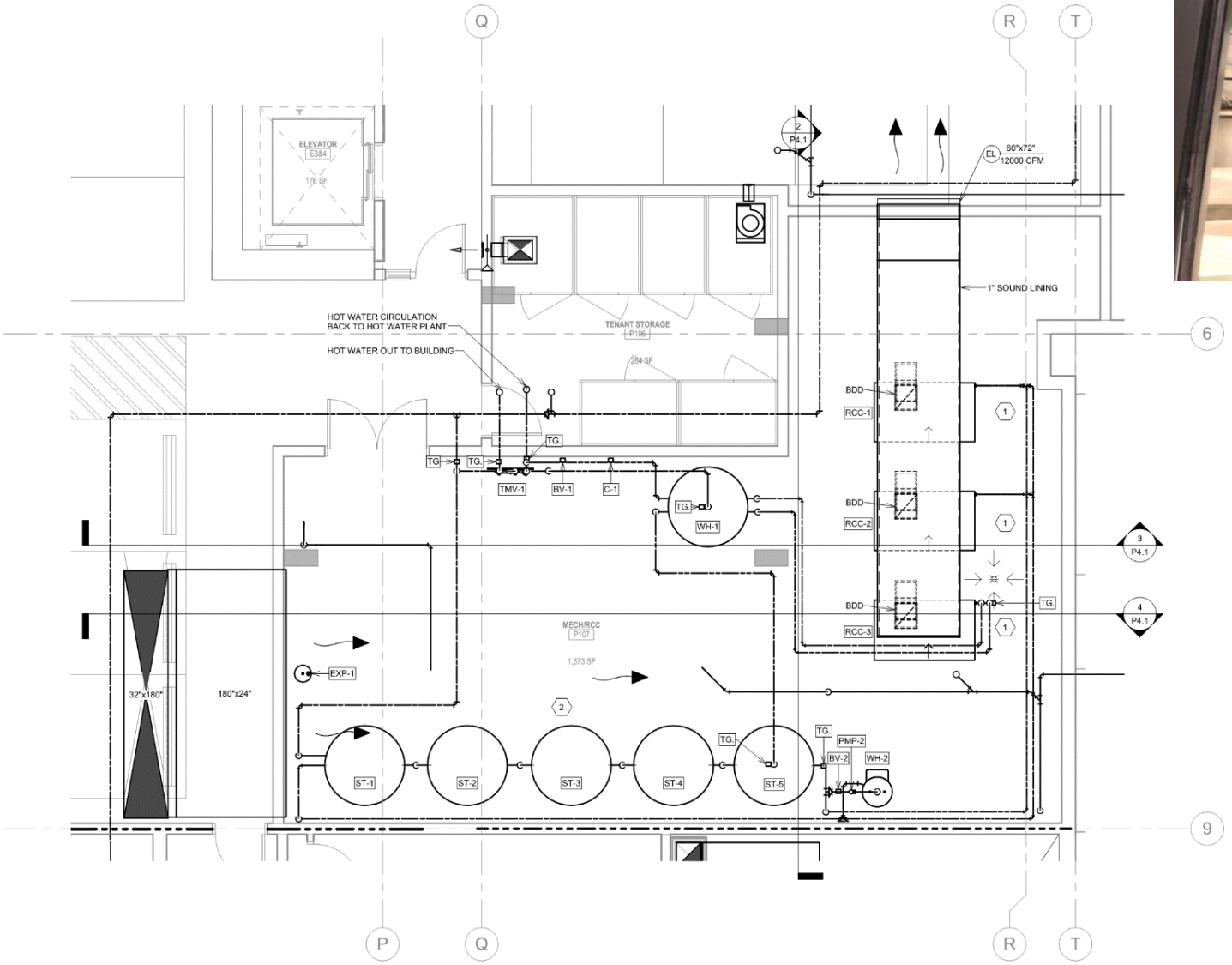
- **Almost same as new construction:**
  - **"Substantial alterations"**
  - **Change of occupancy**
  - **Change of space conditioning**

