

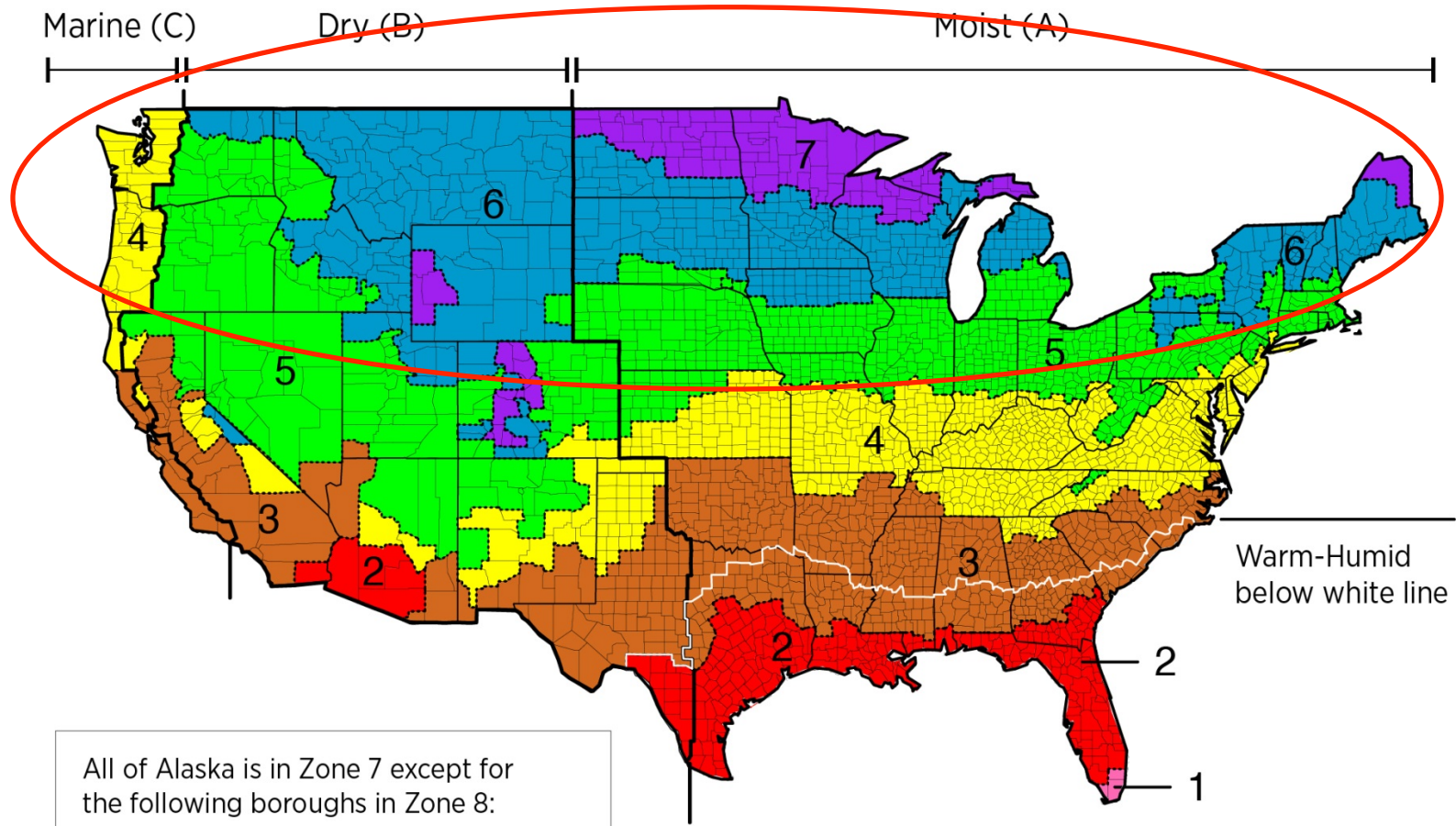
# LOW TEMPERATURE HYDRONIC HEATING FOR COLD CLIMATES



TRAVIS SMITH  
PRESIDENT  
T AND T MOUNTAIN BUILDERS INC

# • COLD CLIMATES

– REFERRING SPECIFICALLY TO CLIMATES ZONES 6 & 7



All of Alaska is in Zone 7 except for the following boroughs in Zone 8:  
Bethel, Northwest Arctic, Dellingham,  
Southeast Fairbanks, Fairbanks N. Star,  
Wade Hampton, Nome, Yukon-Koyukuk,  
North Slope

