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GEN3 SANCO2

Hot water, *naturally*.

Heat Pump Water Heater

www.sandenwaterheater.com

Our Mission

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Hot water, *naturally*.

Creating Hot Water using Outside Air, Natural refrigerant &

Heat Pump technology!

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Unique Sales Points

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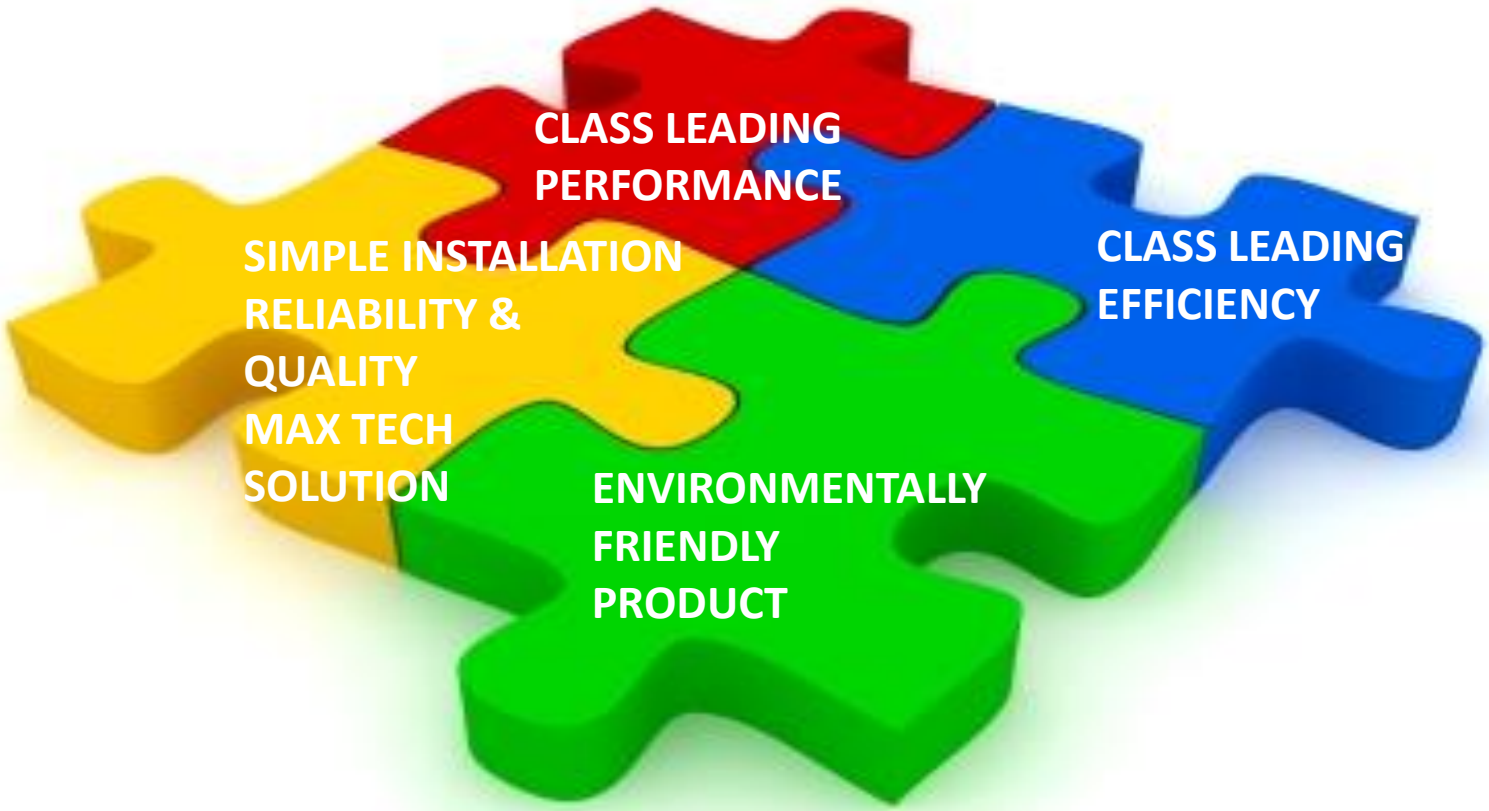

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Sanden Profile

Founded in 1943 / Revenue: $2.8 billion / Employees: > 10,000
Global network: 54 sites in 23 countries , 3 sites in the US

Heating
Core technology
Cooling

Automotive



PEUGEOT CITROËN NISSAN GM Audi DAIMLER FIAT CHRYSLER BUGATTI MINI JAGUAR VOLVO IVECO Mack

Refrigeration




WAL•MART DyDo PEPSI Asahi MARS FamilyMart POKKA

HVAC



MISAWA IMAGINENERGY Daiwa House SEKISUI HOUSE

Sanden Global Facilities

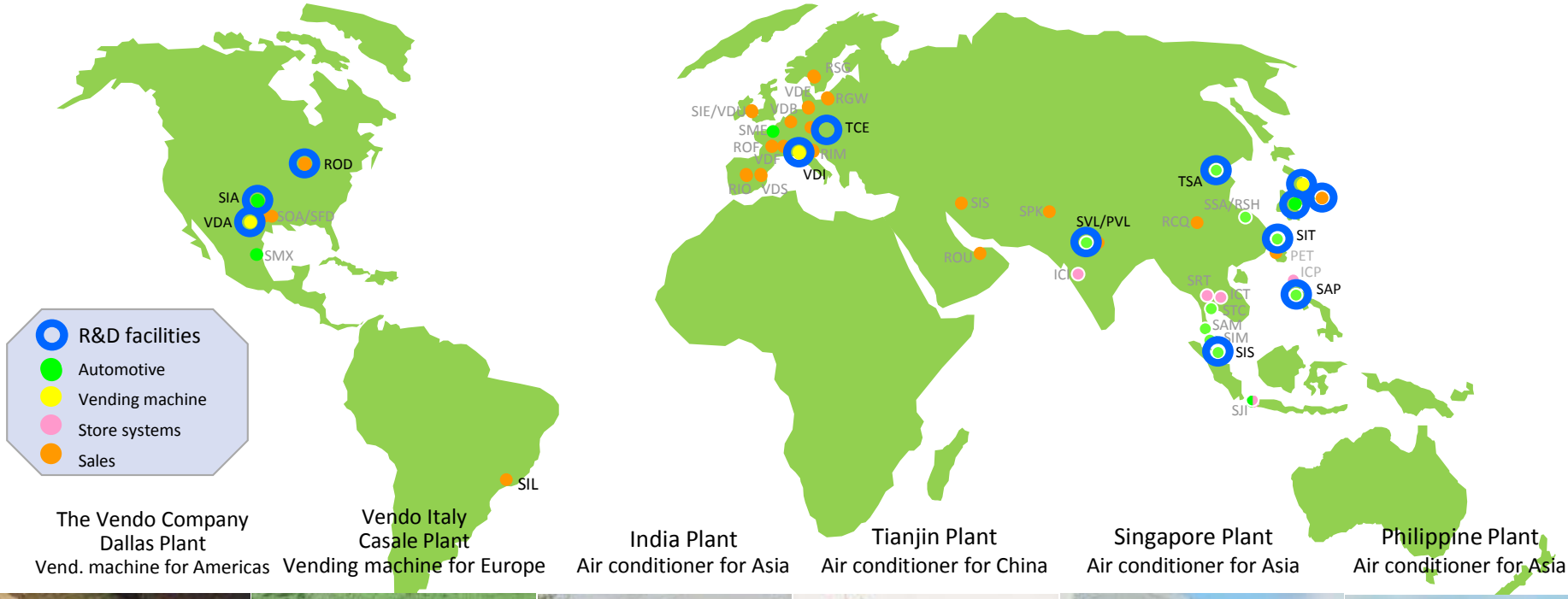
Sanden International USA
Wylie Plant
Comp. for North Americas

Technical Center Europe
In Deutschland
Compressor for Europe

Yattajima
Automotive systems

Akagi
Vending systems

SGCT
Material & Advanced tech



The Vendo Company
Dallas Plant
Vend. machine for Americas

Vendo Italy
Casale Plant
Vending machine for Europe

India Plant
Air conditioner for Asia

Tianjin Plant
Air conditioner for China

Singapore Plant
Air conditioner for Asia

Philippine Plant
Air conditioner for Asia

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Akagi Plant – Sanden Forest

Environmental Preservation

Eco-friendly Technology Development & Manufacturing

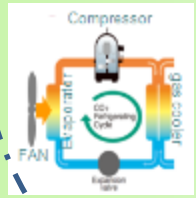
Heating, Cooling & Electronics

GREEN PRODUCTS

Hybrid Compressor

Electric Driven Compressor

CO_2 Compressor



CO_2 Heat Pump

CO_2 Cassette

Water Heater

Vending Machine

Showcase

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Sanden International (USA)

Automotive & Refrigeration business (Wylie & Dallas TX, Plymouth, MI)

- Established 1985
- OEM market
- Heavy Duty Truck market
- Agricultural market
- After market
- Showcases
- Vending Machines
- Hot Food

Compressors
Piston
Scroll

Auto HVAC

HVAC business (Plymouth, MI)

- Living System Division headquarters
- CO_2 HPWH debut at AHR, Pilot sales program started
- R&D & Market Research on Heat Pump Space Heating
- Distribution channel development and lab/field testing of CO_2 water heater.
- Micro Channel Coil and Gas Heat Pump Compressor Sales

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Product Design & Features

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SANCO$_2$ Water Heater

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- Split system HPWH, different to the integrated products currently on market
- 2 Part system, either a 43 or 83 Gallon storage tank coupled with a 4.5kw (15,400 Btu/h) capacity Inverter Compressor Outdoor unit
- Why different? – Based on successful Technology from a Global scale

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Japanese Eco Cute HPWH

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First designed back in 1990's
Product launched in the early 2000's

Currently 500,000 Eco Cute units are sold annually in Japan compared to 100,000 Electric Storage and 2 Million Gas Water Heaters

Designed to use Off Peak Energy Supply to Heat Tank In the most economic way

Outdoor unit major Components are Identical to US product

Tank Designs All Rectangular Low Pressure Water system

All Control capability is located in the Tank and Indoor Thermostat

Controls include a Walkie-Talkie type function

Tank Assembly consists of 2 separate Tanks plus a Heat Exchanger, Pumps, Mixing Valves and sophisticated Controls

Delivers multiple Water Temperatures and volume depending on Usage type
Bath
Shower/Faucets

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Design Changes from Eco Cute

- Core Cold Weather (Hokkaido) global design currently unchanged –Compressor, Heat Pump Controller, Gas Cooler, Evaporator & Water Pump
- Product detail changes as needed to meet the regulatory standards
- “Line Set” length increased – larger residences
- Freeze Protection/Cold Weather line set protection optimized – No Freeze protection used in Japanese market at all
- Tank design changed to a storage cylinder only ALL Heat exchange is in the Heat Pump unit

Why the Split??

- **Typical Integrated HPWH are limited, SANCO$_2$ is Not**
- Integrated HPWH use energy in the home to heat the water, Cooling the home year round, SANCO$_2$ uses Outside air, so only natural heat is used

- Integrated HPWH units are less than 6,000 Btu/h of Heat Pump, when you use a lot of hot water it needs the electric elements to turn on, aka "**HYBRID**", SANCO$_2$ is 15,000 Btu/h and has no electric elements

- Integrated HPWH's are up to 24" taller than standard WH and require much larger clearances for airflow, SANCO$_2$ is virtually noiseless, can be mounted up to 50ft from the tank and the tank can fit anywhere design

$SANCO_2$ Water Heater

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- **Only ½" Cold and Hot Water pipes** connecting between Heat Pump and Stainless Steel Storage Tank are required
- **No refrigeration work required – sealed system**
- Heat Pump can be 50ft from Tank
- Tank requires no power and has 2" clearances, Thermistor is only connection

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SANCO$_2$ Water Heater

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CO_2 Refrigerant in the Outdoor Heat Pump instead of R134A or R410A

Benefits include

- #1 in 1st Hour Rating
- #1 in EF & real world efficiency
- Higher delivered water temperature (176°F)
- Performance in low ambient temperatures, down to -20°F and beyond

ETL CM LISTED C US
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System Specifications

Performance	
Energy Factor - 43 Gal System	3.09
First Hour Rating - 43 Gal System	71 Gallons
Energy Factor - 83 Gal System	3.84
First Hour Rating - 83 Gal System	101 Gallons
Nom Heating Capacity (Btu/h)	15,400 Btu/h
Nom Heating Capacity (kw)	4.5kw
Heating COP	5.0
Water Temperature Setting	130 to 175°F
Refrigerant Type	R744 (CO_2)
Refrigerant Charge (Oz)	22oz
Power Voltage	208/230v-1Ph-60Hz
Breaker Size	15A
MCA (Amps)	13.0A
Compressor RLA/LRA (Amps)	7.5/9.8A
Fan Motor RLA/Watts	0.3A / 70W
Pump RLA/Watts	0.2A / 30W
Noise Level (DbA)	37
Weight (lbs)	106lbs
Storage Tank	
GAUS-160QQTA/SAN-43SSAQA	43 Gallons
GAUS-315EQTD/SAN-83SSAQA	83 Gallons
Tank Connection Sizes	
Cold Water Inlet	3/4" NPT
Hot Water Outlet	3/4" NPT
Cold Water to Heat Pump	3/4" NPT
Hot Water Return from Heat Pump	3/4" NPT
Press Relief Valve Setting	125 Psig

Pipe Size - Tank to Heat Pump	
Size	1/2" & 1/2"
Max Pipe Length inc	50ft
Max Vertical Separation of	16ft
Certifications	
Safety	ETL & ETLc
Performance	AHRI
ARI Certification reference #	TBA
Warranty - System	3 Years Labor
Heat Pump	10 Years Parts
Tank	15Yrs Limited Lifetime

Accessories

General	Std
Honeywell Mixing Valve	X
HW Check Valve	X
Tank PR Valve	X

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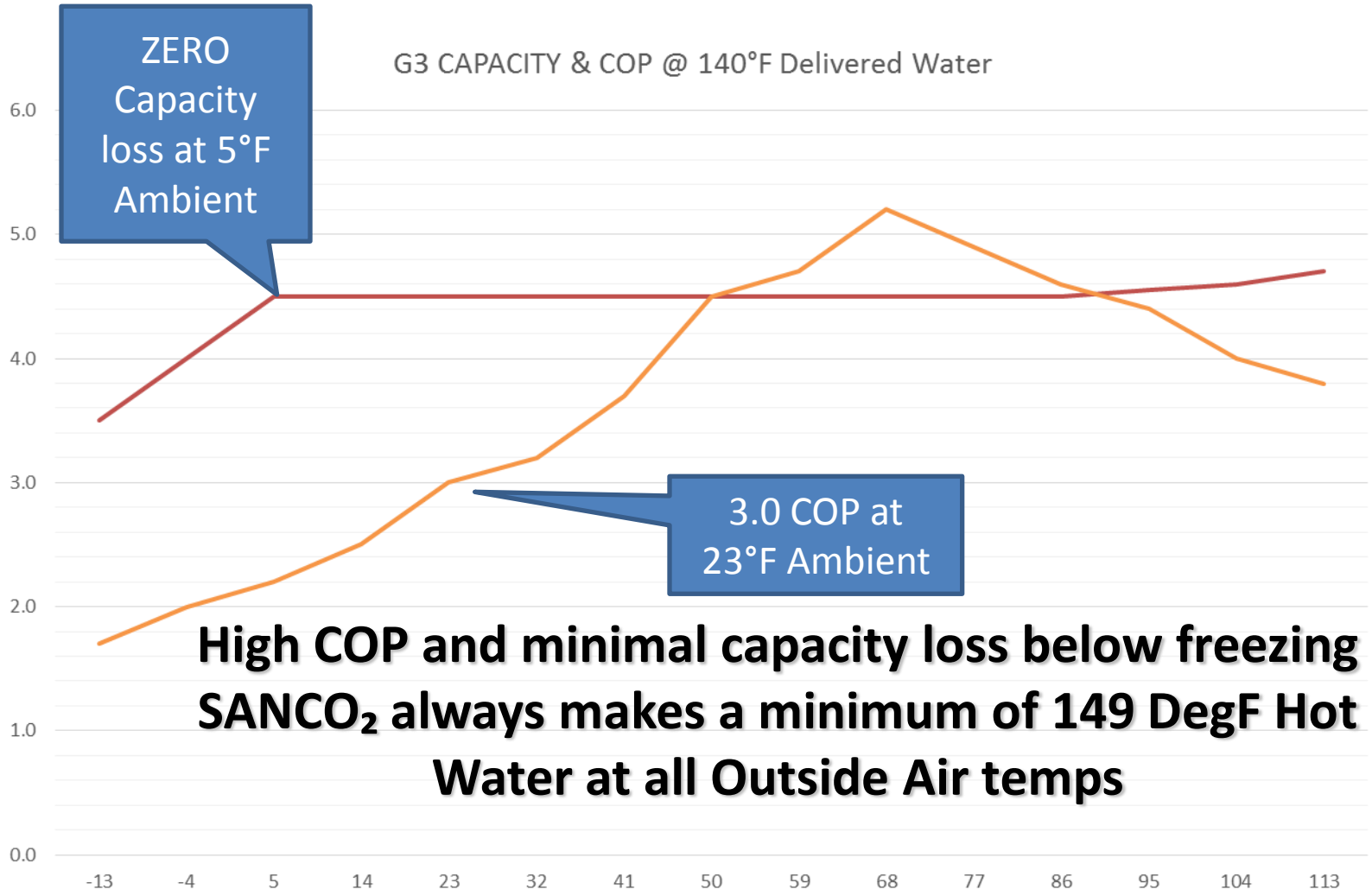
Performance vs Ambient



High COP and minimal capacity loss below freezing
SANCO$_2$ always makes a minimum of 149 DegF Hot Water at all Outside Air temps

Real World Efficiency

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GS3-45HPA + 83 Gallon Stainless Steel Tank

- **Energy Factor = 3.84, NEEA Tier 3+**
- **1st Hour = 101 Gallons at 135°F delivered water temperature**
- **Over 120 Gallons @ 125°F delivered**
- **water temperature**
- **Recovery Rate ≈ 0.3 GPM of 131 to 176°F delivered directly to the top of the tank for immediate use**

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System Component layout

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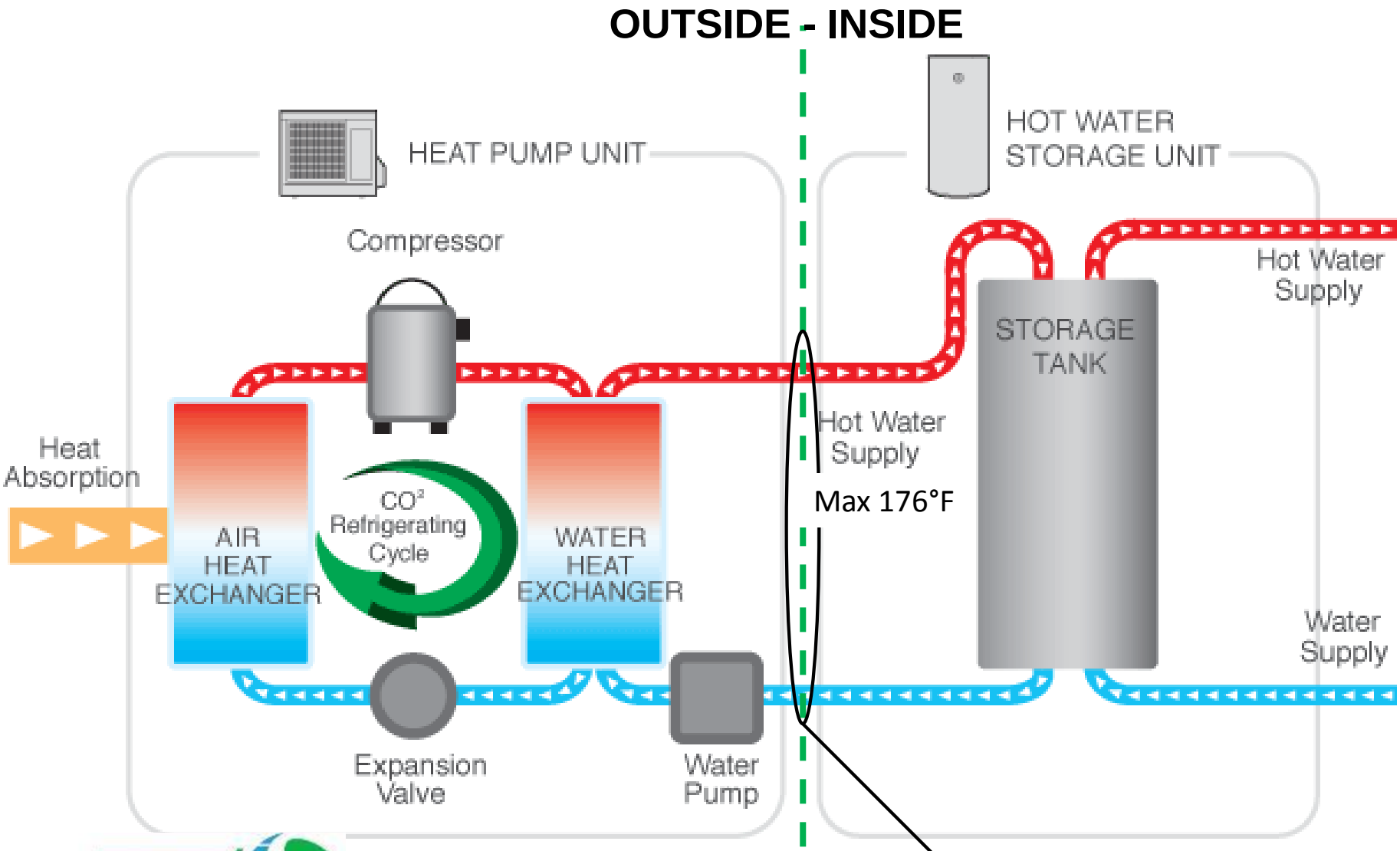