Replacement of hot water system

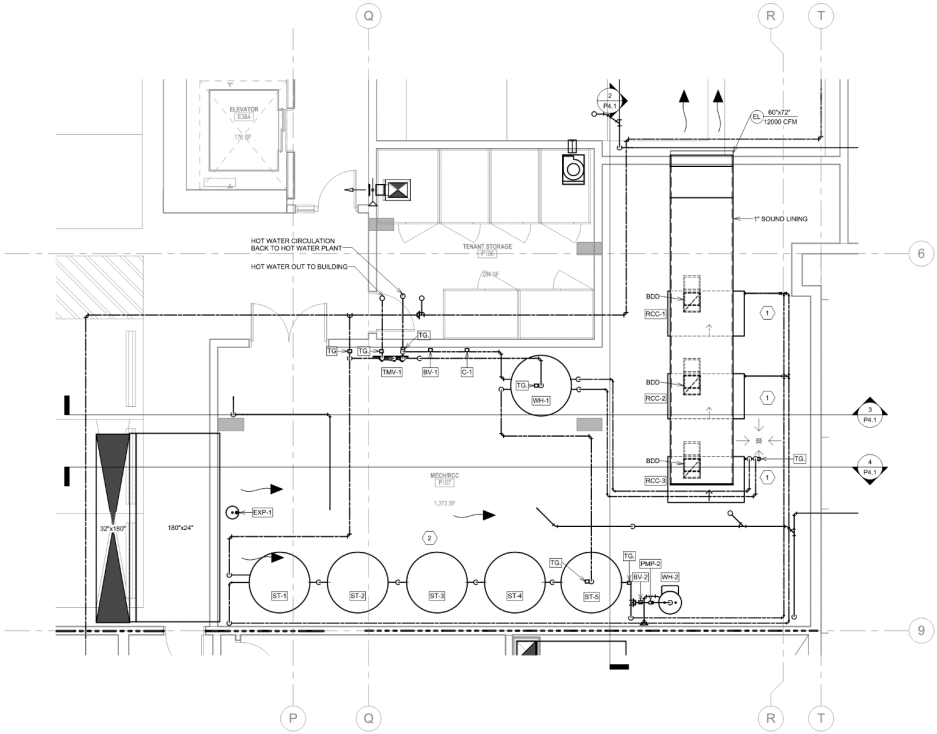
C503.5 Service hot water systems. New service hot water systems that are part of the *alteration* shall comply with Section C404.

Exception. Where only one service hot water appliance is failing and is replaced by another having the same or lesser heating capacity and the same or higher efficiency, no other alterations are made to the central service hot water system, and this exception has not been used within the same building in the previous 24-month period, this provision does not apply.