Zone 1 includes Hawaii,  
Guam, Puerto Rico, and  
the Virgin Islands

# HYDRONIC HEATING

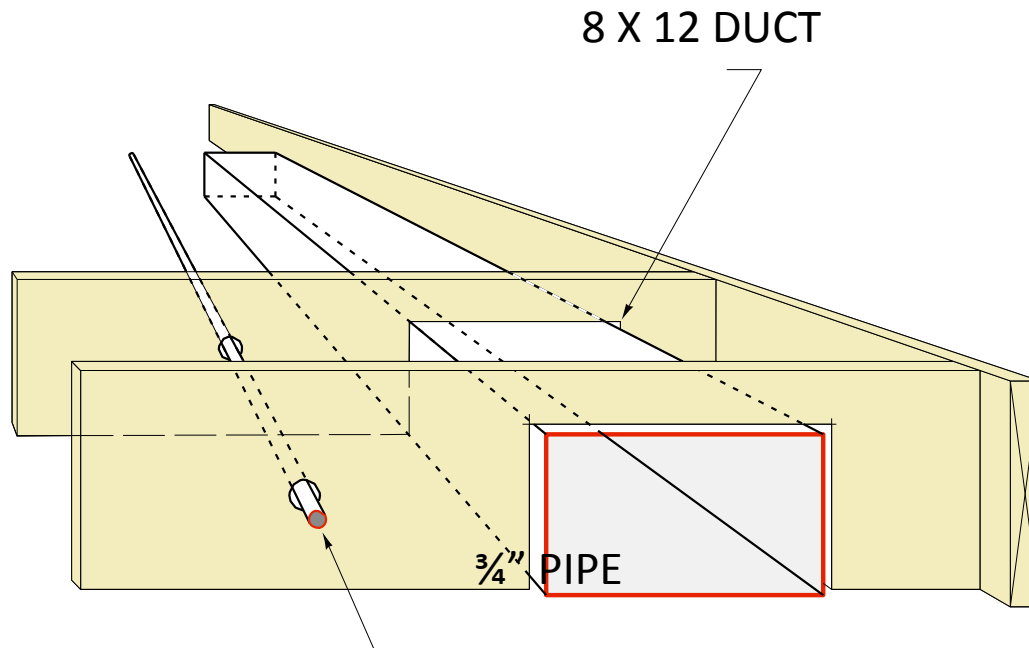
- USING A FLUID TO TRANSFER HEAT
- MANY TYPES OF EMITTERS : PANEL RADIATORS, FAN COILS, RADIANT FLOORS, WALLS, CEILINGS)