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Theory & Operation

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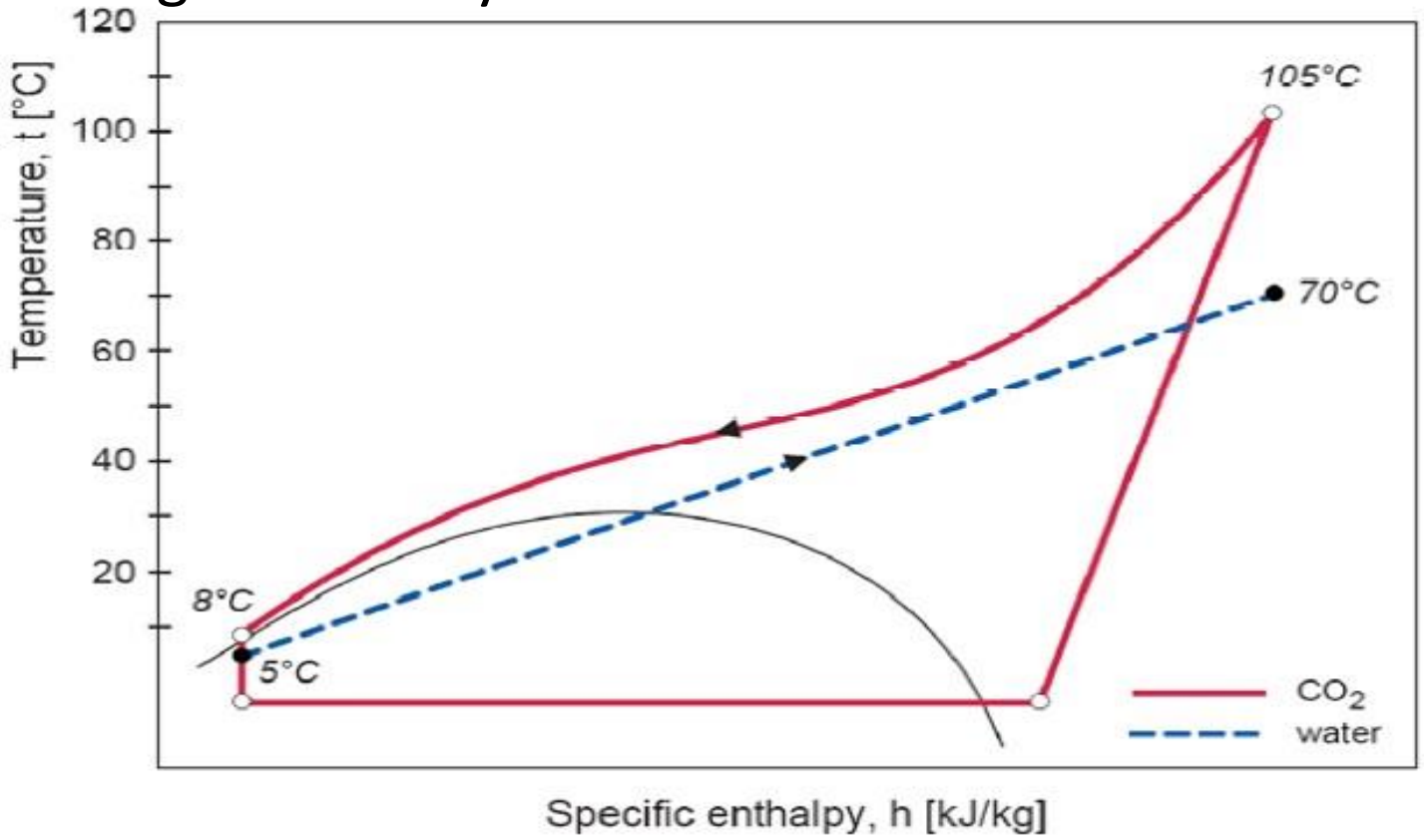
What is CO_2 Transcritical Water Heating???

In a Transcritical system

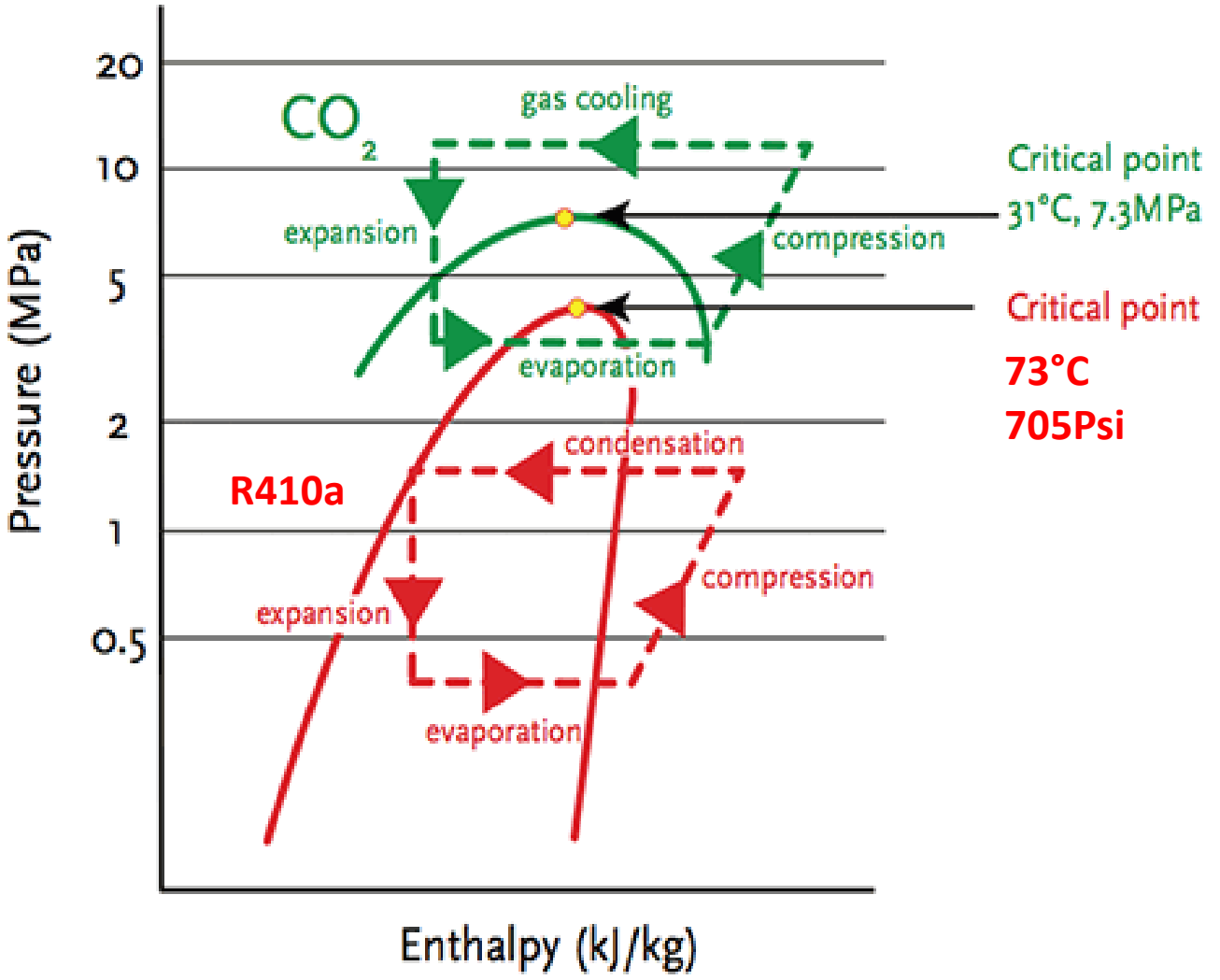
- The HP/HT CO_2 from the compressor is a Gas **BUT** behaves with the density & Heat Transfer capability of a Liquid
- The CO_2 never changes state from a Gas to a Liquid back to a Gas as in a synthetic Refrigerant cycle, it remains a **GAS** at all stages in the cycle



Pressure – Temperature Charts

In a Transcritical system

- As the refrigerant enters the "Condenser" it does not drop below the Critical Point and hence remains a Gas
- We refer to the "Condenser" in a Trancritical CO_2 system as the Gas Cooler



Class Leading Performance

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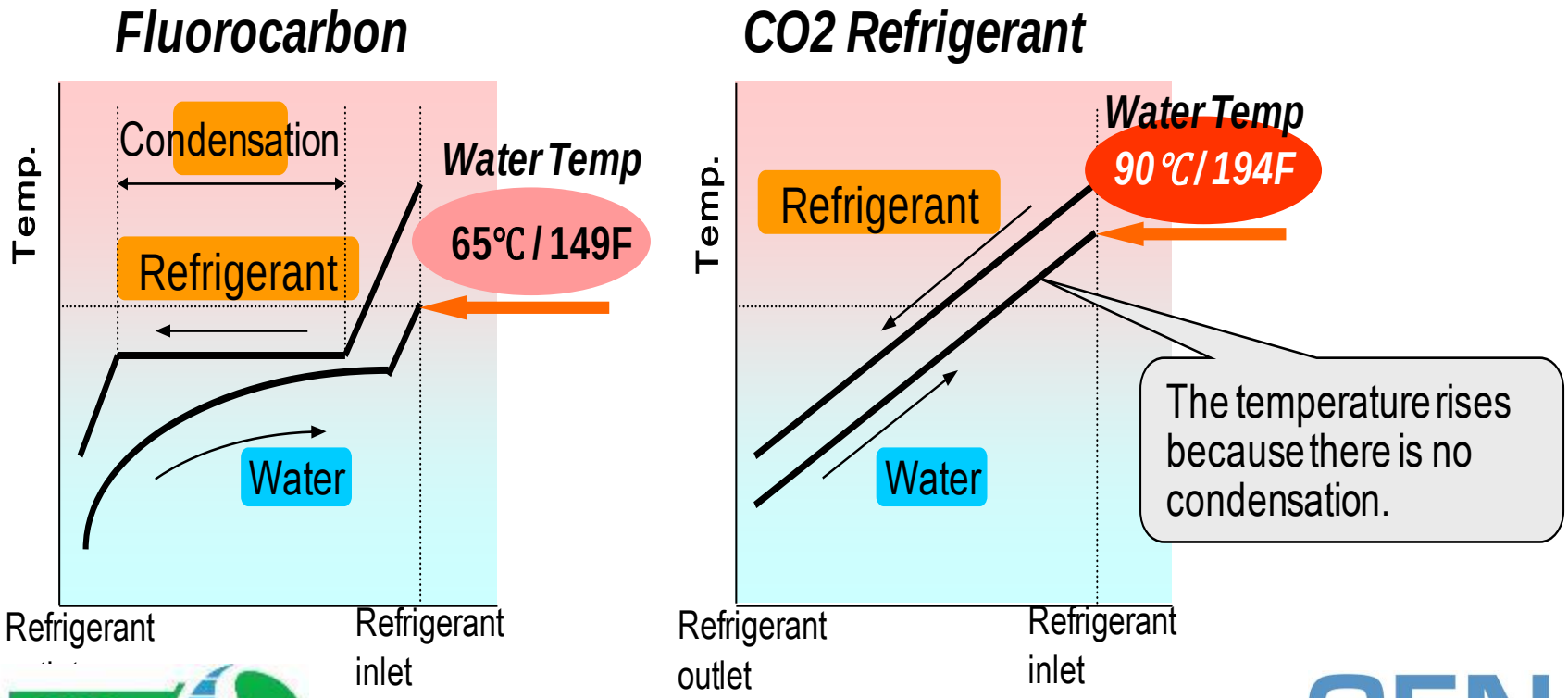
The CO_2 refrigerant operates in the transcritical area (Density of Liquid, Volume of a Gas) transferring heat immediately & effectively

- Minimal Performance loss down at -20° = No element needed
- Exceptional efficiency – no need to preheat water



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CO_2, A Natural Refrigerant

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CO_2 was first used as a refrigerant in the 1890's before R12, R22 were even synthesized, and is making a comeback in the US for Supermarket refrigeration

	Refrigerant	ODP	GWP	Toxicity	Flammability	Notes
Fluorocarbon refrigerant	R134a	0	1,430	No	No	Refrigeration & HPWH
	R410A	0	2,086	No	No	HP, AC & HPWH
	R407C	0	1,800	No	No	HP & AC
Natural refrigerants	**CO_2**	**0**	**1**	**No**	**No**	
	Propane Gas	0	20	No	Yes	Flammable
	NH3 Ammonia	0	<1	Yes	Yes	Plume Study required

CO_2: *Extremely low GWP compared to **ALL** HFC refrigerants – Non Ozone Depleting, Non Flammable, Non Toxic, Safe & Simple*

Future proofed against phase out

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Sanden are experts in CO_2

Since 2004 Sanden has led the Industry in the development of CO_2 products

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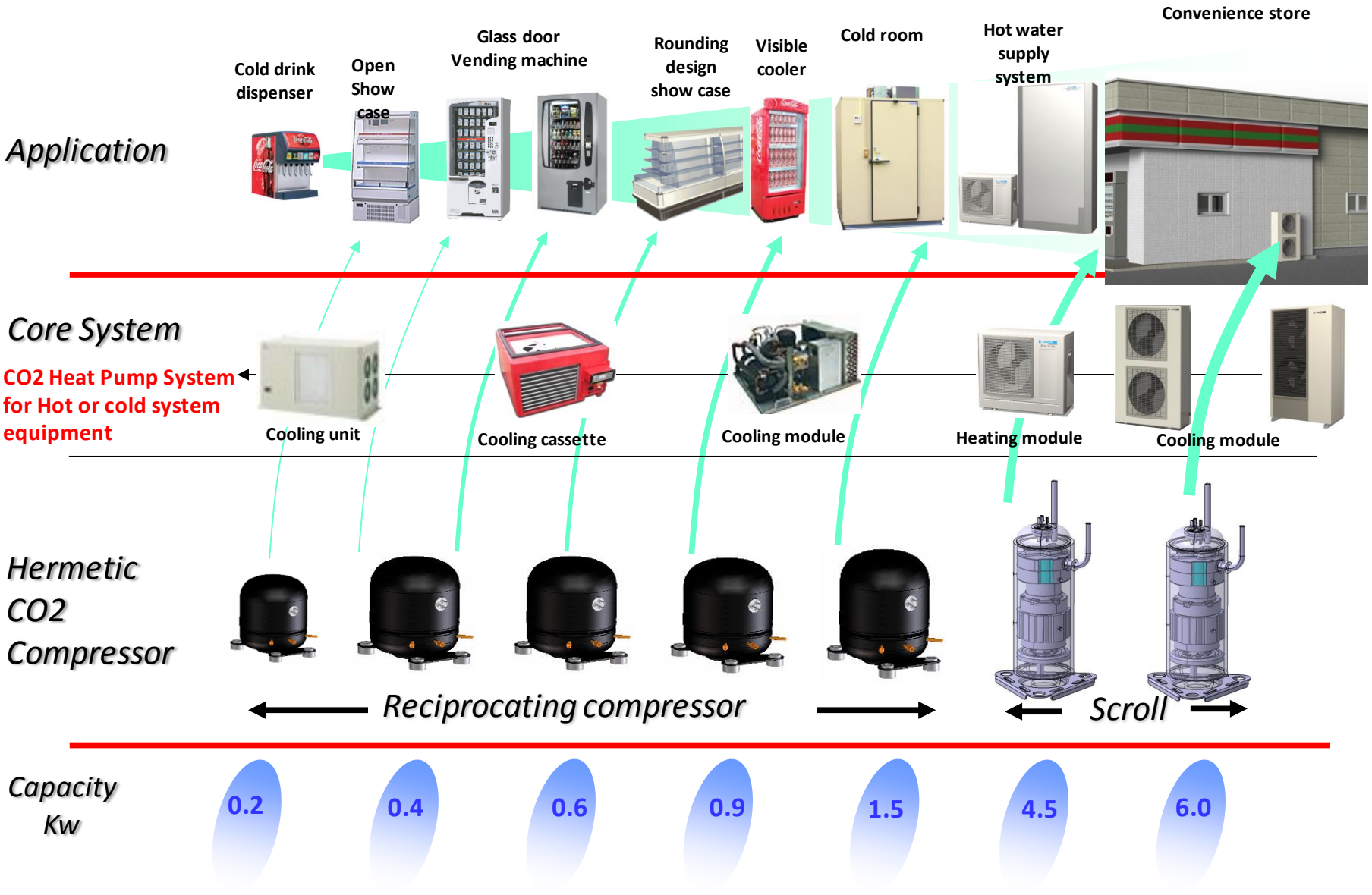

Sanden Water Heater Timeline

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- 2006 Introduced CO_2 Eco Cute in Japan
- 2011 Introduced product into Europe
- 2011 Introduced product into Australia
- 2012 First Test units in US
- 2013/4 WSU/Utility Lab and Field trials
- 2014 Pilot Sales program started
- 2016 Full Launch of
  $SANCO_2$ Split CO_2 HPWH
- 2017 Gen3 released……

$SANCO_2$

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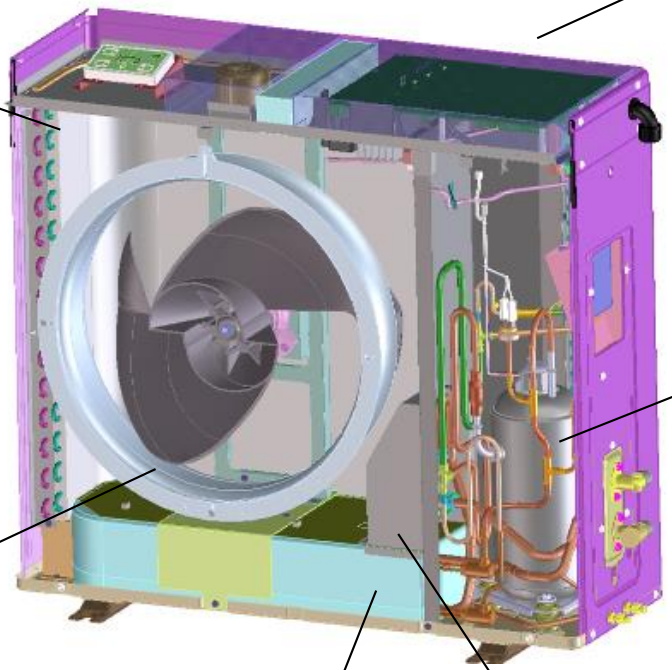
Outdoor Unit – Main Components

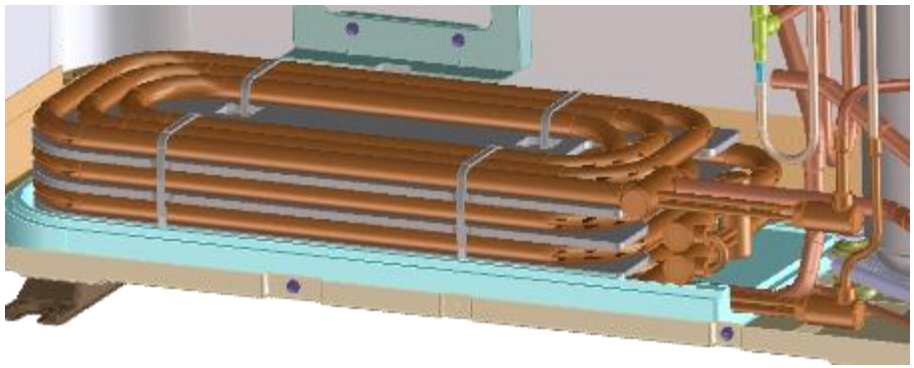
Main PC Board

Evaporator

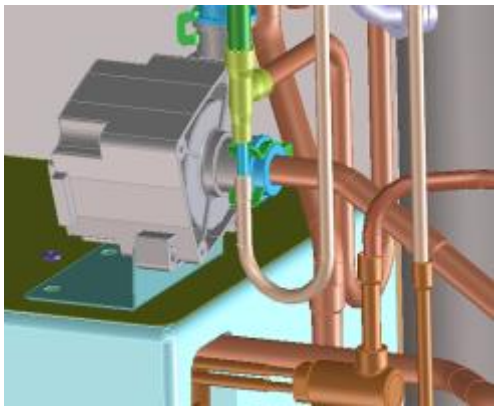


Compressor

Fan

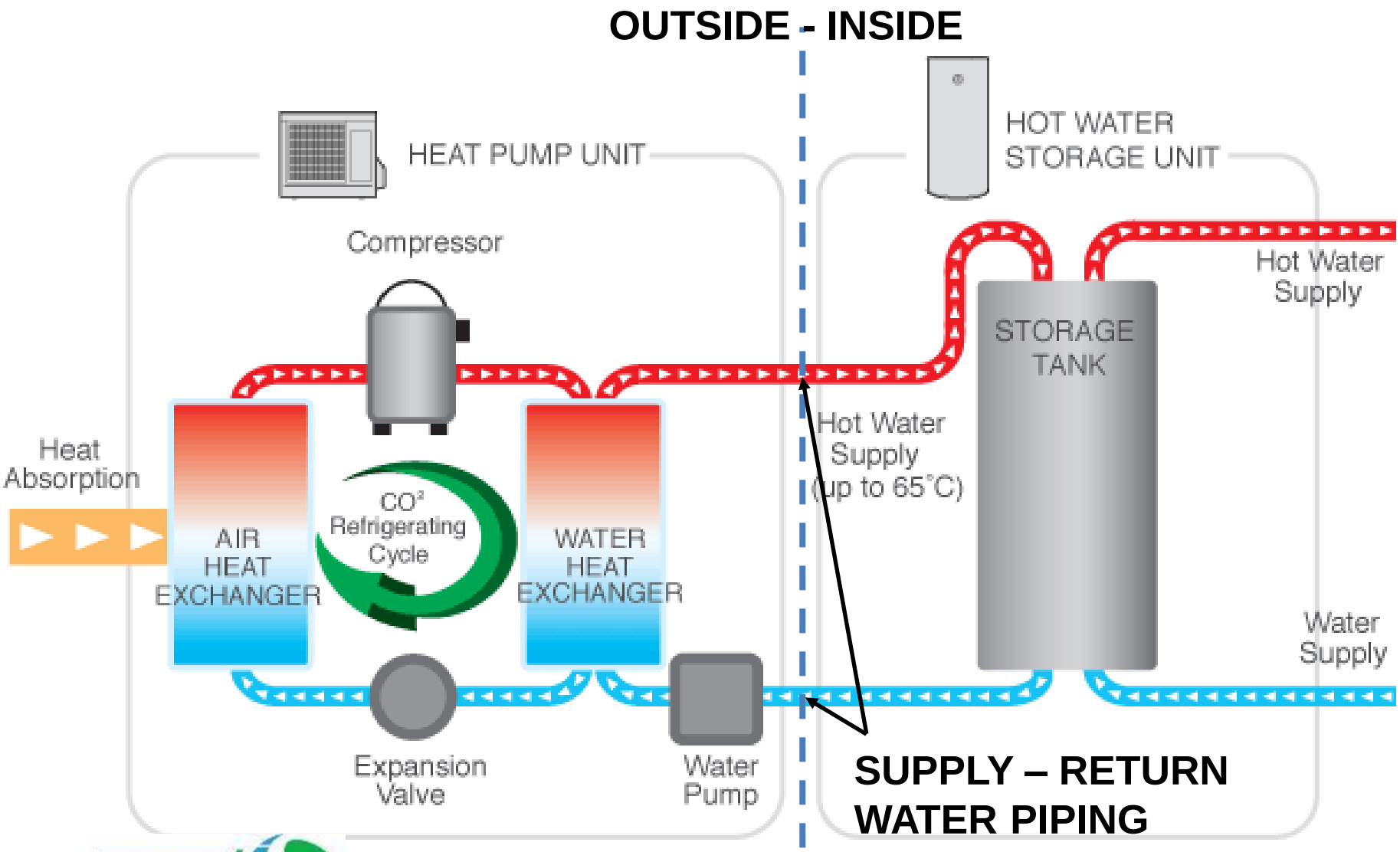


Gas Cooler (CO_2 to Water HX)
Double Wall Construction



Water Pump

Anatomy of CO_2 Split type Heat Pump



Here's how it works

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1. Tank provides storage of Hot Water
2. As Hot Water is used Cold Water enters the bottom of the tank stratifying the tank with the hot water stored at the top so it can be used
3. On an 83 Gallon tank after using about 50 Gal of hot water, the tank thermistor temperature is < 113°F
4. Outdoor unit recognizes that Tank Thermistor is below start point and energizes