Common Challenges
- Air Source

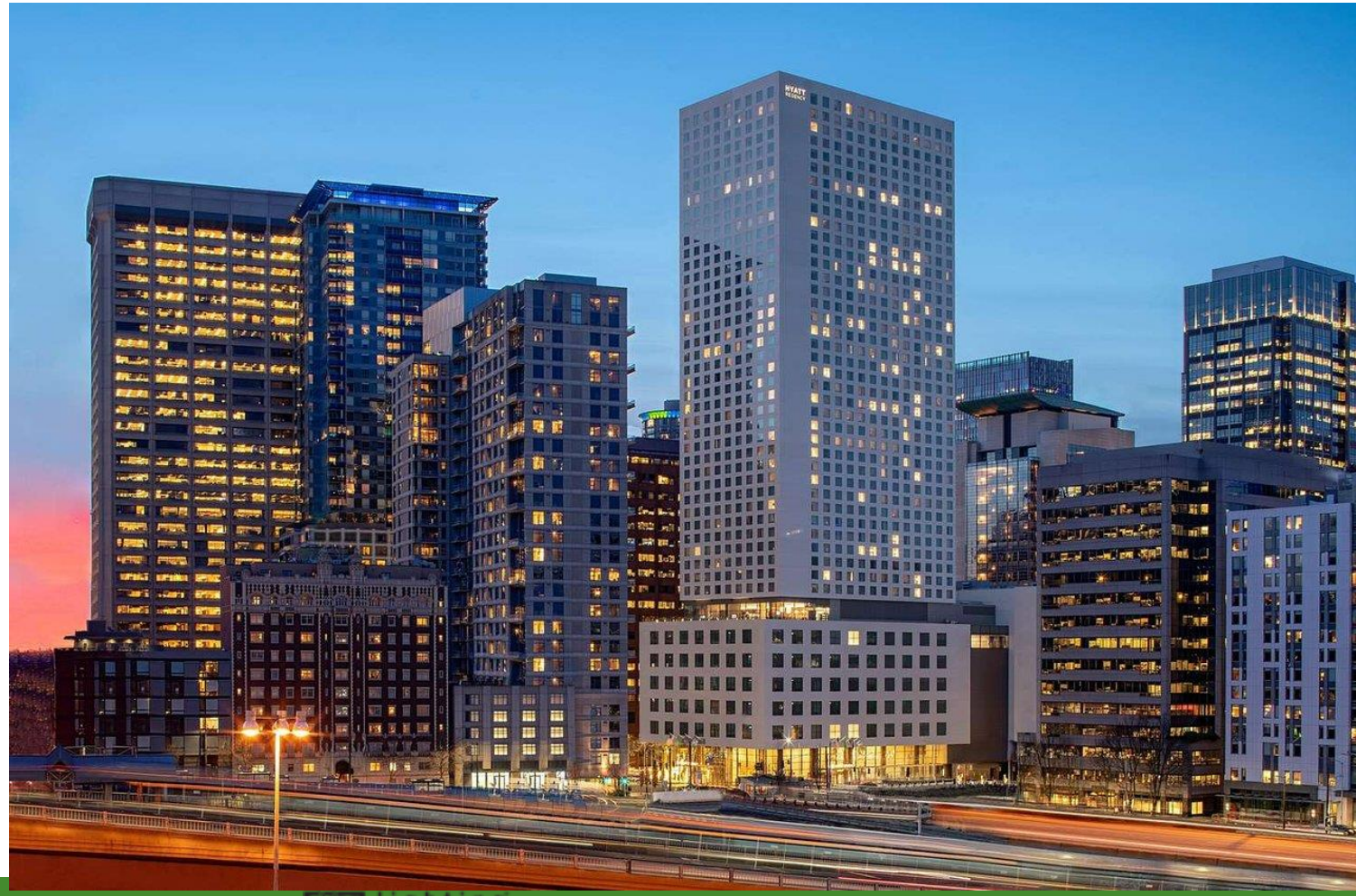


Common Challenges
- Physical space



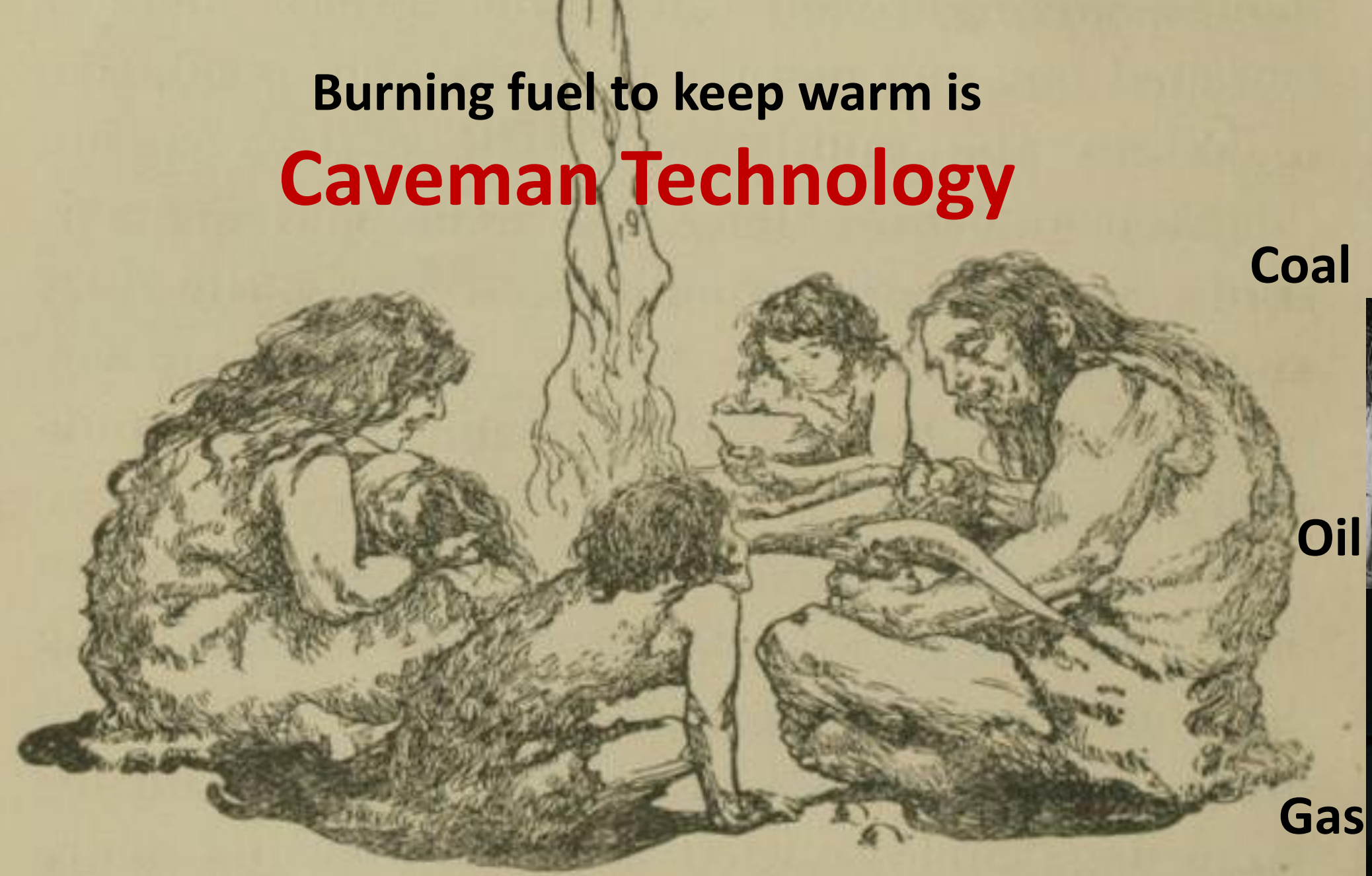
HB 1257: Building performance standard

- Either meet EUI target, or…
  - “Conditional compliance”
- Penalty: $5000 + $1/sf/year
- Reporting schedule:
  - 220,000+ sf June 1, 2026
  - 90,000+ sf June 1, 2027
  - 50,000+ sf June 1, 2028
- Technical assistance