# WHY HYDRONIC HEAT

- HVAC CONTRACTORS TEND TO OVERSIZE EQUIPMENT
- VERY QUIET
- NO BLOWING OF HOT AIR, STIRRING ALLERGENS

# WHY HYDRONIC HEAT

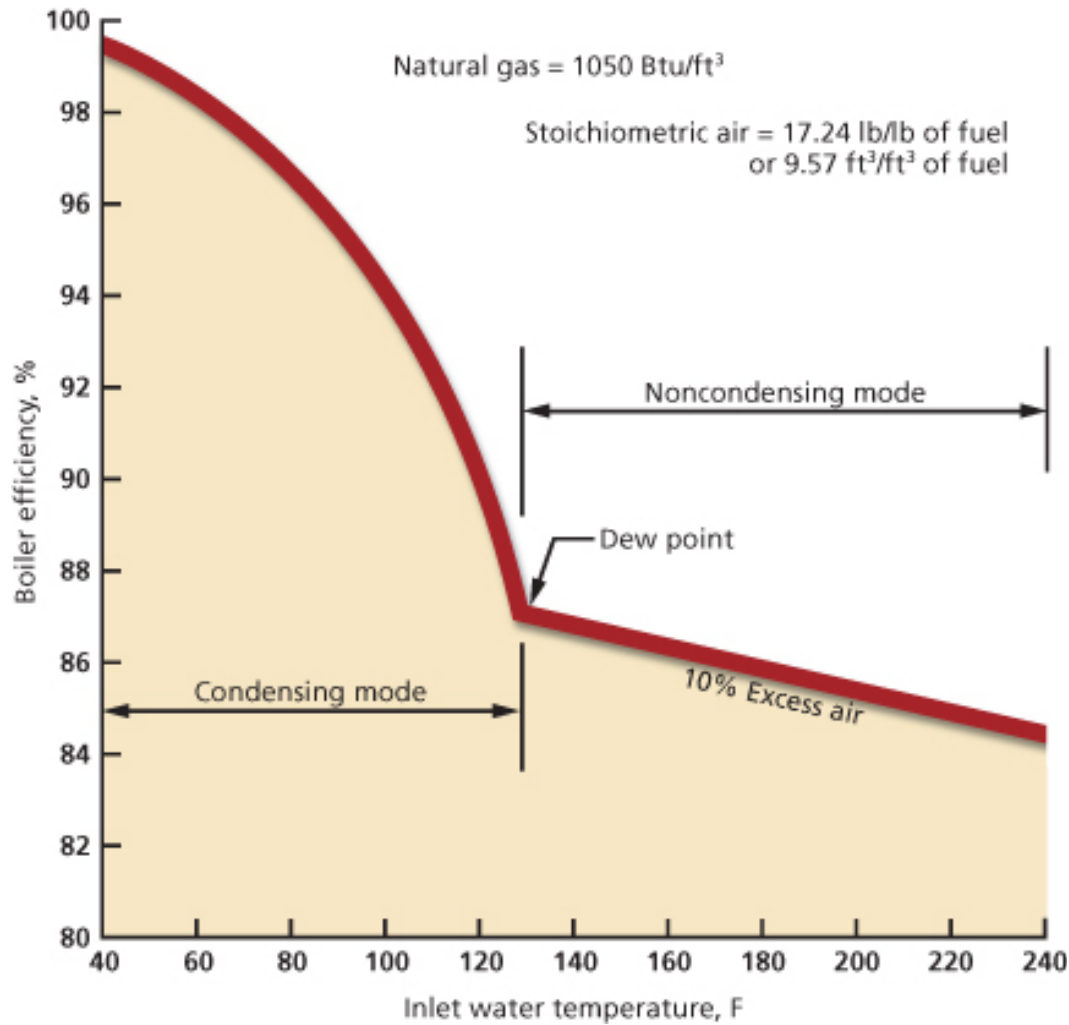
- A GIVEN VOLUME OF WATER CAN ABSORB ALMOST 3500 TIMES AS MUCH HEAT AS THE SAME VOLUME OF AIR, WHEN THEY BOTH UNDERGO THE SAME TEMPERATURE CHANGE



OBVIOUSLY  
NOTCHING A 2 X 12  
JOIST THIS MUCH IS  
UNACCEPTABLE

# LOW TEMPERATURE

- SUPPLY TEMPERATURES OF LESS THAN 120 (DEGREES F)
- WHY LOW TEMPERATURE? IT TAKES LESS ENERGY TO HEAT WATER TO A LOW TEMPERATURE.
- MAKES USE OF SOLAR COMBI-SYSTEMS POSSIBLE
- CONDENSING BOILERS AND WATER HEATERS ONLY CONDENSE AND MAINTAIN EFFICIENCY AT RETURN TEMPERATURES OF 130 DEGREES OR LESS. LOWER TEMPS = HIGHER EFFICIENCY



80 – 100 degree return temperature is the “sweet spot “for efficiency

# PASSIVE HOUSE

- IN HIGH PERFORMANCE HOMES, IT'S TYPICAL TO HAVE HEAT LOADS, IN CLIMATES 6 & 7, OF 10-30K BTU/HR OF HEAT LOSS.
- WHEN SOURCING A BOILER TYPICAL FOR SPACE HEAT, THE SMALL END OF AVAILABILITY IS AROUND 60K BTU/HR OUTPUT.
  - “SMALL” BOILER SIZE OF +/- 60K BTU/HR, WILL MODULATE DOWN 3:1
  - THE LOWEST BOILER SETTING CAN EXCEED THE PEAK HEAT LOAD!