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Here's how it works

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5. Pump energizes and water flows from the Tank to Outdoor Unit
6 3 Minutes later Compressor starts and water is heated to desired set point & is pumped back to the top of the tank
7. As the unit continues to run, this hot water pushes the cold water down to the bottom of the tank and the tank remains stratified
8. When the return water from the bottom of the tank is 122°F (measured at the HX Inlet) Outdoor unit cycles off awaiting the next call

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Detailed Refrigerant Cycle

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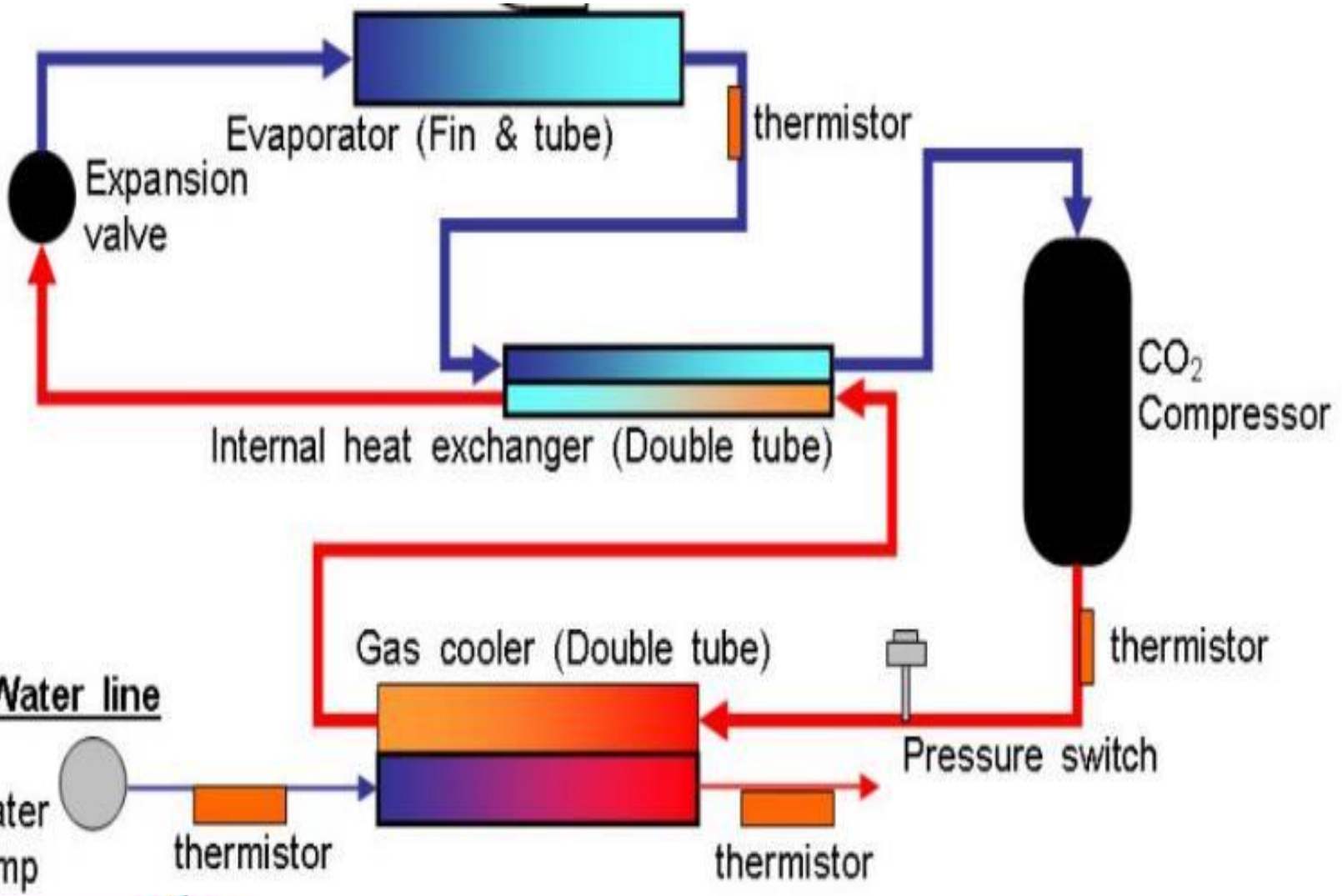

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Independent Field
&
Lab Testing

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5 years Testing, Lab & Field

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Utility/State Funded Projects in North West

Washington State University

Bonneville Power Administration

Northwest Energy Efficiency Alliance

Energy Factor: 3.35

Utility Company Funded Lab Test Project in Tennessee

Energy Factor: 3.2

Pilot Unit test Program Individual Units sold in 8 States & Mexico

Government Funded Field Test in Tennessee

Average Energy Consumption: 2.5 kw/h per day (64 gallons daily usage)

Homes used for field test

Tennessee Valley Authority

OAK RIDGE National Laboratory

Field Testing Overview

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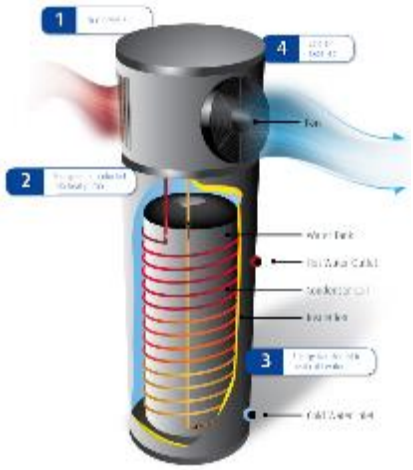
Standard HPWH **VS** **Sanden HPWH**



- R134a/R410a
- Indoor installation
- Noise >50dB
- Electric backup element required
- Cools home even in the winter

- CO_2 (R744)
- Heat Pump installed Outside, Tank Inside
- Noise <40dB
- NO electric backup element
- No Energy loss to home

#1 : Replacing Electric Resistance Water Heaters field test

- Homes across the NW from the Coast to Montana; Min family size 4, Maximum of 7
- Partners —Washington State University, NEEA, BPA, Avista, Energy Trust of Oregon, Ravalli Electric Coop, and Tacoma Power

#2 : Demand Potential Comparison

- What is the energy storage capacity in long-term field use when subject to high hot water use – 130+ Gallons per 24 hours
- Partners : Washington State University, NEEA, Bonneville Power Authority, PNNL & DOE

Field Test Monitoring

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Sample Site	Sampled Days (n)	kWh/Day	Total Household Hot Water (Gal/day)	Mean OAT (°F)	Minimum OAT (°F)
Addy, WA	420	6.8	98.7	46.6	2.1
Corvallis, MT	604	6.0	75.6	49.6	-15.7
Portland	690	3.5	45.4	57.1	17.9
Tacoma	607	5.0	80.5	52.9	22.2

Units were monitored for Energy and Water use, along with multiple temperature sensors in the system

The energy needed to heat the cold water supply for each flow event was calculated as:

Supply Water BTU = Volume (Supply water) x 8.34 x (Avg. hot water temp. – Avg. cold water temp.) x 1 Btu/lb./oF, where 8.34 lb./gal is the density of water

A Field Energy Factor (Energy Factor being the official DOE Water Heater Descriptor) was calculated :

FEF = Energy Contained in Total Useful Hot Water/Total Energy In

Data from installation through 10/31/2014

Field Test Results

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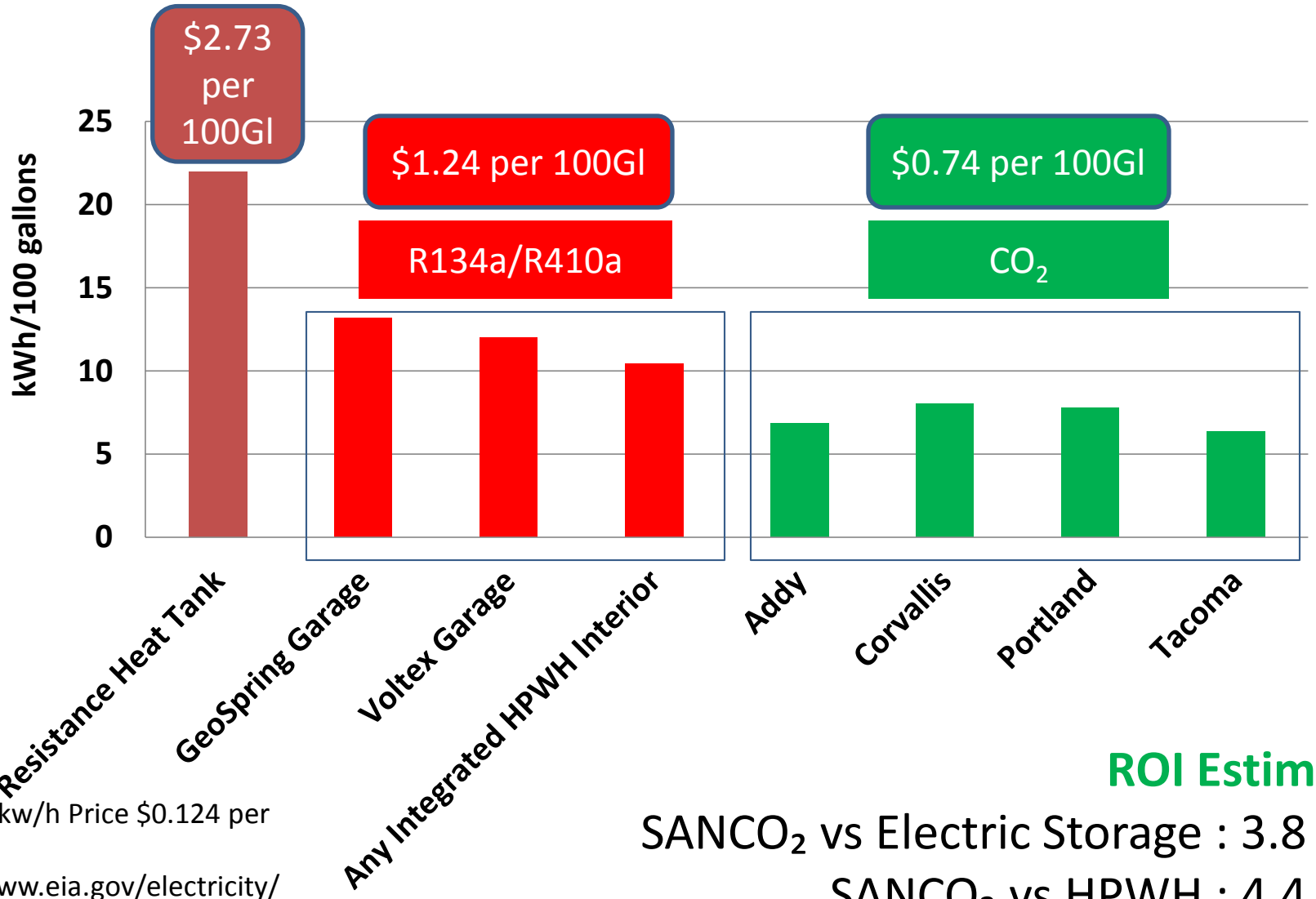
kWh/100 gallons – Standard HPWH results from a NW Test



Average kw/h Price $0.124 per kwh
http://www.eia.gov/electricity/monthly/update/end_use.cfm

ROI Estimation

$SANCO_2$ vs Electric Storage : 3.8 Years

$SANCO_2$ vs HPWH : 4.4 Years

Demand Response

Approx. 130 Gallons used per 24 Hour Period using varying Flow Rates and Length of Draw

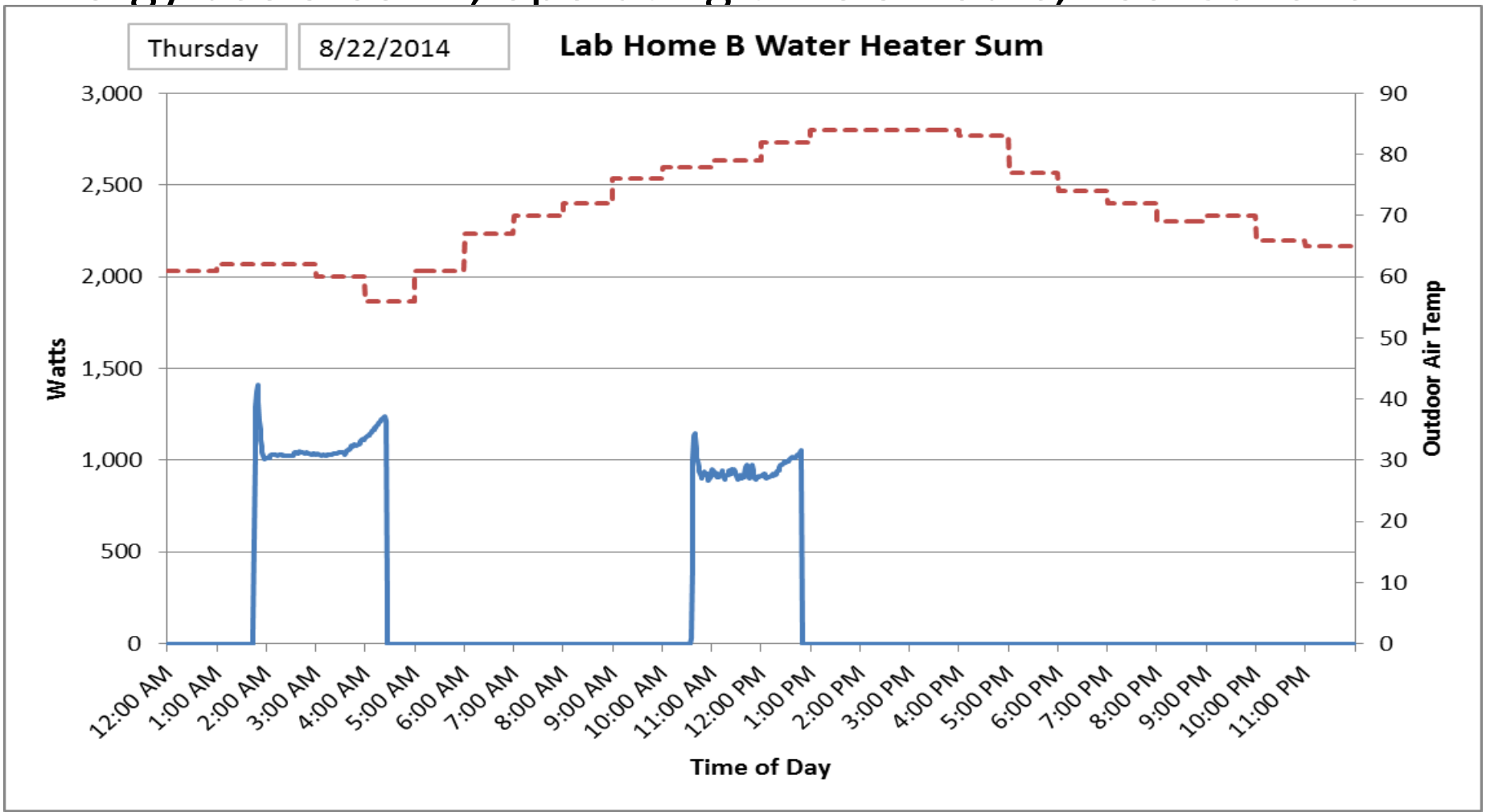
System potential test : Outdoor unit is turned off for varying periods of time to determine if the system can meet Hot Water demand

Over Supply Schedule		
	Off Time	On Time
Day 1	None	None
Day 2	5PM	Midnight
Day 3	4PM	Midnight
Day 4	3PM	Midnight
Day 5	2PM	Midnight
Day 6	1PM	Midnight
Day 7	Noon	Midnight

System Power Usage

This graph shows the unit in standard operation responding to the draw pattern & tank temperature

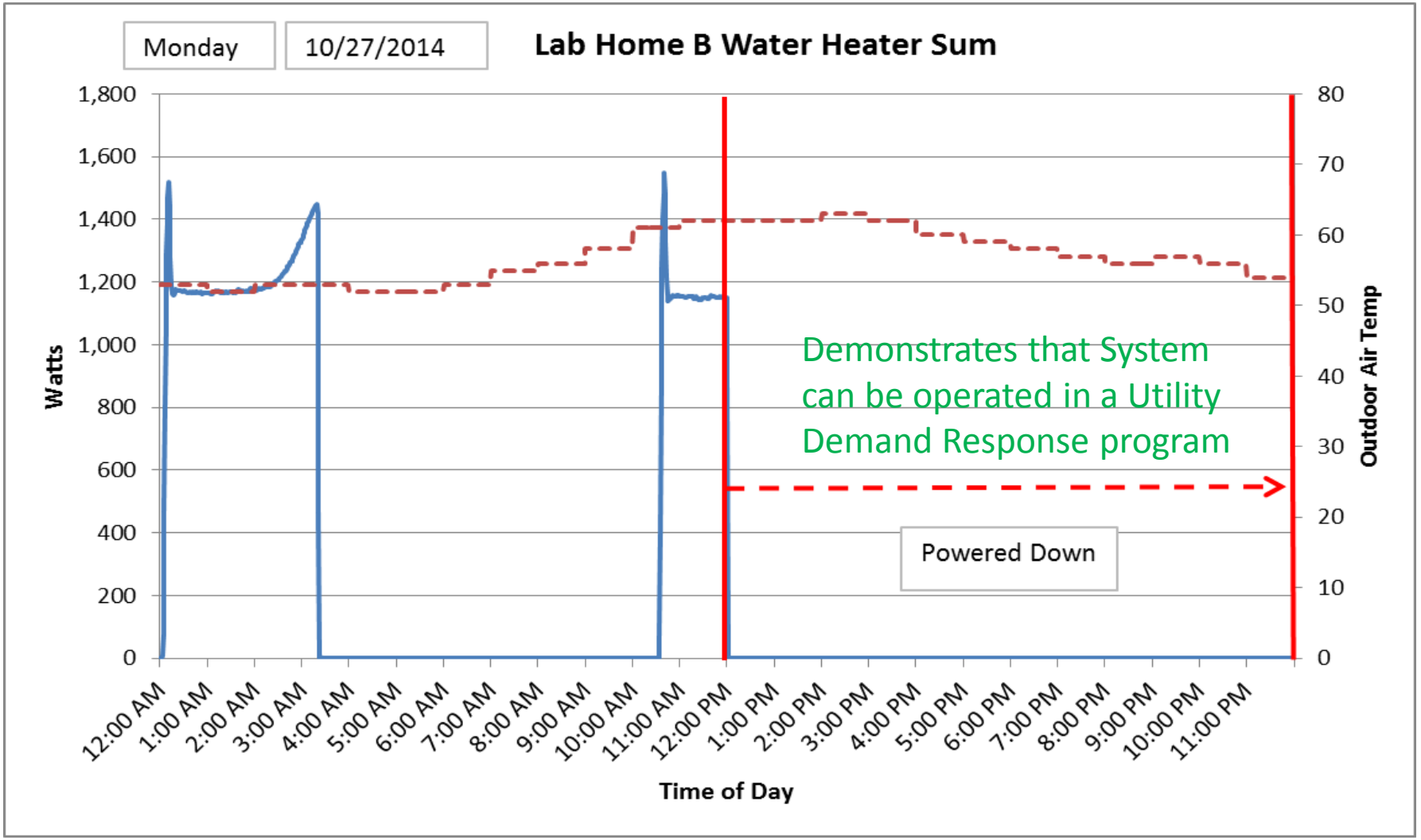
Energy use 5.05kw, operating time 5 hours, 139 Gallons