- Positive ROI investments
- Equip end of life timing
- Cap on assistance $$



Burning fuel to keep warm is

Caveman Technology



Coal

Oil

Gas

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Now a Few Words with

Customer Care & Energy Solutions (CCES)

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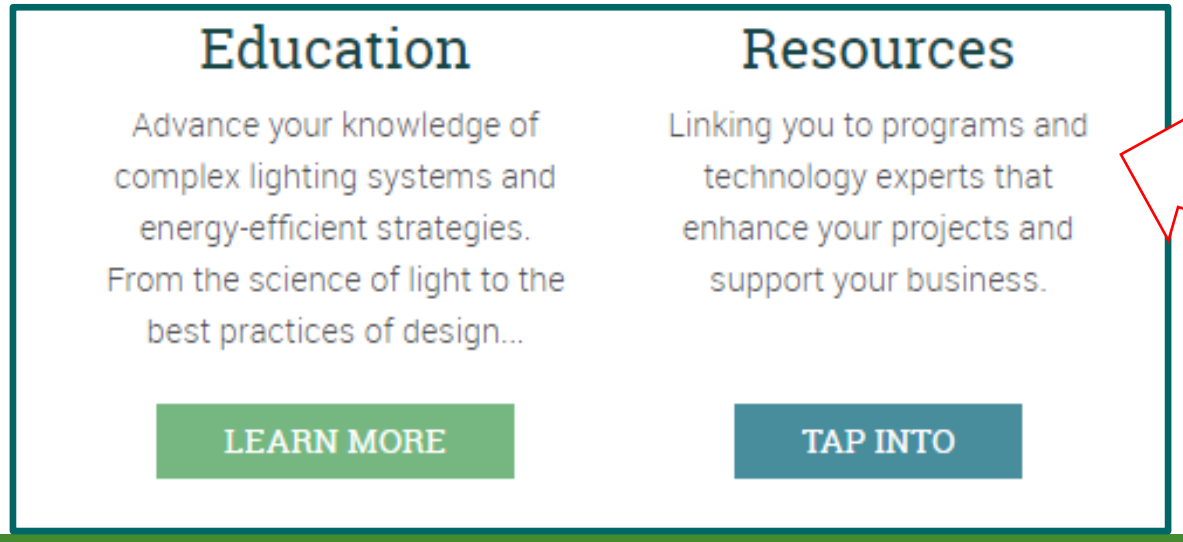

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