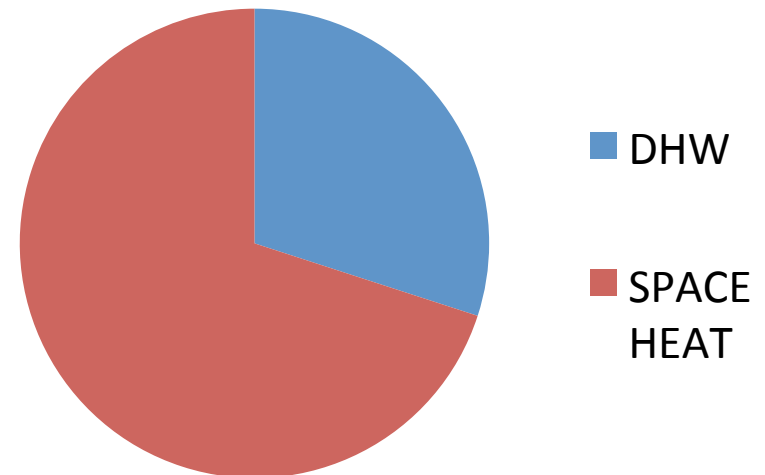
# SOLUTION

- COMBINED DHW AND SPACE HEAT
  - ONE APPLIANCE FOR BOTH
  - THE MOST COST EFFECTIVE WAY TO INTEGRATE HYDRONIC HEATING IN A LOW ENERGY HOME
  - THE EUROPEANS HAVE BEEN DOING THIS FOR MANY YEARS

*NOTE : THE DHW AND THE SPACE HEATING SIDES ARE HYDRAULICALLY SEPARATED WITH A HEAT EXCHANGER, NOT AN “OPEN” SYSTEM*

# SPACE HEAT vs. DHW

- WHEN COMPARING SPACE HEAT TO DHW ,ON AN ANNUAL BASIS, DHW PRODUCTION ACCOUNTS FOR ABOUT 30% OF THE OVERALL ENERGY USE. (LOOSELY)
- CONCLUSION: IT DOESN'T MAKE SENSE TO FOCUS SOLELY ON EFFICIENT SPACE HEAT, AND NOT CONSIDER THE POTENTIAL FOR EFFICIENT DHW HEATING



# HEAT SOURCES

## ELECTRIC OPTIONS

- AIR TO WATER HEAT PUMPS

DAIKIN ALTHERMA

CHILTRIX

SPACEPAK SOLSTICE EXTREME



# ELECTRIC OPTIONS

- HEAT PUMP WATER HEATER ?????
- THE UNITS CURRENTLY ON THE MARKET DON'T HAVE THE CAPACITY FOR SPACE HEATING AND DHW WATER HEATING
- POSSIBLY OK AS A STAND ALONE UNIT
- MAY WORK IN MILDER CLIMATES, BUT THEN BUT DOESN'T PENCIL OUT DUE TO ASHP SPLIT SYSTEMS



# ELECTRIC OPTIONS

- RESISTANCE (ELECTRIC BOILER)



NOT IDEAL FOR COMBI SYSTEM  
NO THERMAL BUFFER

OK FOR STAND ALONE HYDRONIC HEAT

BETTER TO SEPARATE THE DHW  
PRODUCTION WITH ANOTHER UNIT

THIS LITTLE BOX IS THE BOILER !

FAIRLY INEXPENSIVE

# GAS FIRED COMBI-APPLIANCES



HTP PHOENIX WATER HEATER  
96% EFFICIENT, 5:1 TURNDOWN  
SEALED COMBUSTION, CONDENSING  
WATER HEATER.

NOTICE THE ADDITIONAL PORTS ON THE  
TANK FOR ADDING AUXILIARY HEATING

THIS DESIGN IS THE BEST OF BOTH WORLDS:  
SUPER EFFICIENT CONDENSING HEAT  
EXCHANGER, WITH 55 GALLONS OF  
THERMAL STORAGE TO PREVENT SHORT  
CYCLING.

ALSO IDEAL FOR A HOT WATER  
RECIRCULATION SYSTEM

***NOTE: 76% OF UTAH'S POWER IS  
GENERATED BY COAL FIRED POWER PLANTS  
AND 19% GENERATED BY NATURAL GAS***

# GAS FIRED COMBI-APPLIANCES

TANKLESS UNIT.

PROS:

MODULATES FROM 12k TO 120 K BTU/HR OUTPUT. (10:1 !)

FAIRLY INEXPENSIVE

CONS:

HOT WATER RECIRC?



**KD Navien®**  
The Leader in Condensing Technology

# SOLAR THERMAL COMBI-SYSTEM



THESE UNITS FROM HTP FEATURE A SOLAR FED HEAT EXCHANGER IN THE BOTTOM OF THE TANK, THAT PROVIDES THE PRIMARY HEAT.

THE BACK-UP HEAT GENERATION IS GAS FIRED.

THIS WILL PROVIDE A LARGE PERCENTAGE OF THE DHW FOR THE YEAR, BUT ONLY A SMALL FRACTION OF THE SPACE HEAT.