Demand Potential Power Usage

This graph shows the unit was shut off for 12 hours

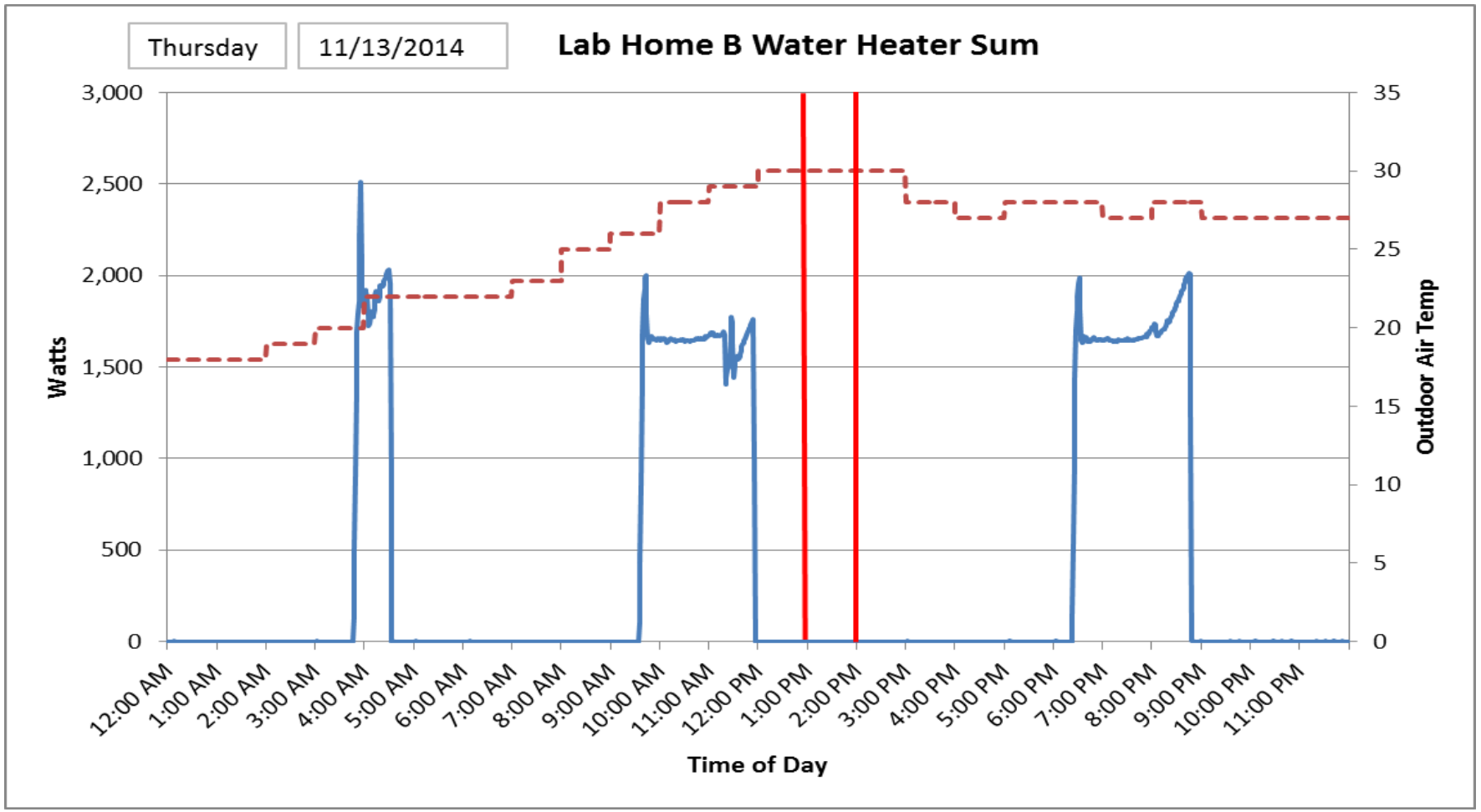
Total Energy use 5.63 kw, no reduction in HW performance



Demand Potential Power Usage

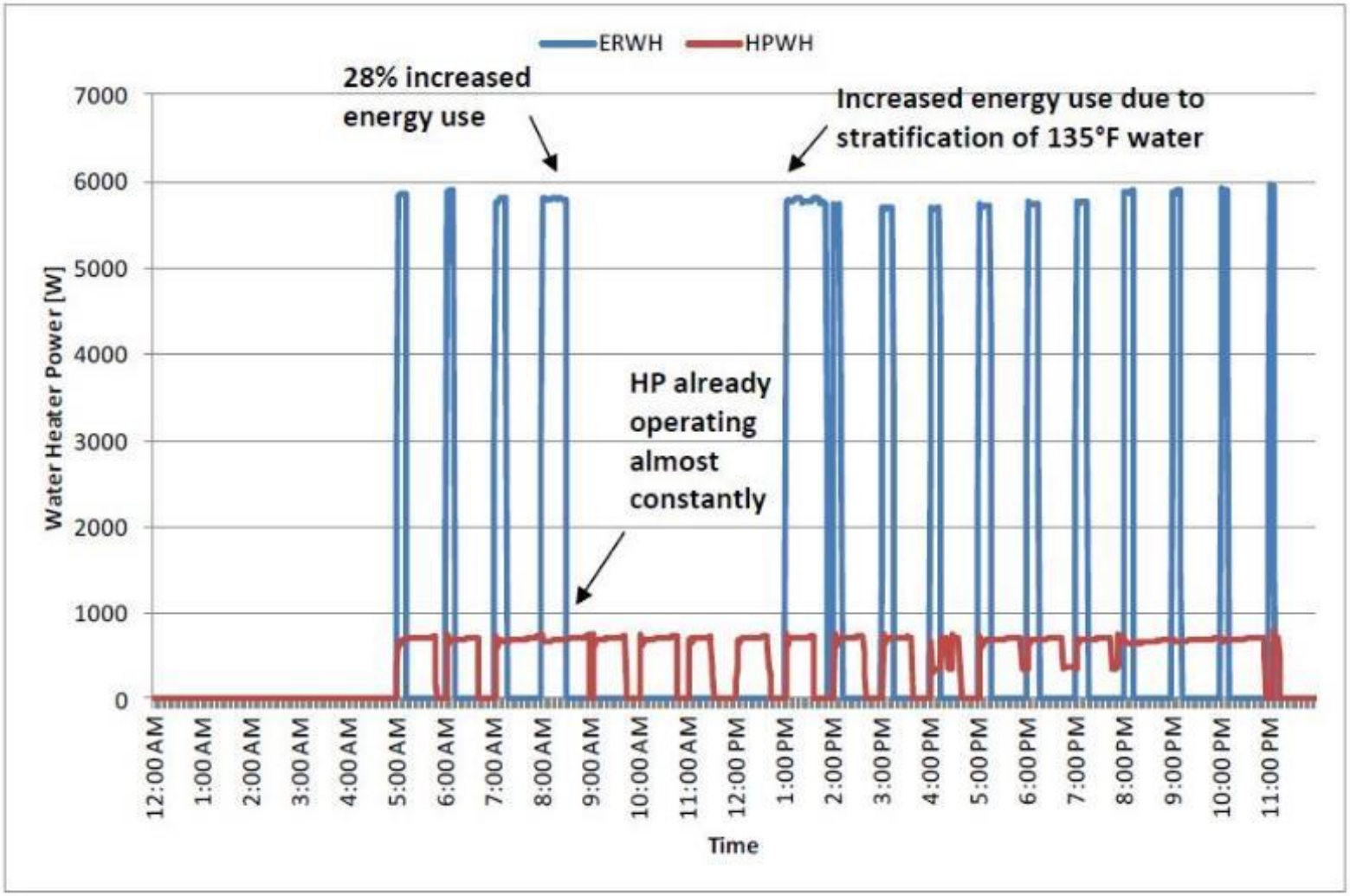
Showing effect of Ambient temperature below freezing and a shut down period on power use

9.4kw total use over a 6 hours run time, no loss of HW performance

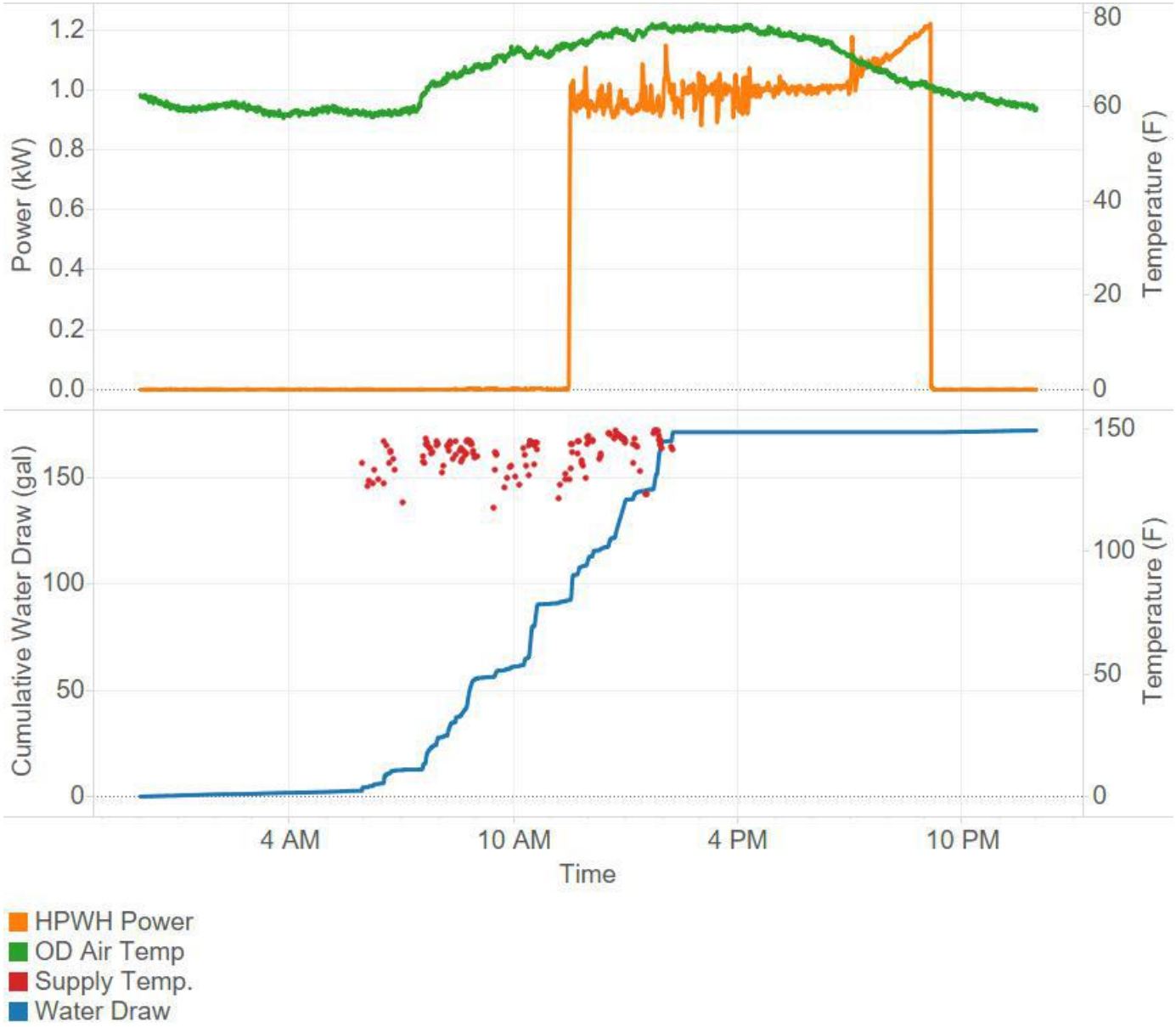


Standard HPWH Water Heater

72 Gallons usage only – Note Electric Heater usage



Institutional Power Usage – 2 Tank & 1 Hp



Tested Validations

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The Sanden SANCO$_2$ HPWH

- Provides Domestic Hot Water to any home in **Ambient temperatures down to -20°F and beyond**
- **Does not require a Back up Electric Element** for the Storage Tank
- **Only needs to operate 25%** of the time, when compared to Synthetic Refrigerant HPWH's
- Is **over 3 x more efficient** than electric resistance water heating and **40% more efficient IN COLD AMBIENTS** than Synthetic Refrigerant HPWH's
- **Can produce over 135 gallons of Hot Water daily** including a 12 hour shut down period

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Application & Installation

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DHW Usage Sizing – Residential

- 2 Sizes of tank available, 43 & 83 Gallon
- Size with the First Hour rating in the specifications, use the smallest tank possible unless you believe load will grow
- In a cold ambient < 25°F design temperature we recommend the use of the larger capacity tank
- Follow piping diagram and standard installation practice
- Multiple Tanks and Heat Pumps can be used to increase storage or recovery in high water usage or commercial applications

Typical Unit Installations

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DHW Usage Sizing – Commercial

- Storage and Recovery are very important – We will be adding extra tank sizes from 120 to 500 Gallons shortly
- Each Heat Pump recovers at approx. 18 GPH
- Usage Patterns and Fixture Size need to be accounted for to determine Peak load requirement and duration – ASHRAE sizing is conservative
- Recirculation becomes paramount, 24/7 type recirculation is not recommended, Enovative Recirculation systems are flow/temp sensitive

DHW Recovery Rate per Heat Pump

Gallons per Minute (GPM)						
	Incoming Water Temperature					
Heat Pump Set Point	40	45	50	55	60	65
130	0.34	0.36	0.39	0.41	0.44	0.47
140	0.31	0.32	0.34	0.36	0.39	0.41
150	0.28	0.29	0.31	0.32	0.34	0.36
160	0.26	0.27	0.28	0.29	0.31	0.32
165	0.25	0.26	0.27	0.28	0.29	0.31
175	0.23	0.24	0.25	0.26	0.27	0.28

Gallons per Hour (GPH)						
	Incoming Water Temperature °F					
Heat Pump Set Point °F	40	45	50	55	60	65
130	20.5	21.7	23.1	24.6	26.4	28.4
140	18.5	19.5	20.5	21.7	23.1	24.6
150	16.8	17.6	18.5	19.5	20.5	21.7
160	15.4	16.1	16.8	17.6	18.5	19.5
165	14.8	15.4	16.1	16.8	17.6	18.5
175	13.7	14.2	14.8	15.4	16.1	16.8

DHW Tank Fraction

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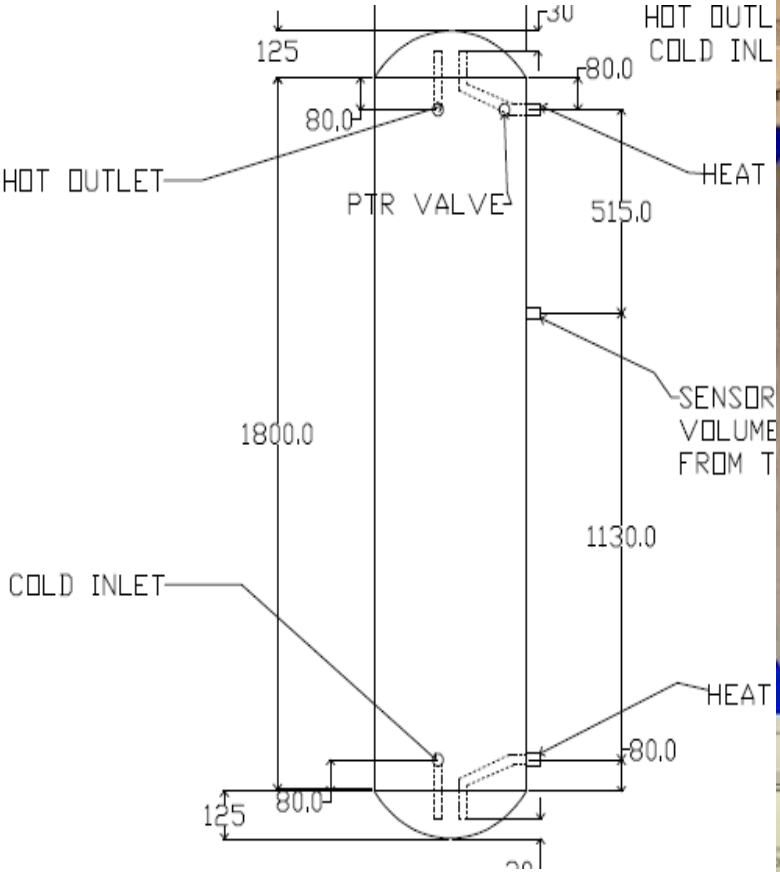

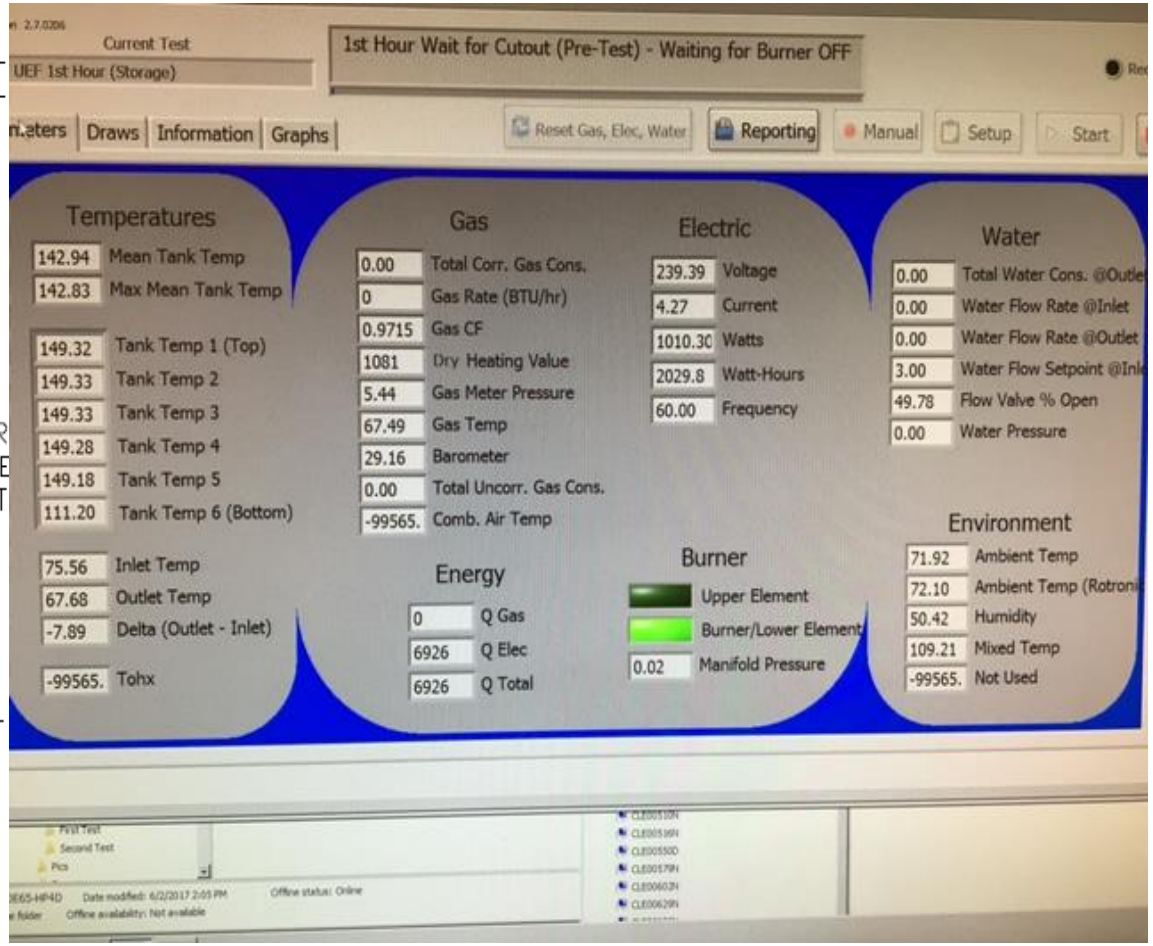

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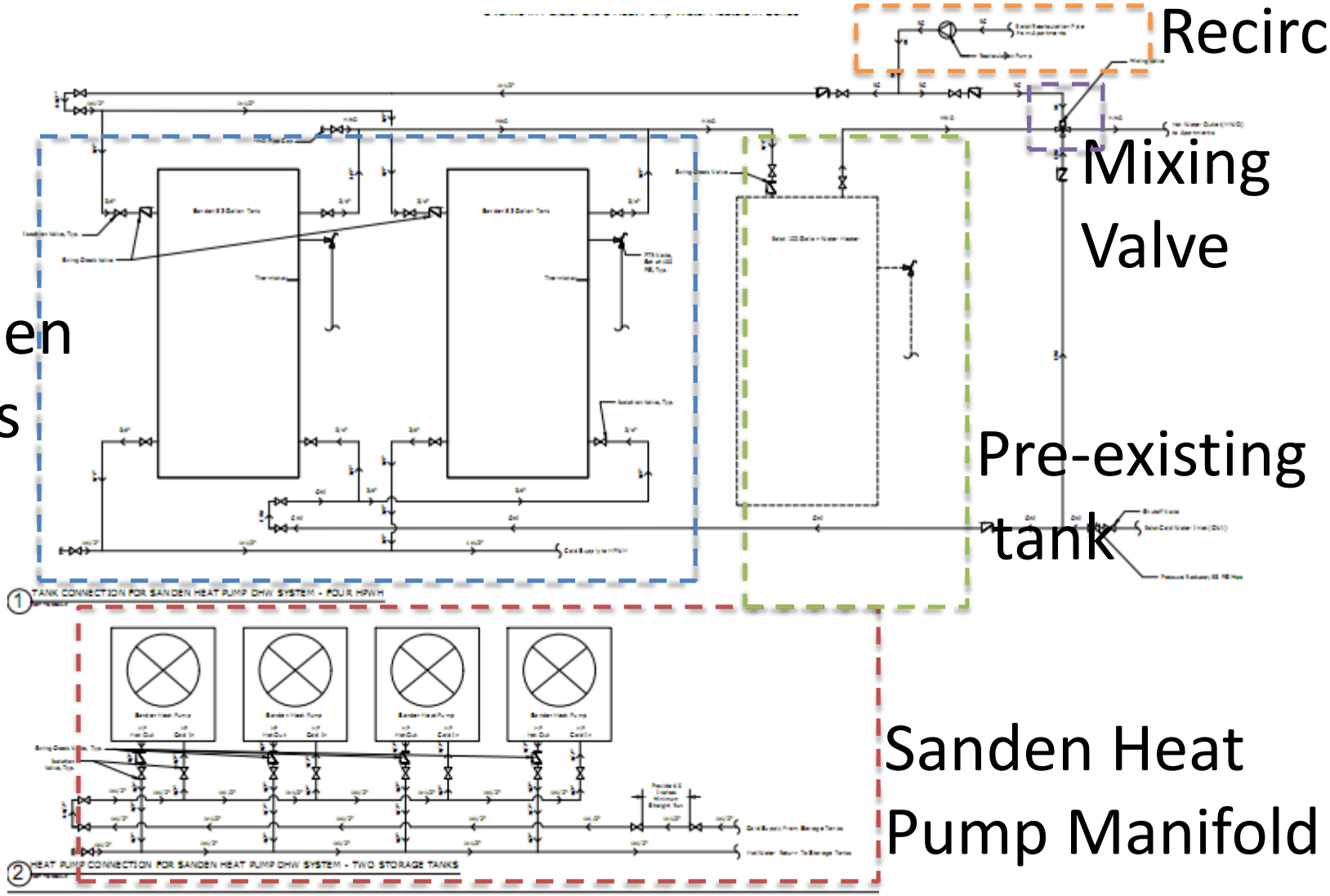
GEN3

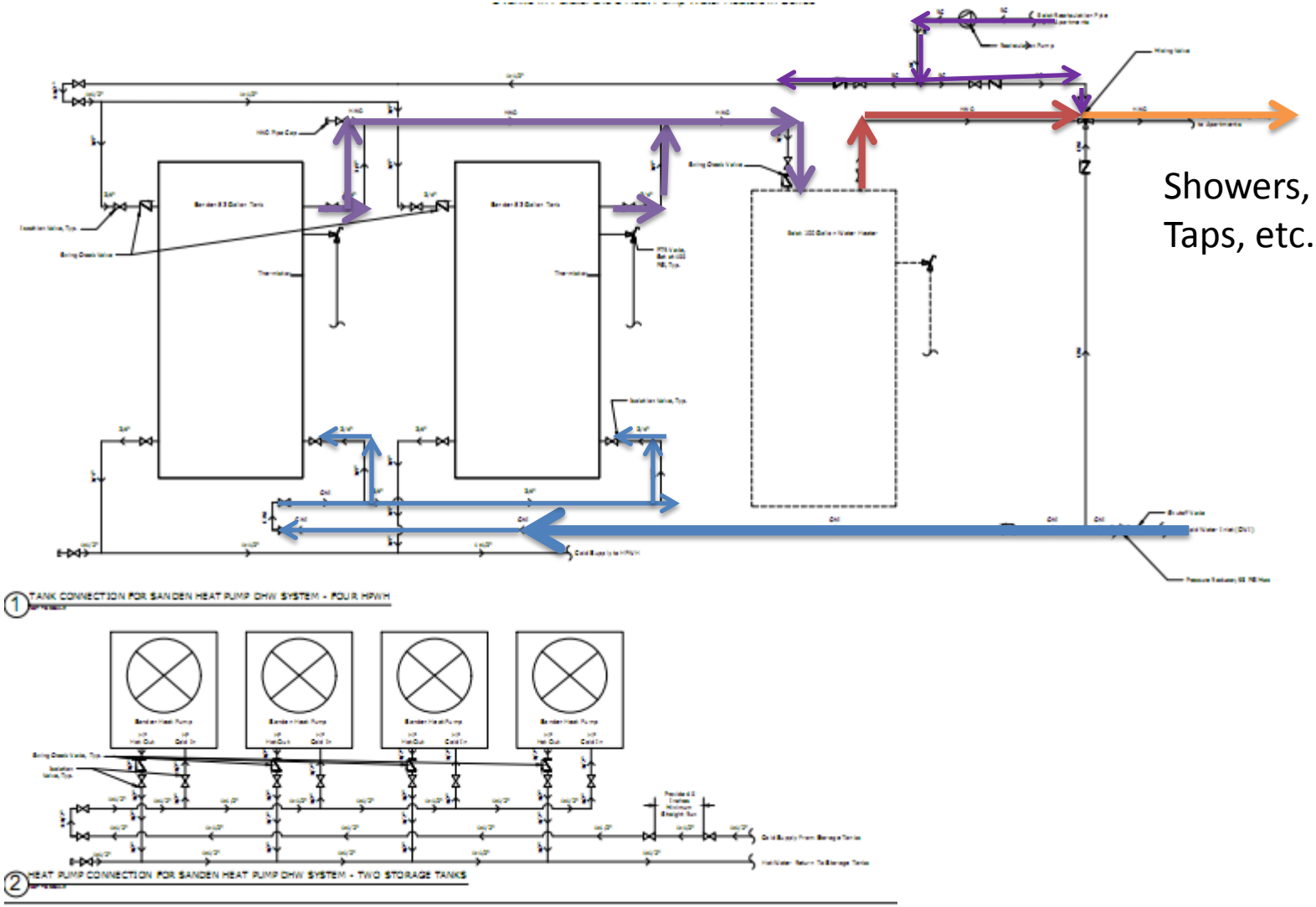
DHW Usage Sizing – Commercial

- Indoor HP installation is possible – units need approx. 800 CFM ventilation air per Heat Pump

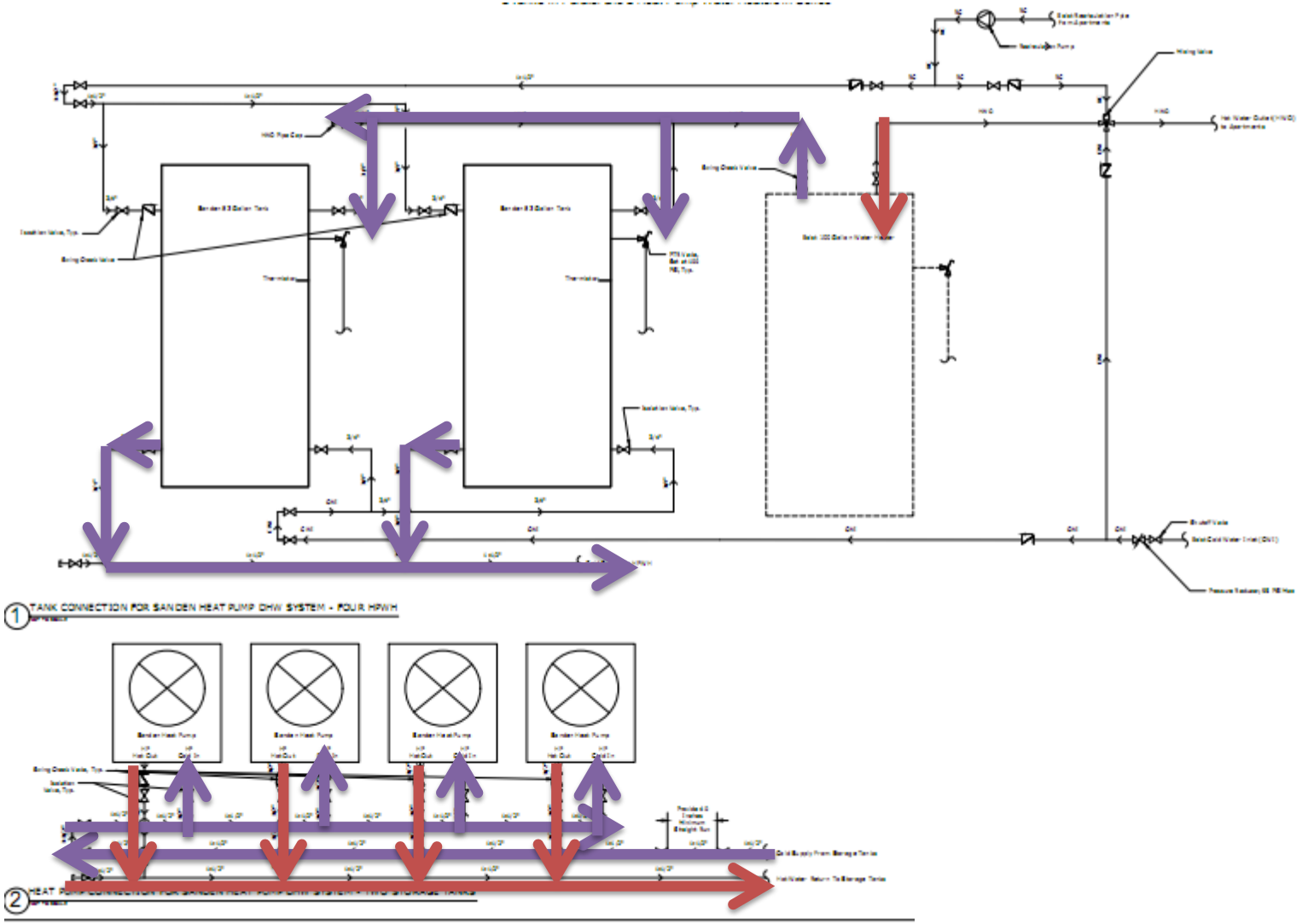
Typical System Schematic



System Operation - Usage



System Operation - Heating



I want “Instant” Hot Water!

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- Recirculation – MUST be Temperature or sensor controlled NOT Timer controlled

- Ennovative Auto Hot is recommended

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I want “Instant” Hot Water!

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- Recirculation – MUST be Temperature or sensor controlled NOT Timer controlled

- Pump sized to just push water through the unit to remove the cold plug – depending on size/length of piping this can only need to be 3 or 4 gallons of water to be moved

- We require the type of recirculation systems which are installed under the last fixture and push the plug in the system back to the cold water side of the tank, and are controlled by Aquastat only

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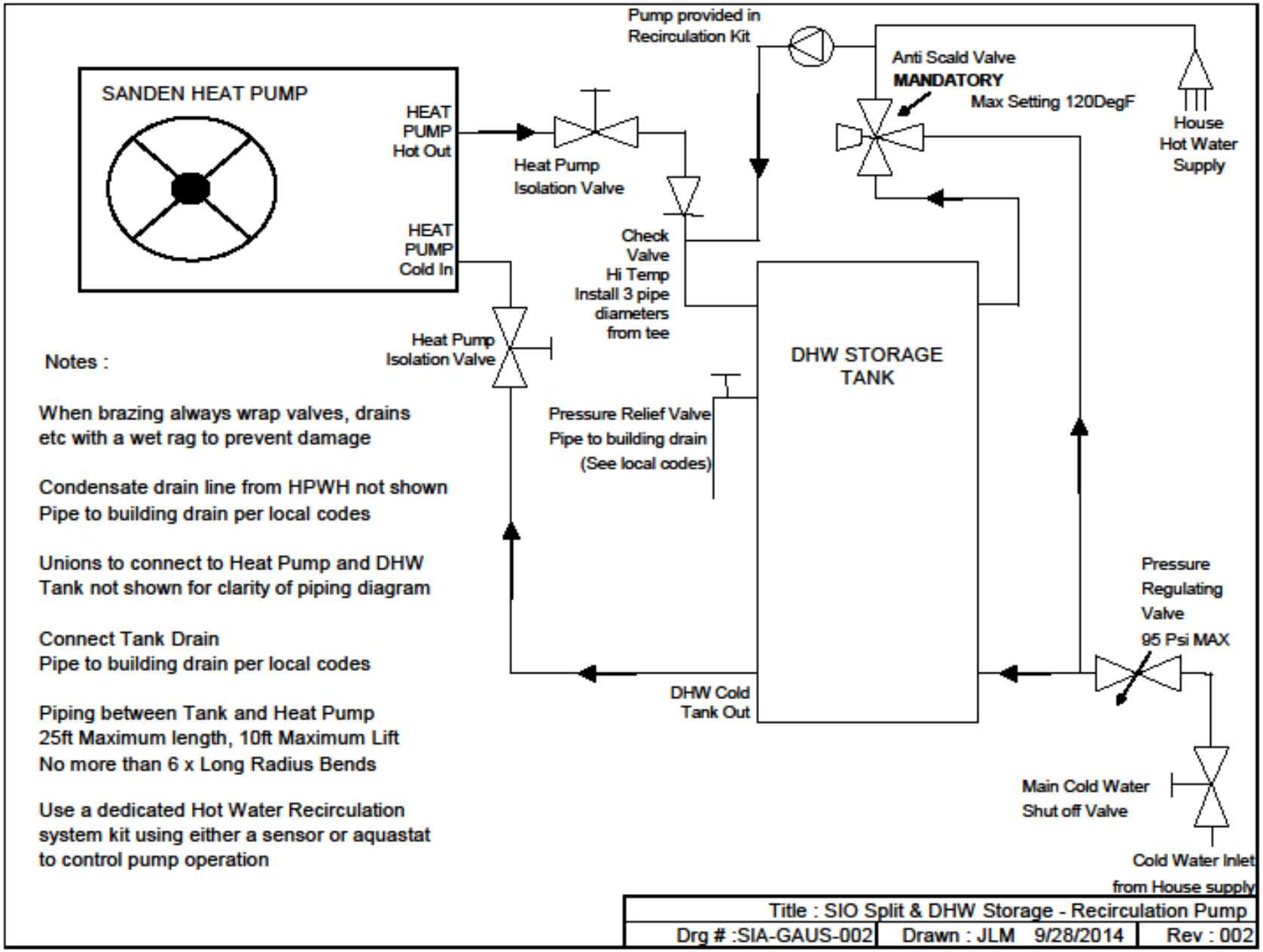
GEN3



Notes :

When brazing always wrap valves, drains etc with a wet rag to prevent damage

Condensate drain line from HPWH not shown
Pipe to building drain per local codes

Unions to connect to Heat Pump and DHW Tank not shown for clarity of piping diagram

Connect Tank Drain
Pipe to building drain per local codes

Piping between Tank and Heat Pump
25ft Maximum length, 10ft Maximum Lift
No more than 6 x Long Radius Bends

Use a dedicated Hot Water Recirculation system kit using either a sensor or aquastat to control pump operation

Title : SIO Split & DHW Storage - Recirculation Pump		
Drg # :SIA-GAUS-002	Drawn : JLM 9/28/2014	Rev : 002

Interconnect Piping

- Max Distance between Tank and Outdoor :

  50ft including 16ft of lift

  6 Bends maximum
- Piping size : Ø1/2” NSF Copper or PEX (Potable Water)
- **Both lines must be insulated with minimum ¾” Closed Cell Insulation**
- **Keep Outside Water Piping to a minimum**

Water Supply – Pressure & Quality

- **Water Supply Pressure** :
- Minimum Water Supply Pressure – 29 Psi

- Maximum Water Supply Pressure – 95 Psi

- **It is MANDATORY to install a Pressure Regulating Valve, even if the supply water pressure is less than 95 Psi**

Water Supply – Pressure & Quality

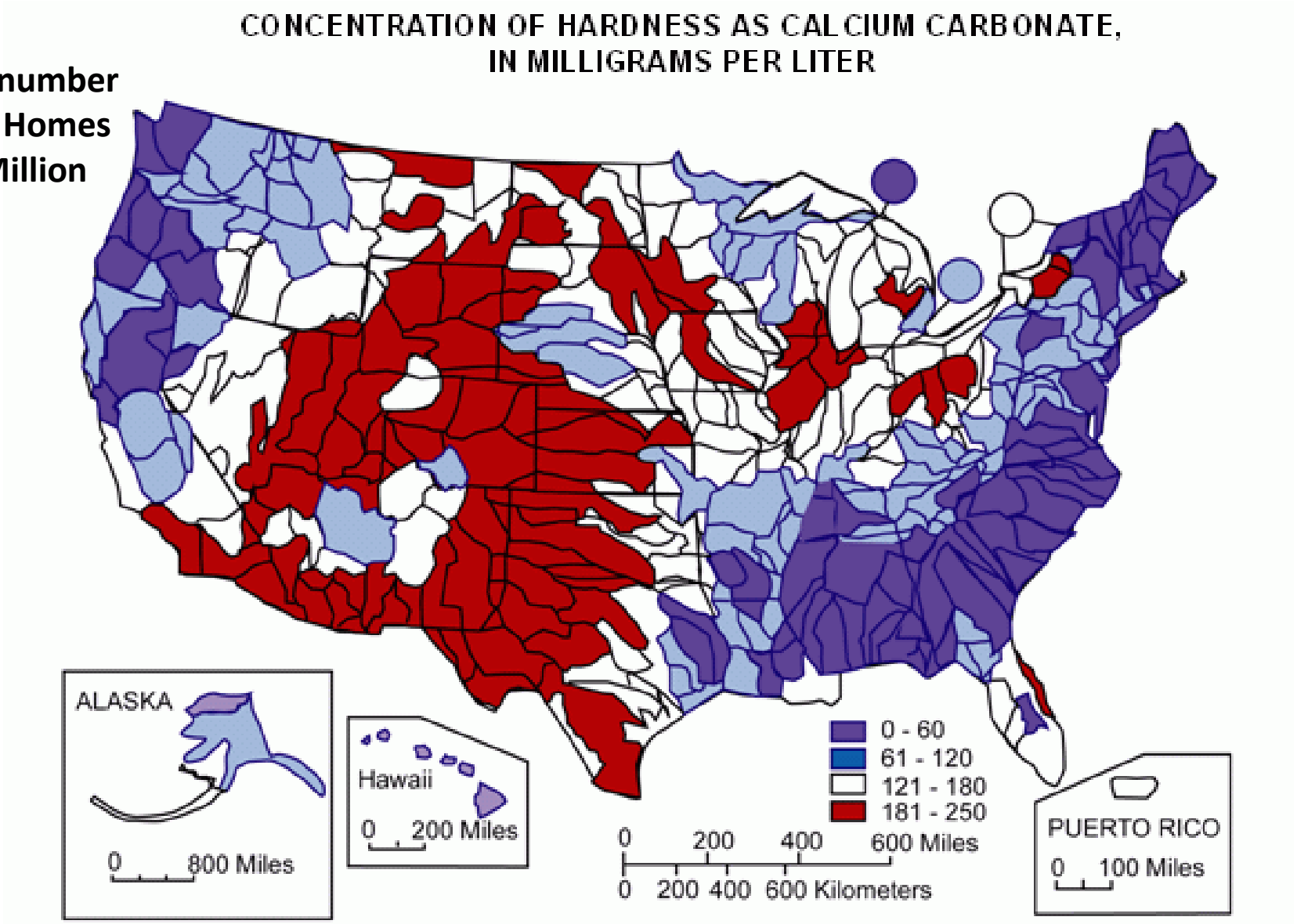
- **Water Quality** :

Description	PH	TDS (Total Dissolved Solids	Total Hardness	Aluminum	Chlorides	Copper	Iron	Manganese	Zinc
Maximum Levels	6.0 to 9.0	Up to 500 ppm	Up to 200 ppm or 12 grains hardness	Up to 0.2 ppm	Up to 200 ppm	Up to 1.0 ppm	Up to 0.3 ppm	Up to 0.05 ppm	Up to 5 ppm

- If the water quality is outside of these guidelines then treat it, or the system could fail, multiple options are available at the plumbing counter

US Water Hardness Map

Total number of US Homes 132 Million



Before Installing the Unit

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1. Size the Unit correctly
2. Location Water Supply – Pressure & Quality
3. Location for the Outdoor Unit