# HEAT EMITTERS

- BASEBOARD RADIATORS +/- \$25 LF, UNITS SHOWN ARE \$130 WITH VALVES
- LOW MASS DESIGN IS IDEAL FOR LOW ENERGY USE BUILDINGS
- RELIABLE HEAT OUTPUT AT LOW SUPPLY TEMPERATURES
- NO FIN TUBE ! CANNOT PERFORM RELIABLY AT LOW SUPPLY TEMPERATURES



MYSON RCV DÉCOR STYLE BASEBOARD RADIATORS

# HEAT EMITTERS

## TOWEL BAR WARMERS

A LUXURY ITEM, VERY LOW HEAT OUTPUT



MYSON TOWEL BAR WARMER, WITH TRV

# HEAT EMITTERS

- PANEL RADIATORS



MANY DIFFERENT STYLES  
POSSIBLE

RELIABLE HEAT OUTPUT AT LOW  
SUPPLY TEMPERATURES

THE STANDARD IN EUROPE

GOOD HEAT OUTPUT PER SIZE  
OF UNIT

# HEAT EMITTERS

- FAN CONVECTORS



MYSON IVECTOR

THESE CAN HEAT AN ENTIRE LEVEL OF A PASSIVE HOUSE

REMOTE FAN COIL UNITS

HIGH HEAT OUTPUT ON  
LOW WATER TEMPS

VERY QUIET

THESE HAVE THE  
CAPABILITY TO COOL WITH  
CHILLED WATER

GIVEN THE HIGHER OUTPUT  
FEWER UNITS NECESSARY .

+/- \$1800 EACH

OUTPUTS @120 EWT  
RANGE FROM 6,710 –  
16,776 BTU.

# HEAT EMITTERS

KICK SPACE FAN CONVECTORS

FAIRLY INEXPENSIVE

GREAT FOR KITCHENS, BATHS, LAUNDRY ROOM, WHERE THERE ISN'T TYPICALLY WALL SPACE FOR A PANEL RADIATOR

OUTPUTS OF 2516 – 4629 BTU/HR



MYSON WHISPA FAN CONVECTORS +/- \$250 EACH

# HEAT EMITTERS

- SITE BUILT WALLS

HIDDEN FROM VIEW

QUIET OPERATION

OUTPUT PER SQ FT DEPENDENT ON SUPPLY TEMPERATURE (TYPICAL FOR ALL RADIANT PANELS)

POTENTIALLY LOWER INSTALLED COST THAN BASEBOARD AND PANEL RADIATORS

FLOOR PLAN LAYOUTS AND FURNITURE PLACEMENT SHOULD BE CONSIDERED



# HEAT EMITTERS

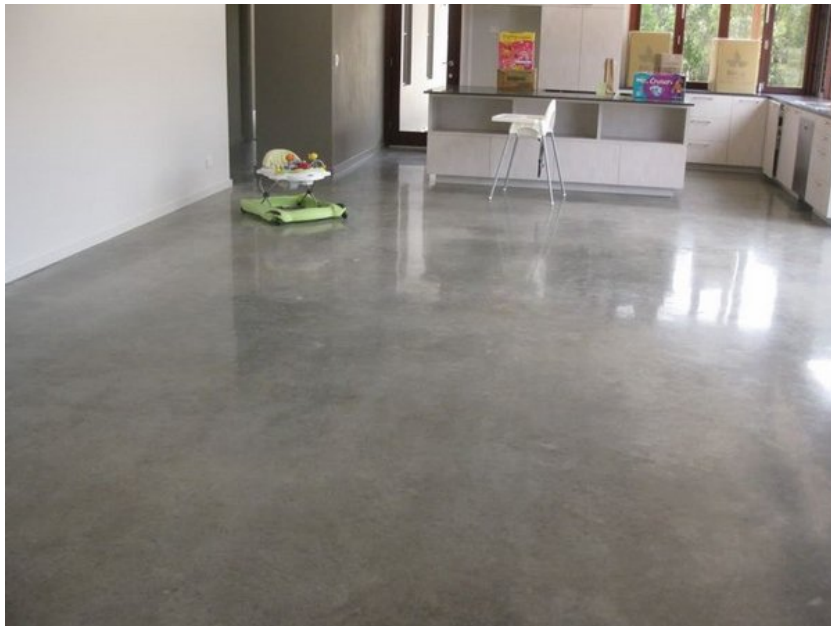
- RADIANT HEAT, IMBEDDED IN CONCRETE POUR