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Outdoor Unit Location

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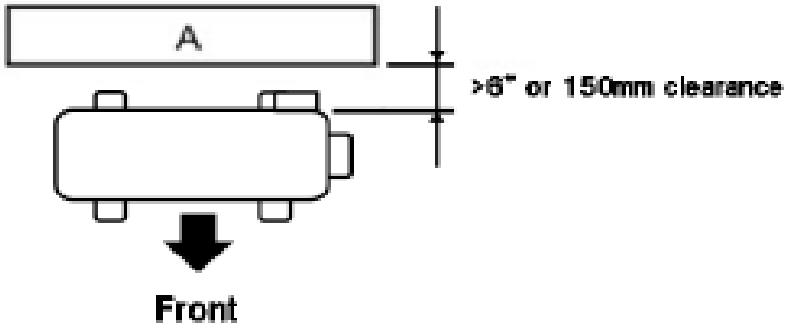
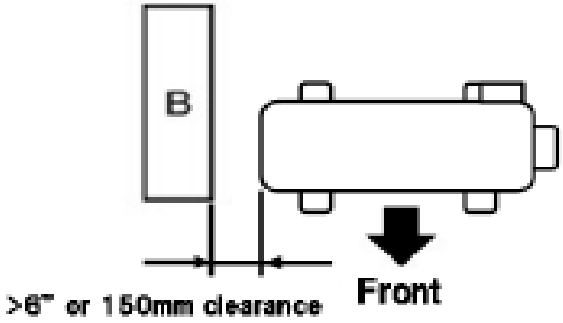
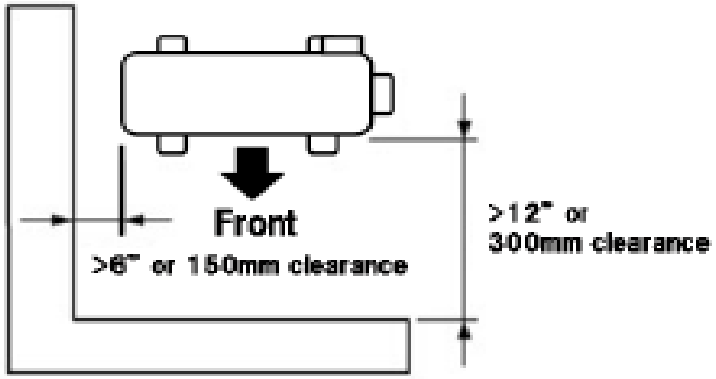
Flat wall installation

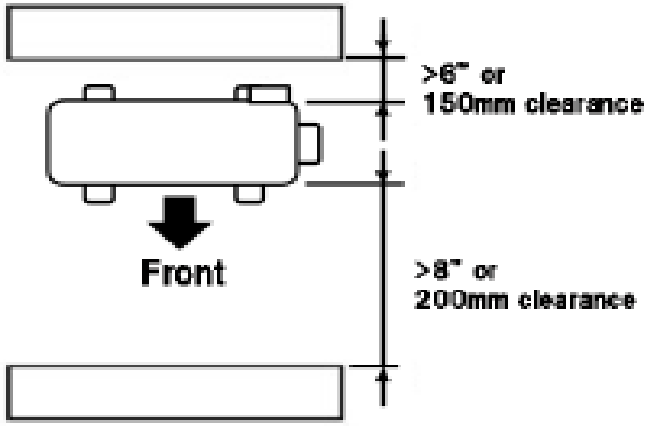
Caution: *Water fitting side must have 12" clearance. 24"is desirable*





Corner installation





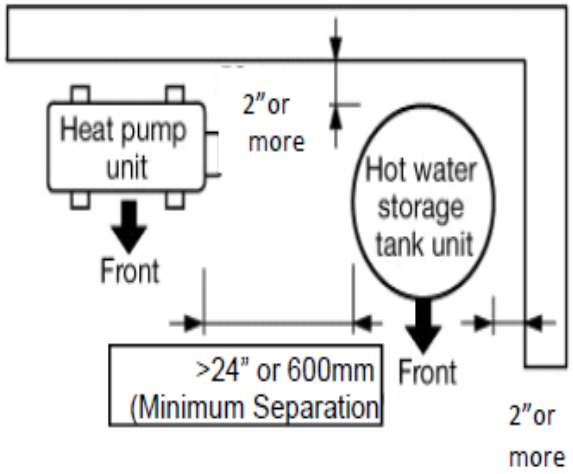
1 Unit should have a minimum of 18" or 500mm space above the unit to ensure correct operation
2 Discharge Air blowing against a wall/obstacle in front of the unit may stain the wall/obstacle
3 If the unit is not able to operate with adequate airflow due to obstacles and reduced clearances, Then heating output will be reduced by approx. 10% and power consumption increased by approx.10%
4 For optimum operation install the unit per the above or in a location with no obstacles

Before Installing the Unit

1. Size the Unit correctly
2. Location Water Supply – Pressure & Quality
3. Location for the Outdoor Unit
4. Location for the Tank

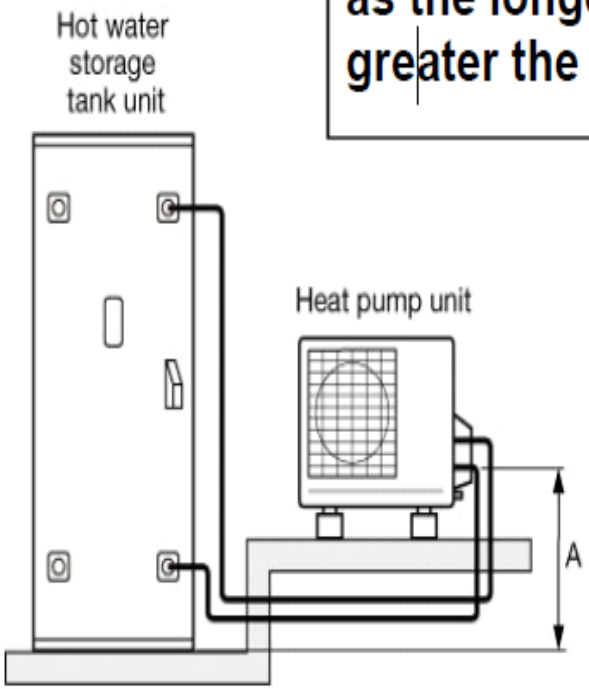
Location for the Tank

Overhead view
Standard layout



Maximum pipe length 50ft (15m) per line between Tank & Heat Pump Unit.
Maximum number of bends- 6, use long radius bends not street "L's"

Side view



Caution
Keep the piping run to a minimum as the longer the pipe run, the greater the potential for heat loss

(A) Difference in height between the base of tank and base of Heat pump should be no more than: 16ft(5m) Max.

Also consider the location of the tank relative to the main usage of DHW
This will reduce the "plug" of cold water before hot water is delivered

Before Installing the Unit

1. Size the Unit correctly
2. Location Water Supply – Pressure & Quality
3. Location for the Outdoor Unit
4. Location for the Tank
5. Additional Parts required

Additional Parts Required

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Plumbing

- Interconnecting pipes
- Connecting Unions
- Pressure Regulating Valve
- Isolation Valves
- 5/8” ID Condensate Hose & Drain piping

Parts Provided

- Hot Supply Check Valve
- Anti Scald Valve
- Pressure Relief – 125 Psig

Electrical/Mechanical

- 15 Amp 208/230V 2 Pole Breaker
- Disconnect Box and Whip
- 15 Amp HACR Fuses
- 14-3 AWG Wire (check NEC for correct wire sizing)
- Pad for Outdoor unit
- Lumber/Pump up’s

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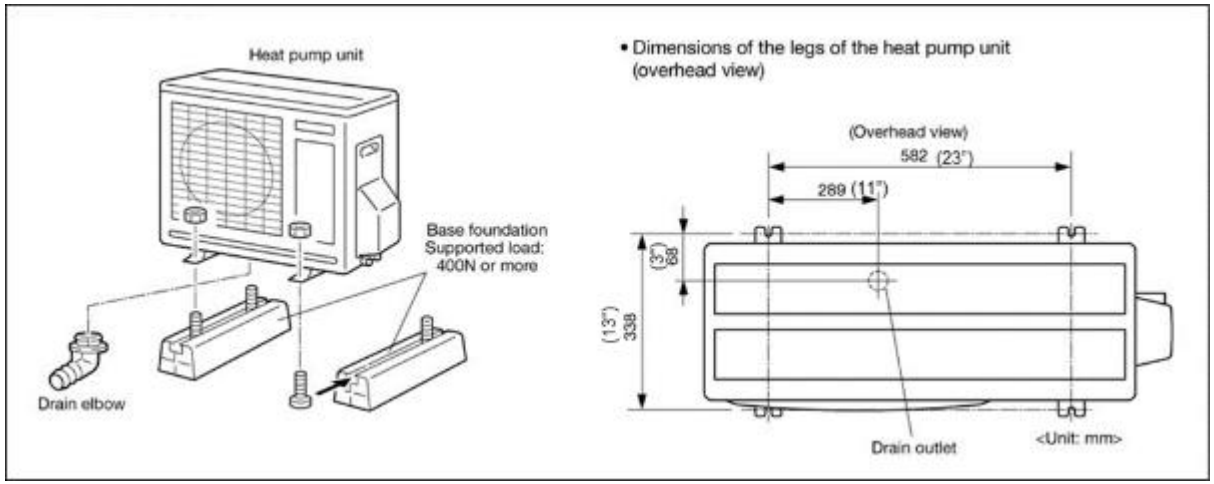
Before Installing the Unit

1. Size the Unit correctly
2. Location Water Supply – Pressure & Quality
3. Location for the Outdoor Unit
4. Location for the Tank
5. Additional Parts required

Use the 7 P's!!!!!!!!

Installing the Outdoor Unit

- Respect Unit clearances (see previous)
- More than 6” behind and on LHS, then 12” In Front and on RHS (Service access)
- Be careful Stacking – The Controller and some Service Access is by removing the top cover
- Raise up outdoor unit 4 to 6” from the pad/ground to help drain the unit coil during defrost – Treated lumber or “Pump Up’s”



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Typical Installed Outdoor Unit

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Piping Diagrams

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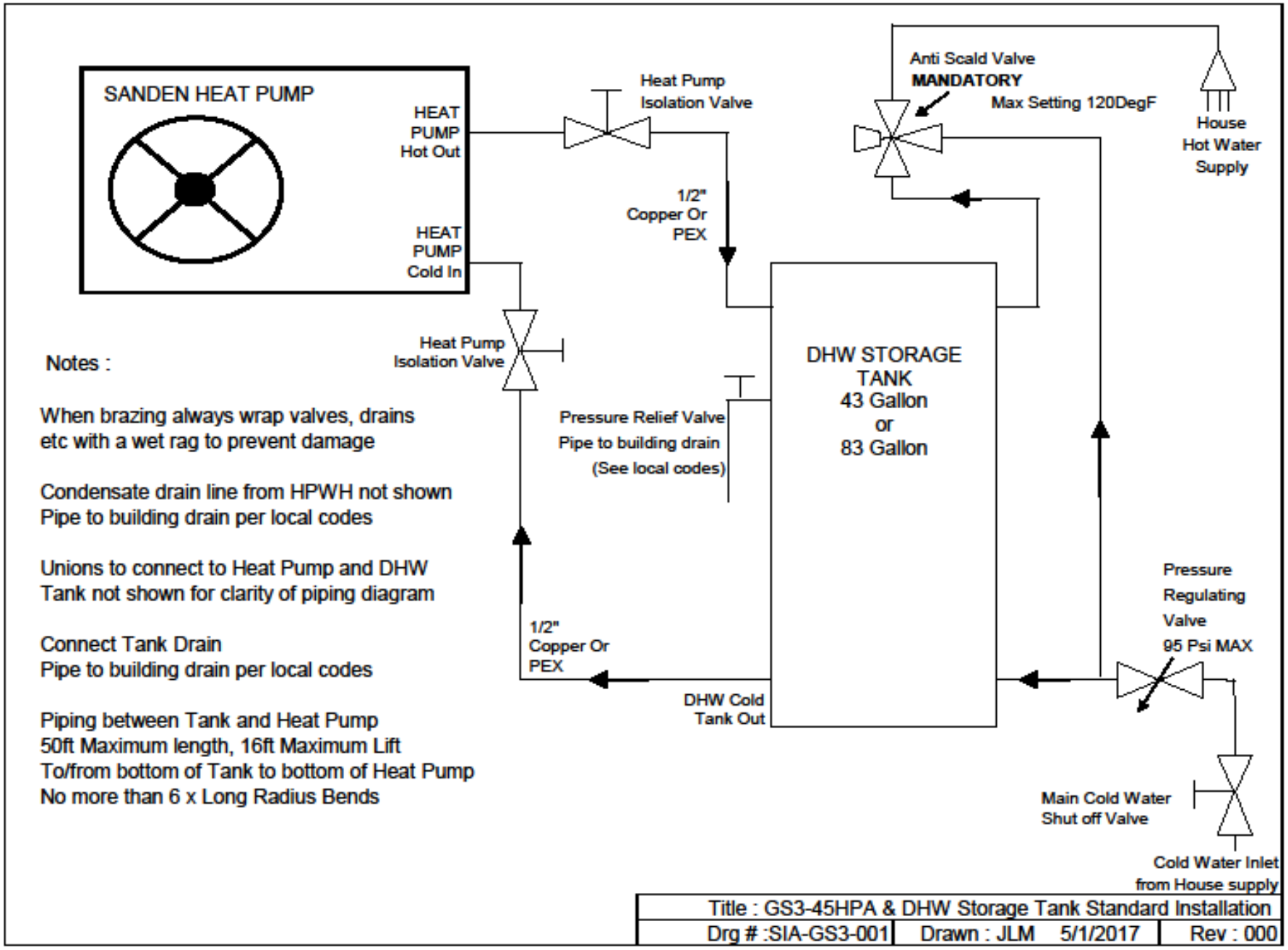


Notes :

When brazing always wrap valves, drains etc with a wet rag to prevent damage

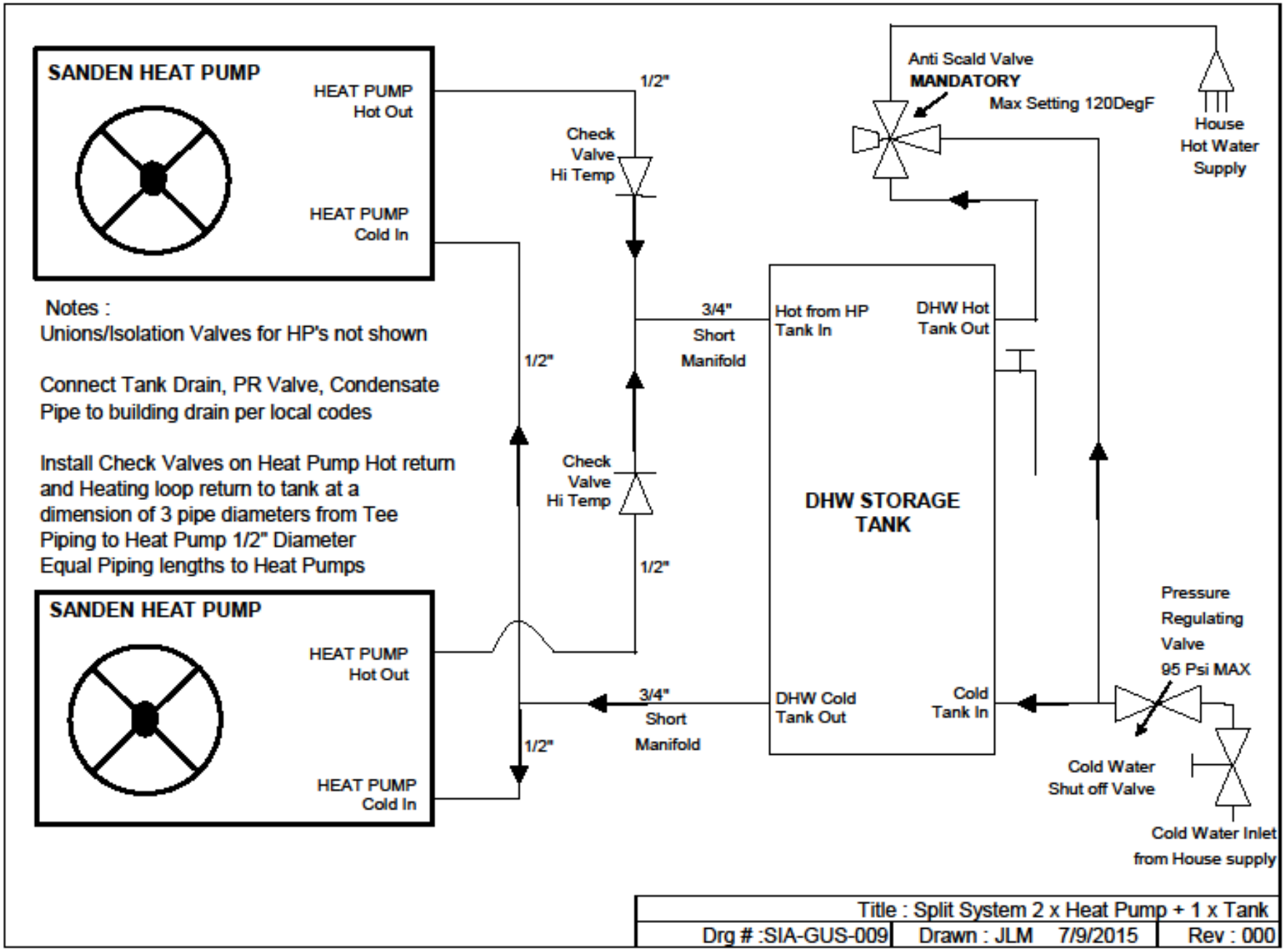
Condensate drain line from HPWH not shown
Pipe to building drain per local codes

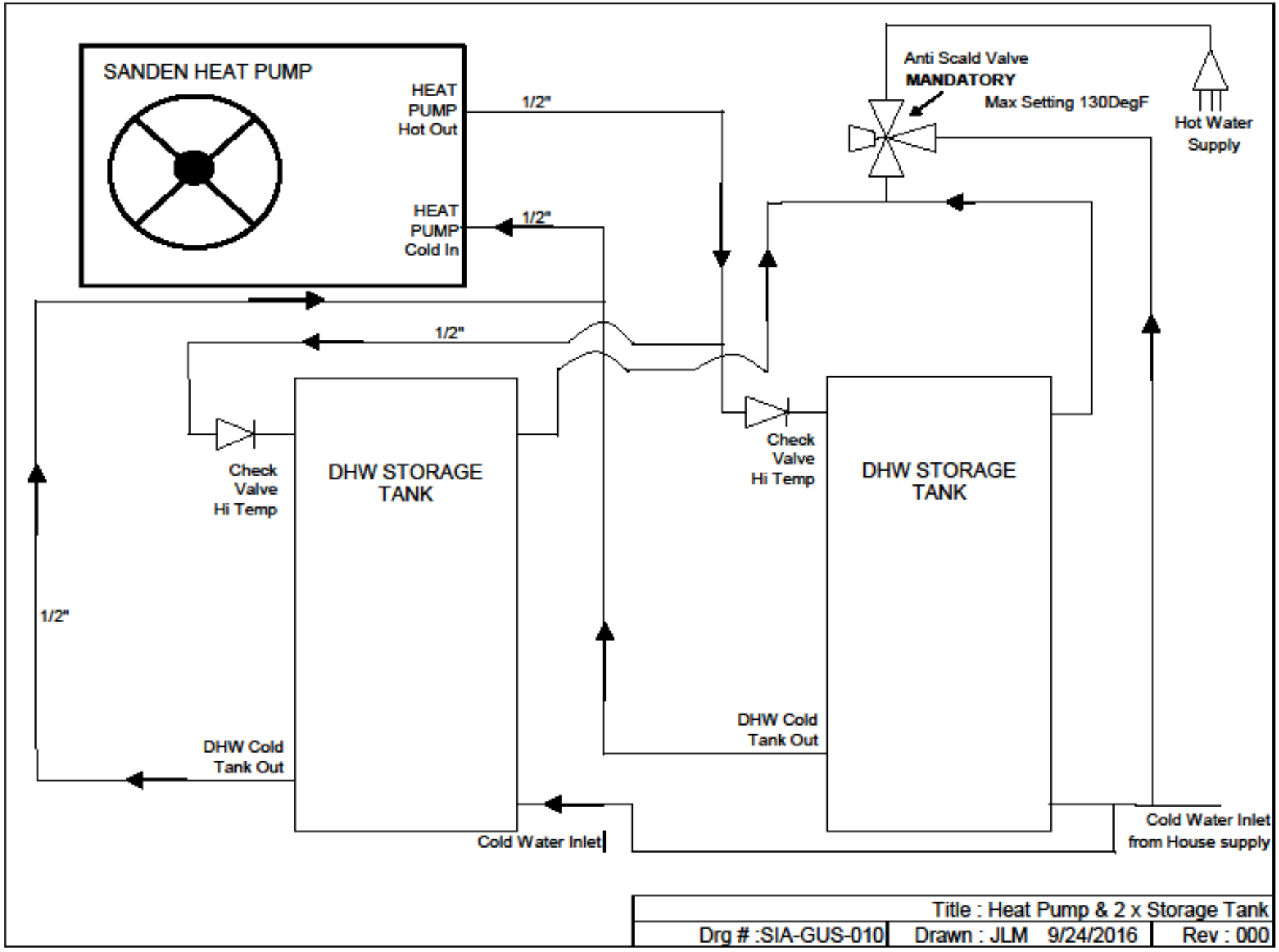
Unions to connect to Heat Pump and DHW Tank not shown for clarity of piping diagram

Connect Tank Drain
Pipe to building drain per local codes

Piping between Tank and Heat Pump
50ft Maximum length, 16ft Maximum Lift
To/from bottom of Tank to bottom of Heat Pump
No more than 6 x Long Radius Bends

Title : GS3-45HPA & DHW Storage Tank Standard Installation		
Drg # :SIA-GS3-001	Drawn : JLM 5/1/2017	Rev : 000


SANDEN HEAT PUMP
HEAT PUMP
Hot Out
HEAT PUMP
Cold In
1/2"
Check
Valve
Hi Temp
Anti Scald Valve
MANDATORY
Max Setting 120DegF
House
Hot Water
Supply
Notes :
Unions/Isolation Valves for HP's not shown
Connect Tank Drain, PR Valve, Condensate
Pipe to building drain per local codes
Install Check Valves on Heat Pump Hot return
and Heating loop return to tank at a
dimension of 3 pipe diameters from Tee
Piping to Heat Pump 1/2" Diameter
Equal Piping lengths to Heat Pumps
3/4"
Short
Manifold
Hot from HP
Tank In
DHW Hot
Tank Out
1/2"
Check
Valve
Hi Temp
DHW STORAGE
TANK
1/2"
SANDEN HEAT PUMP
HEAT PUMP
Hot Out
HEAT PUMP
Cold In
Pressure
Regulating
Valve
95 Psi MAX
3/4"
Short
Manifold
DHW Cold
Tank Out
Cold
Tank In
1/2"
Cold Water
Shut off Valve
Cold Water Inlet
from House supply
Title : Split System 2 x Heat Pump + 1 x Tank
Drg # :SIA-GUS-009
Drawn : JLM 7/9/2015
Rev : 000


SANDEN HEAT PUMP
HEAT PUMP Hot Out
HEAT PUMP Cold In
1/2"
1/2"
1/2"
Anti Scald Valve
MANDATORY
Max Setting 130DegF
Hot Water Supply
Check Valve Hi Temp
DHW STORAGE TANK
Check Valve Hi Temp
DHW STORAGE TANK
1/2"
DHW Cold Tank Out
DHW Cold Tank Out
Cold Water Inlet
Cold Water Inlet from House supply
Title : Heat Pump & 2 x Storage Tank
Drg # :SIA-GUS-010
Drawn : JLM 9/24/2016
Rev : 000

Interconnect Piping

- Max Distance between Tank and Outdoor :

  50ft including 16ft of lift from bottom of Tank

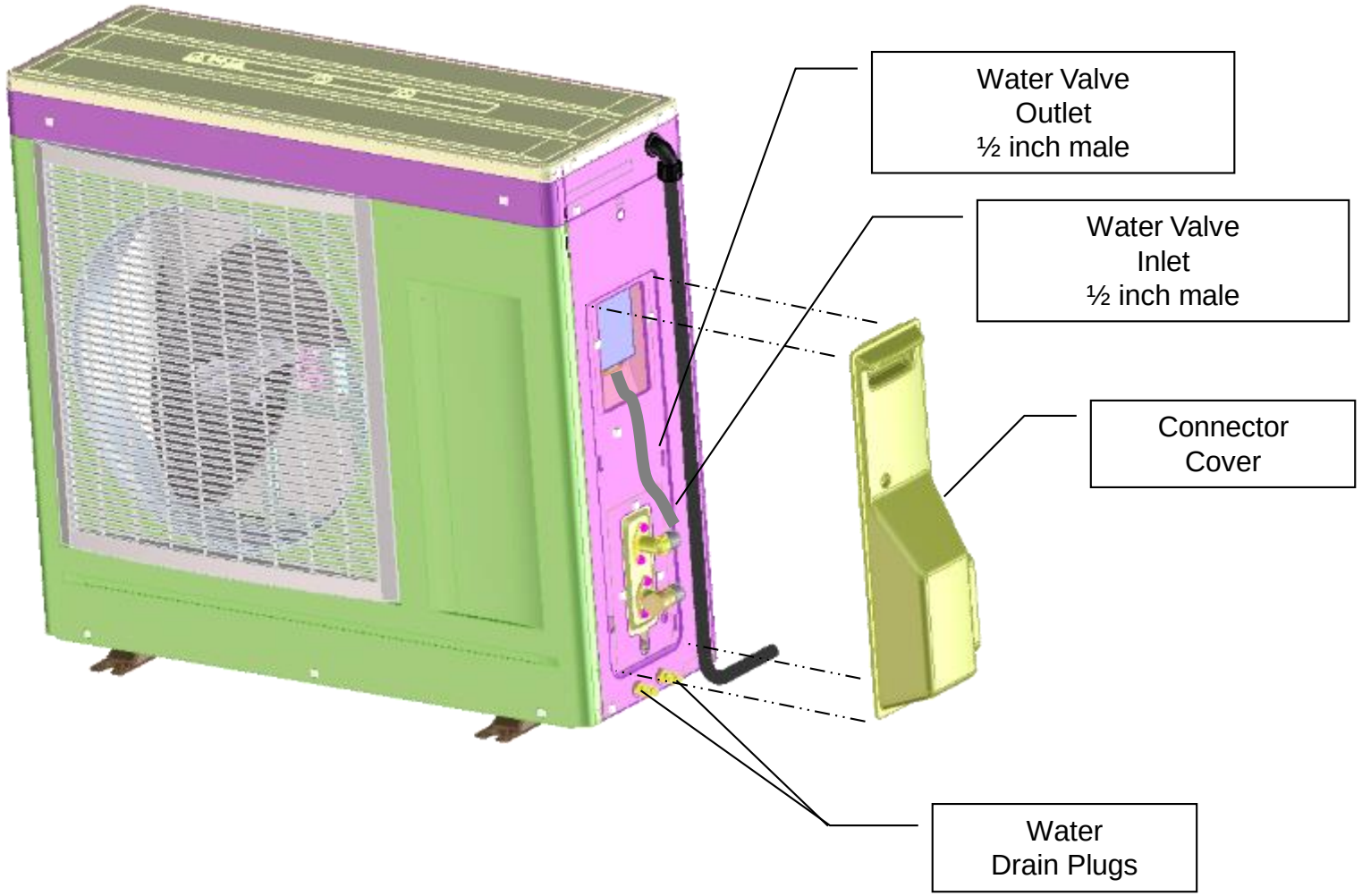
  6 Bends maximum
- Piping size :

  Ø1/2” NSF Copper or PEX (Potable Water) – **Both lines must be insulated**
- Check if Heat Tape is required – potential freezing issue if the weather drops below freezing for an extended period of time

Building Penetration

- Hole Size – Minimum 3”
- 2 x ½” pipes + ¾” wall insulation + 3/8” conduit
- Sleeve the penetration
- Air Seal to prevent moisture ingress and heat egress
- If pipes are covered/buried ensure covering is water tight to prevent water from collecting

Outdoor Unit Connections



Interconnect Water Piping

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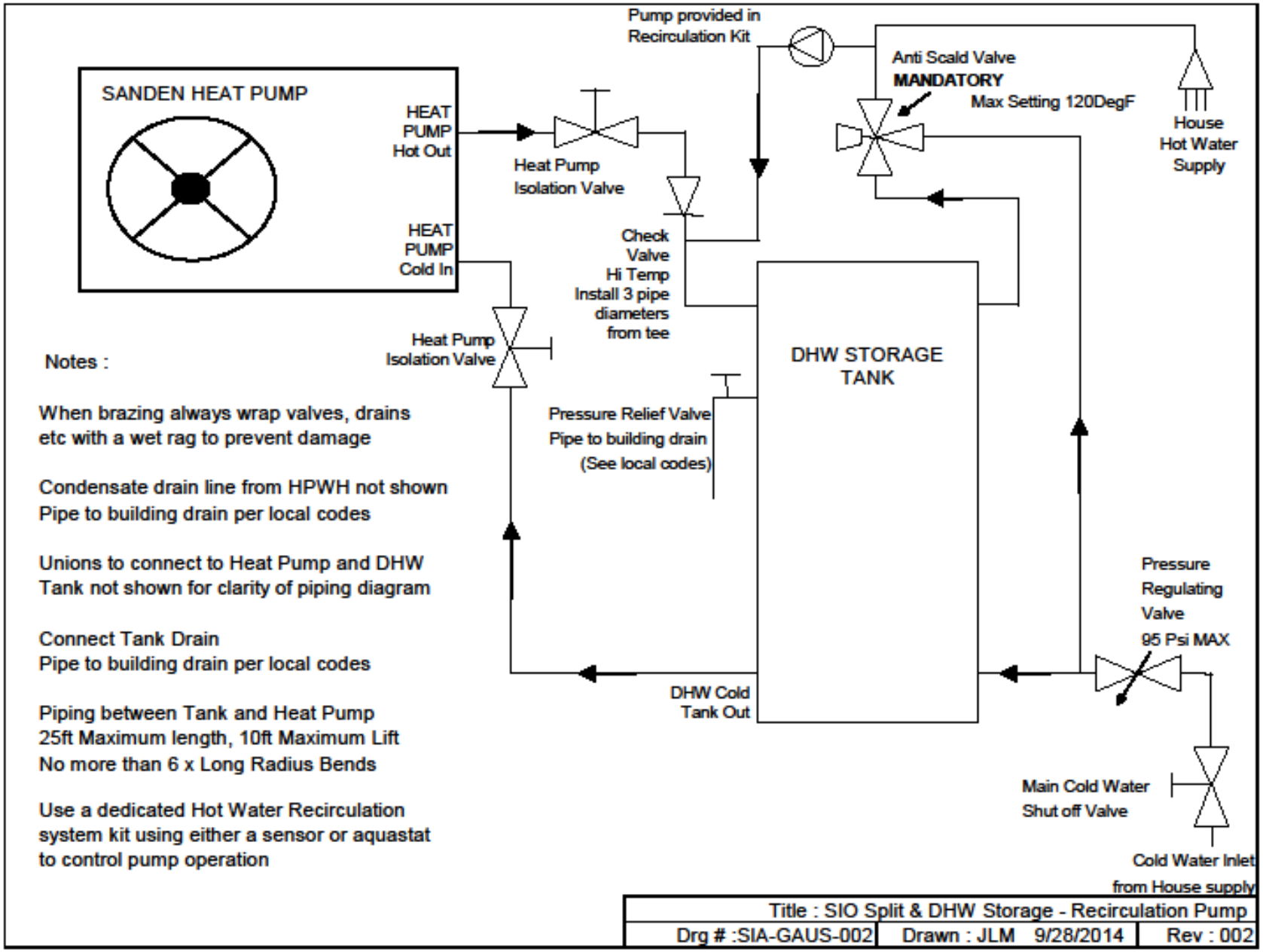
Accessories - I want “Instant” Hot Water!

- Recirculation – If you do your own system we require it to be **Temperature or Sensor NOT Timer** controlled

- Pump sized to just push water through the unit to remove the cold plug

- We recommend the type of systems which are installed under the last fixture and push the plug in the system back to the cold water side of the tank, and are controlled by Aquastat



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Connect Tank Drain
Pipe to building drain per local codes

Piping between Tank and Heat Pump
25ft Maximum length, 10ft Maximum Lift
No more than 6 x Long Radius Bends

Use a dedicated Hot Water Recirculation system kit using either a sensor or aquastat to control pump operation

Title : SIO Split & DHW Storage - Recirculation Pump		
Drg # :SIA-GAUS-002	Drawn : JLM 9/28/2014	Rev : 002

Condensate Piping

- Outdoor unit will create Condensate from both normal operation, especially if it is humid and also the Defrost Cycle when colder

- Elbow connection provided with unit – insert into the base pan and connect with a 5/8” ID Drain hose

- Need to pipe condensate away from unit and ensure Condensate does not spill onto walkway or other area where it may freeze

Freeze Protection

- Obviously the Outdoor unit & Piping has Water in it – so we care about cold weather and it's possible effect on the system

- Interestingly it gets cold in Japan and they do nothing to the system to worry about cold weather

- We have 3 strategies & a back up plan to minimize freeze up's

Freeze Protection

1. **Minimal Water Piping Outdoors** – Plan your job site and unit location to penetrate into the building adjacent to the Heat Pump

Use ¾” minimum thick Closed Cell insulation on the external piping

Tape joints and ensure that none of the system is piping is exposed

Freeze Protection

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2. **Inbuilt Freeze protection** –

System continually monitors Inlet and Outlet Water Temperatures at the Heat Exchanger

If Outdoor Ambient is below 36 DegF and the Heat Exchanger Temperatures are below 42 DegF

System will turn on the Pump and then the unit if necessary to prevent it from freezing

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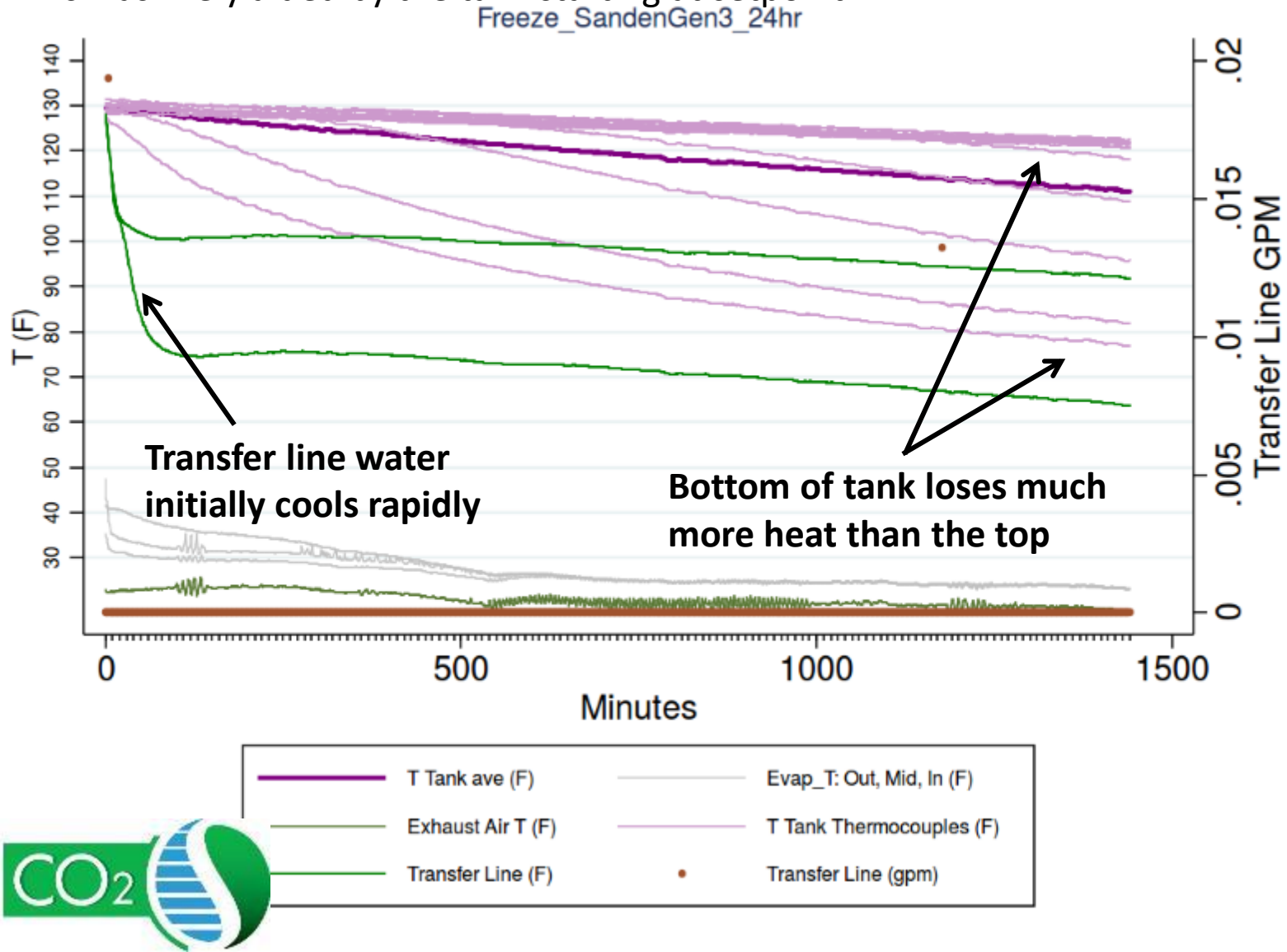
Freeze Protection

3. **Heat tape on the pipe work** – Self regulating 5 to 8W is preferred for better sensing – Wrap tightly under the insulation on pipes exposed to the ambient air, all the way up to the unit connections – Connect to separate power supply

Pentair Frost Guard is good

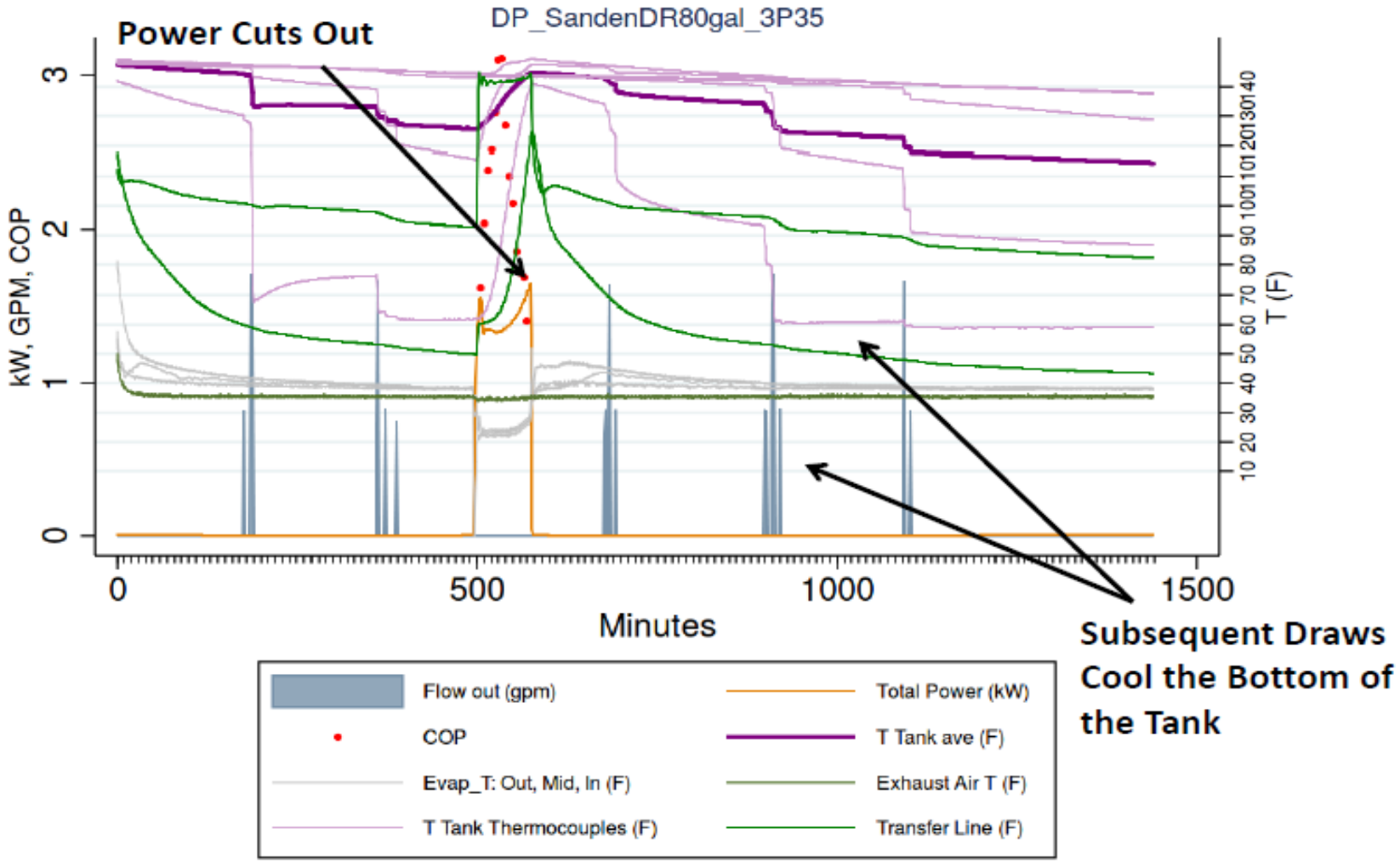
In the 24 hour freeze test – Testing at 25 DegF or -4 DegC

the transfer line temperatures initially dropped quickly but leveled out in the 70s and slowly dropped into the 60s (F). Given the greater dropoff in temperature for lower thermocouples in the tank, we suspect that heat from the bottom of the tank kept the transfer lines from freezing. This was likely aided by the tank starting at setpoint.



24 hour freeze test – Effect of draws

Starting with lower tank temperatures and then introducing draws into the tank with 35 DegF Water reduces the pipe temperatures but never below freezing



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But What happens if we Lose Power?

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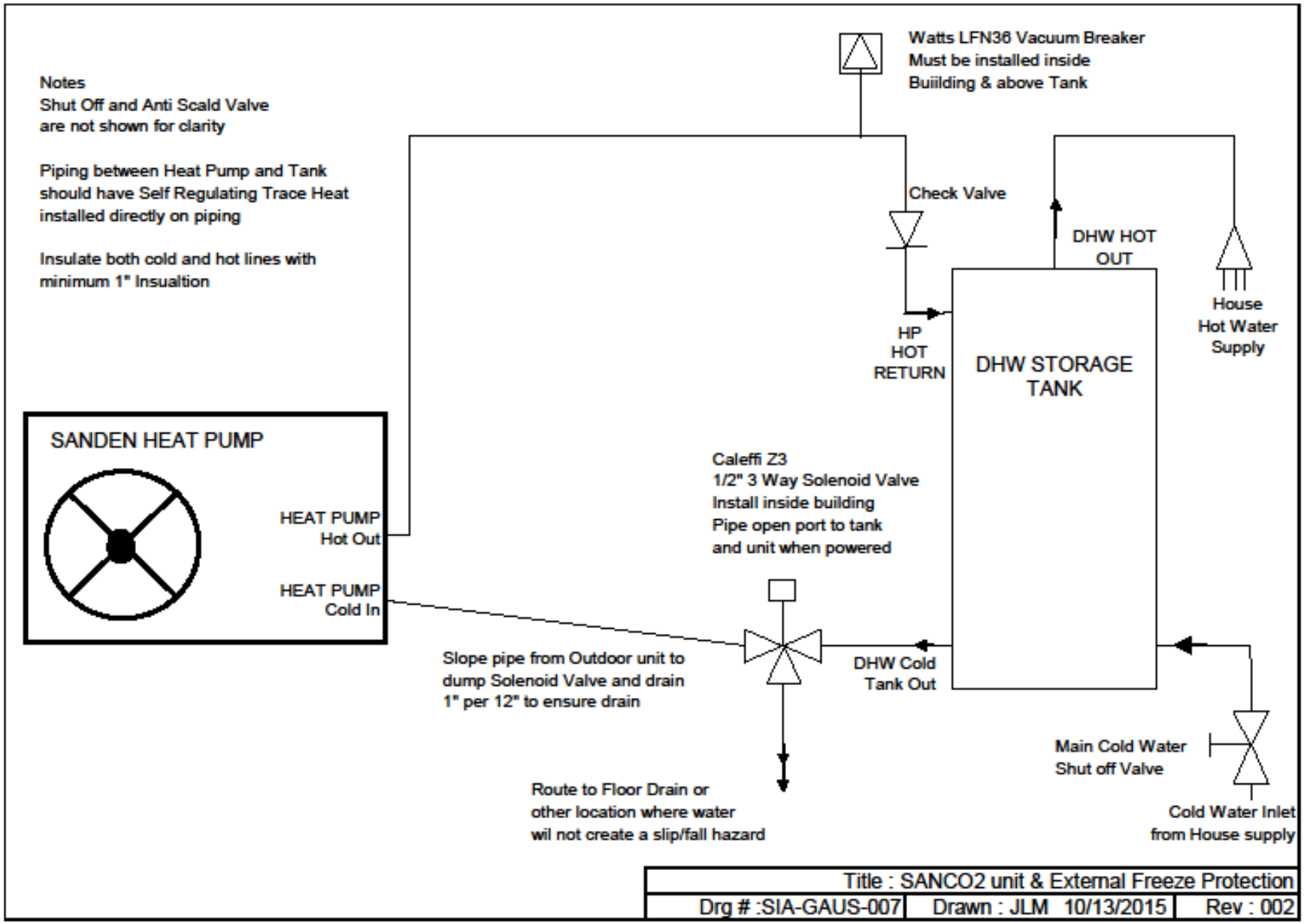
Freeze Protection - Valve

A 3-way solenoid valve is supposed to drain the outdoor unit water lines (transfer lines) in the event of power failure, to prevent freezing and damage to the unit. The Freeze Protection – Valve test repeatedly cut and restored power to the unit and observed to see if the water lines drained as intended and the unit powered back up with no problems.

Freeze Protection 3-way valve

Notes

1) The valve must be located at a lower elevation than the outdoor unit to drain the water lines. After power cut-out the lines evacuated as intended.
2) The pump was able to restore pressure after power-up without suffering an air lock. This was verified by repeating 10x.
3) During power-up approximately 4L of water drained out from the tank. This was unexpected but also did not appear to cause any significant problems.


Notes
Shut Off and Anti Scald Valve
are not shown for clarity
Piping between Heat Pump and Tank
should have Self Regulating Trace Heat
installed directly on piping
Insulate both cold and hot lines with
minimum 1" Insualtion
Watts LFN36 Vacuum Breaker
Must be installed inside
Buiilding & above Tank
Check Valve
DHW HOT
OUT
House
Hot Water
Supply
HP
HOT
RETURN
DHW STORAGE
TANK
SANDEN HEAT PUMP
HEAT PUMP
Hot Out
HEAT PUMP
Cold In
Caleffi Z3
1/2" 3 Way Solenoid Valve
Install inside building
Pipe open port to tank
and unit when powered
Slope pipe from Outdoor unit to
dump Solenoid Valve and drain
1" per 12" to ensure drain
DHW Cold
Tank Out
Main Cold Water
Shut off Valve
Route to Floor Drain or
other location where water
wil not create a slip/fall hazard
Cold Water Inlet
from House supply
Title : SANCO2 unit & External Freeze Protection
Drg # :SIA-GAUS-007
Drawn : JLM 10/13/2015
Rev : 002

Electrical & Power Wiring

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Electrical Supply

- 208/230V-1Ph-60Hz
- 15 Amp 2 Pole Breaker
- Ensure unit has power at least 5 hours per day

Power Wiring

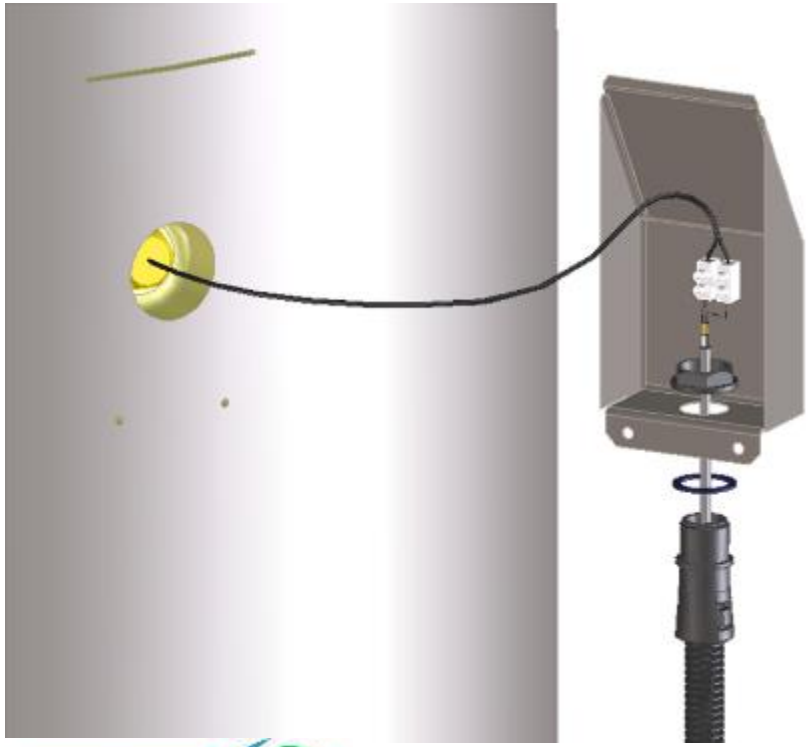
- Wire from Breaker VIA Local Disconnect to L1, L2 and Ground (Earth)
- 15 Amp HACR Fuses

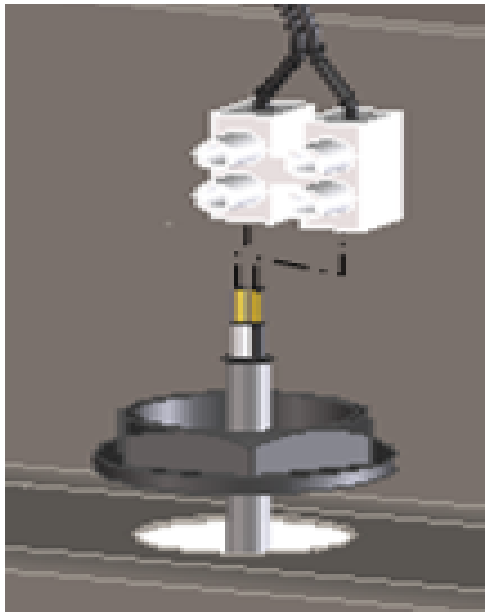
DO NOT TURN ON THE POWER YET!!!!!

Tank Thermistor

Thermistor & Conduit are supplied in a 20ft Length

Every Heat Pump requires it's own Thermistor





Tank Thermistor

- Cut to suit your Installation if desired
- Extend using 16AWG 2 Wire Shielded Cable if needed
- Connect Thermistor wire to Terminal Blocks on Tank (not polarity sensitive)

Filling the System

Now installation is complete we need to fill the system and purge the air from the water pipes

1. Open Tank PR valve via the lever – Very important this allows the air to escape the tank
2. Open the Cold Water Shut Off Valve , Open HP Unit Isolation Valves

Filling the system

3. Once water drains from PR Valve, close it & open up Hot Water Faucets/Showers in the house
4. Once air has stopped burping out, and water flow is steady, close the Faucets
5. Go to the Outdoor unit, close Isolation valves
6. Check for leaks and any other piping issues

Filling the System

7. Open Drain Valves on the Outdoor Unit. Once Air has stopped burping from the drain plugs close both of them
8. **Switch on the mains power to the unit**
9. Open up Faucets and Showers to bleed air for the final time until flow is steady – Can also open unit drains for a final check

Installation is Finished

- There is a 3 minute time delay but after that, unit is able to start

- Unit will run when the thermistor in the Tank senses a temperature by below 113 DegF

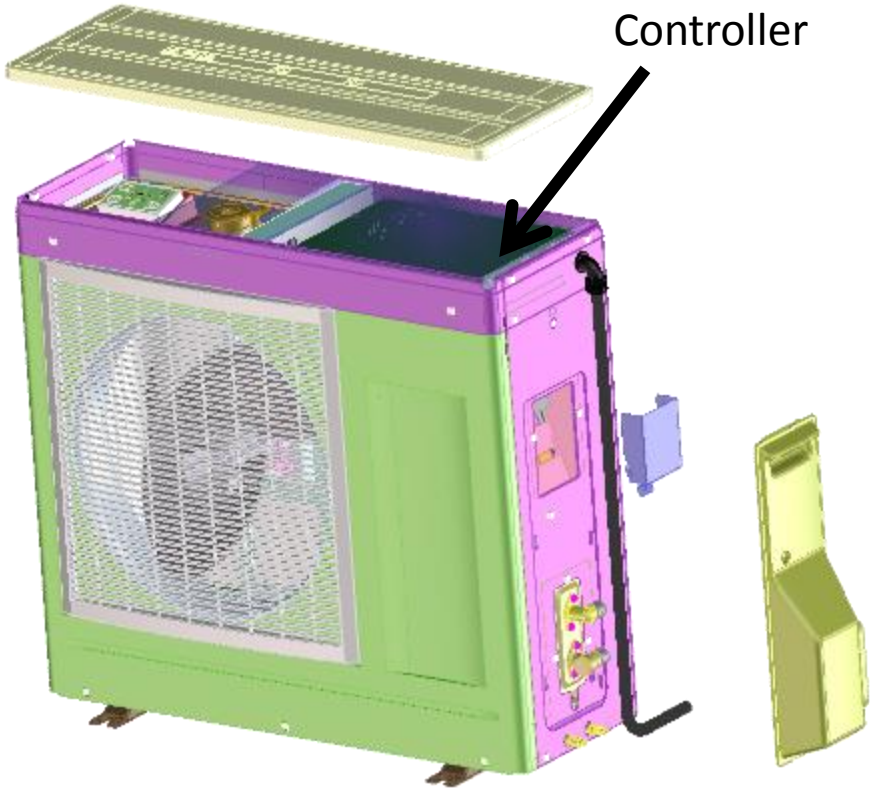
- If that is the case, the unit will start, first the Outdoor Fan and Pump, then the compressor

Installation is Finished

- Listen to the Outdoor unit, if you hear a bubbling, hissing sound, that is air in the pump and water system
- Open up the bleed valves once again and remove the air. Once the stream of water has no bubbles and is steady close the valves
- Default setting is 140 DegF delivered water temperature
- It Takes about 3 to 4 hours to heat 80 Gallons from a cold start depending on

Final Unit Set up

- Set up the Programmable Controller
- Delivered Water Temperature can be now set between 130 and 176 DegF
- Recommended setting 150 or 160 DegF
- Unit can be programmed just like a T-Stat this will allow us to stop the unit from working during certain hours of the day



Setting the Unit Time

1. When the unit is first powered up the time starts at 0000

2. Now the display will read the time of operation – for example 0005 or something similar depending on how long the unit has been powered up

Setting the Time

3. Press the Up or Down arrows to set the time (holding makes it go quicker….)

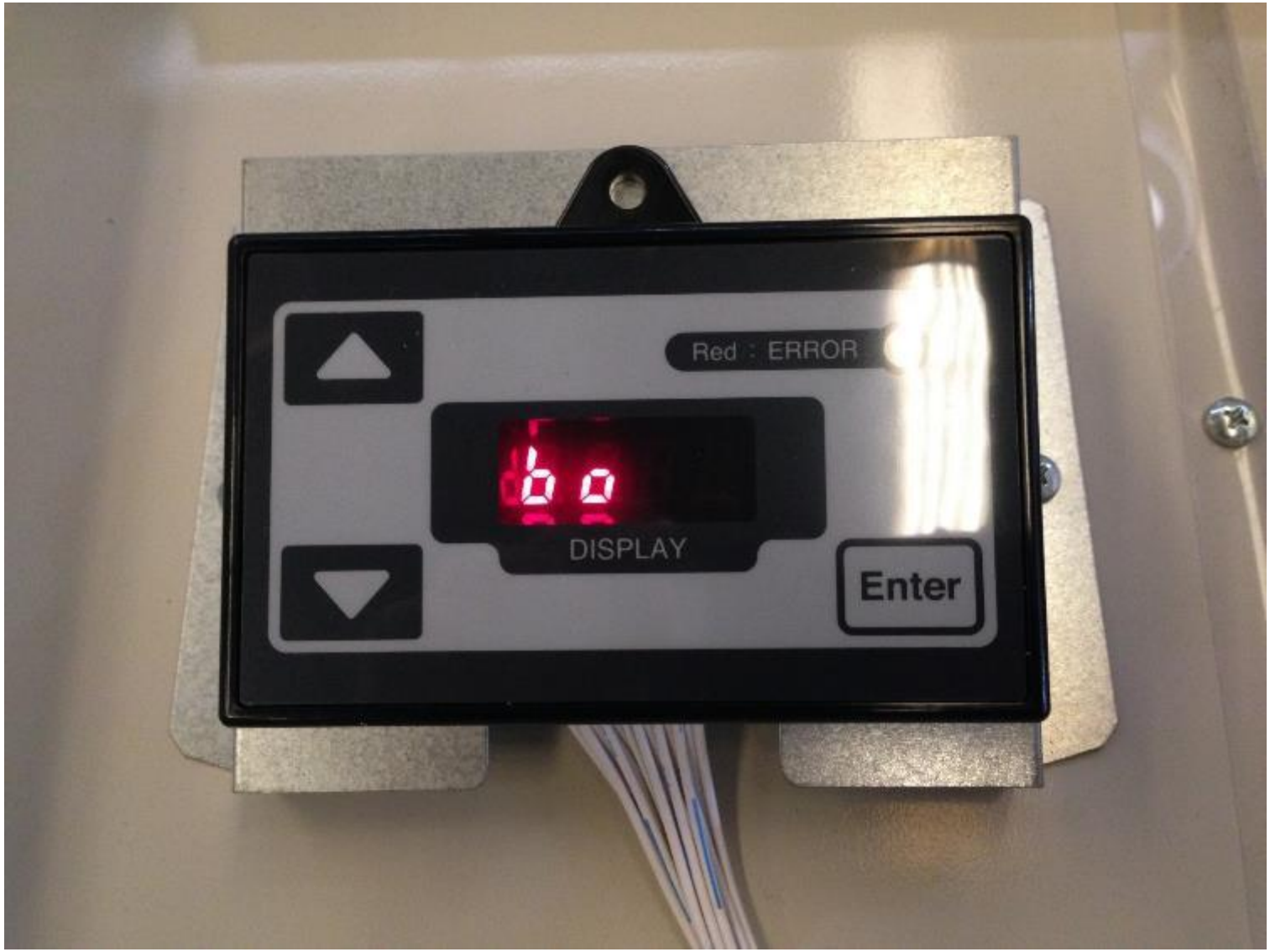
4. Once you have the time set – Time is in Military time (24 hour, no AM or PM)

5. PRESS ENTER

The controller will always go sleep if no buttons are pressed for 60 Seconds

Optional Programming – OFF/ON Timer

1. Press and hold both the UP & DOWN arrow keys
2. Display will show “BO” & “00XX”
3. Press the UP Arrow. The 00 will flash
4. Use the UP Arrow to set the OFF time for the unit (can only be set as an hour e.g. 10, 12, 14 etc, remember this is Military time)
5. PRESS ENTER – OFF time is now set


Red : ERROR
bo
DISPLAY
Enter

Optional Programming OFF/ON Timer (cont)

6. “XX” will now be flashing
7. Use the UP or DOWN Arrow to set the ON time for the unit (can only be set as an hour 15, 17 etc, remember this is Military time)
8. PRESS ENTER – ON time is now set
9. Both OFF and ON time will flash briefly, then unit will display “BO” and the times set
10. Press Enter one last time to go back to the clock or don’t press anything for 60 seconds

This unit is set to be OFF at 12 Noon and ON at Midnight

Optional Programming OFF/ON Timer (cont)

- Unit will now turn “OFF” for the period of time set, and then the unit will turn back “ON” after this time
- Unit may not start depending on tank temperature during this time, but is awake and waiting for a signal to run
- Hot Water is still available from the tank outside of these times – just ensure your tank capacity can handle demand
- If you decide this is not providing enough hot water and to cancel the Program, just set both the “OFF and ON” time to 00 and the Program will be cancelled – Default

Commissioning Mode

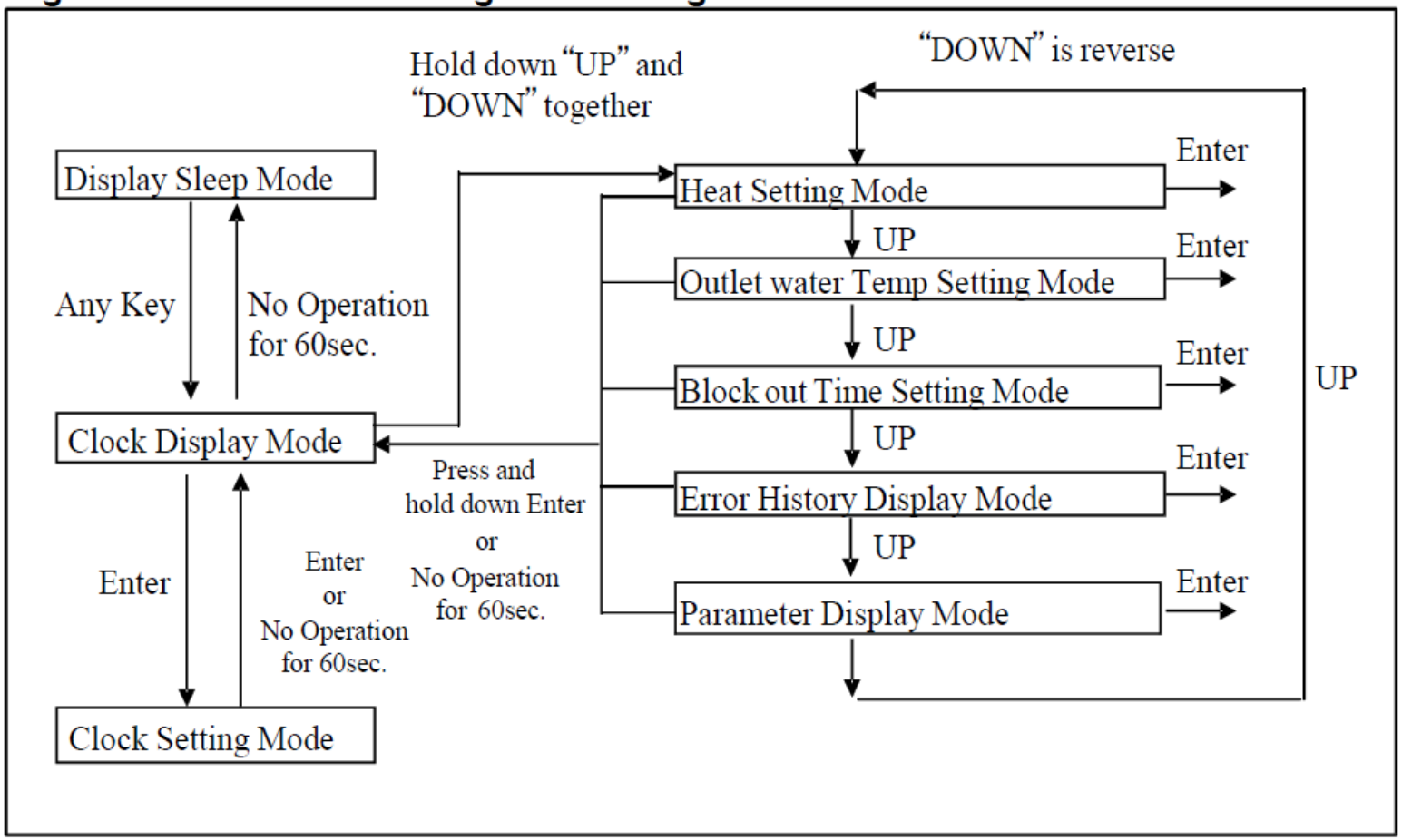
SANDEN
Delivering Excellence

- **Heat setting mode** - Set the heating mode to either ON (Unit Runs) or OFF (Unit cannot operate)
- **Outlet water temperature setting mode** - Set the Outlet Hot water temperature 130～175°F
- **Block out time setting mode** (Time of use) - Set the block out time
- **Error history display mode** - Check the time & history of any errors that may have occurred.
- **Parameter display mode** - Check the values measured by the thermistors in the unit.

SAN CO_2

Commissioning Mode

Figure 13 Commissioning mode diagram



- Press the UP/DOWN arrows in any mode to access it and then scroll to see information or use ENTER to access that particular mode

Sanden Installation Recap

Similar to a Mini Split, but easier

- 2 x water lines – ½” Copper/PEX from the tank connections to the Outdoor
- No Refrigeration connections
- 208/230V-1Ph @ 15A Power – thermistor cable provided
- 50ft distance, 16ft lift between Outdoor and Tank
- Tank has similar connections to a standard North American Tank (just 2 more of them)

Warranty & Support

Standard Warranty Residential usage

- **Compressor & Refrigeration System – 10 Years**
- **All other Outdoor unit Components – 10 Years**
- **3 Year Labor Warranty**
- **3 Year Replacement Warranty**
- **Tank Warranty – 15 Years, Pro Rated**

- Tech Support : 734 738 5915

Thank You!

www.Sandenwaterheater.com

Facebook : Sanden Water Heater

Twitter : @SandenCO2HPWH

John Miles
Sanden Water Heaters
Tel : 213 400 7758
John.miles@sanden.com