PROS:

EXPOSED CONCRETE FLOORS ARE IN FASHION, WITH IMBEDDED HEAT, THE EMITTER IS OUT OF SIGHT. MINIMALIST LOOK

THE MOST COMMON RADIANT INSTALL  
CONS:

HIGH MASS, SLOW RESPONDING



# HEAT EMITTERS

## IMBEDDED TUBING

THESE ARE NOT “BARE FOOT FRIENDLY FLOORS

SURFACE TEMPERATURE IS ONLY 4 DEGREES ABOVE AMBIENT, THEY HARDLY FEEL “WARM”

REQUIRES A LOWER SUPPLY TEMPERATURE TO PREVENT OVER HEATING IN A LOW ENERGY HOME, VIA A MIXING VALVE

NOTICE THE THICKNESS OF THIS SLAB, THIS WOULD TAKE 36 HOURS TO RESPOND TO TEMPERATURE CHANGE ! NOT IDEAL FOR A LOW ENERGY HOME!





# RADIANT FLOORS

- KEY POINTS FOR RADIANT FLOORS IN LOW LOAD BUILDINGS

KEEP THE FLOOR SURFACE DESIGN TEMPERATURE LIMITED TO 4 DEGREES ABOVE THE INTENDED ROOM TEMPERATURE

THIS WILL CREATE AN OUTPUT OF 8 BTU/HR/SF

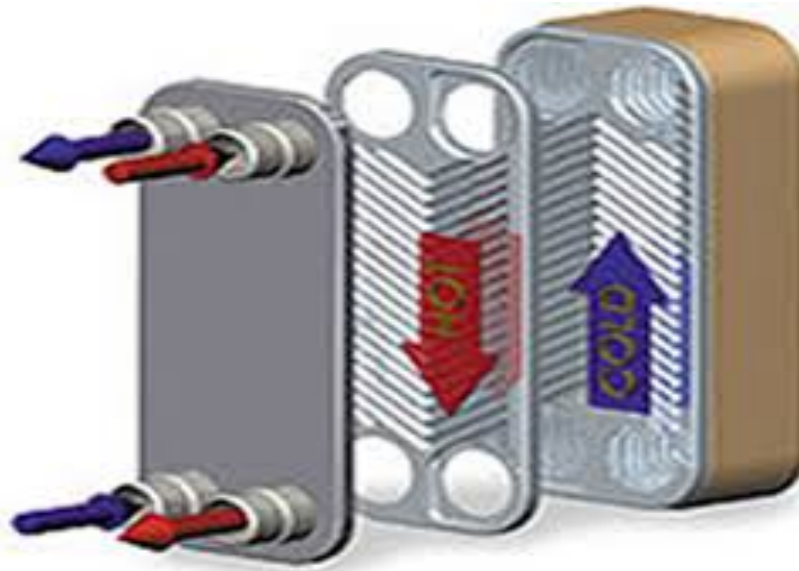
DO NOT EXCEED 12" TUBING SPACING

THE CONCRETE FLOOR WILL PROVIDE SOME THERMAL STABILITY, AND IS LIKELY TO NOT SIGNIFICANTLY OVERSHOOT THE DESIGNED ROOM TEMPERATURE, WHEN SOLAR GAIN IS A FACTOR

.

# HEAT EXCHANGERS

- THE CORE COMPONENT TO HYDRAULICALLY SEPARATE THE DHW FROM THE CLOSED LOOP SPACE HEATING SYSTEM.



TYPICAL BRAZED PLATE  
HEAT EXCHANGER

# SUPPLY TEMPERATURE

- BRAZED PLATE HEAT EXCHANGER'S TYPICAL HAVE AT LEAST A 10 DEGREE DELTA t
- TO SUPPLY THE EMITTERS WITH 120 DEGREE WATER, THE HEAT OUTPUT OF THE APPLIANCE MUST BE AT 130 DEGREES, DEPENDING ON FLOW RATE
- THIS DOESN'T ACCOUNT FOR DISTRIBUTION LOSSES IN HOME RUN PIPING SYSTEMS
- INSULATE THE TUBING HOMERUNS
- POTABLE WATER MIXING VALVES BECOME NECESSARY , 130 DEGREES CAN SCALD ON THE DHW SIDE
- USE CHECK VALVES ON THESE UNITS TO PREVENT THERMAL SIPHONING



# ZONING

- ROOM BY ROOM ? LEVEL BY LEVEL?
- THERMAL ZONES SHOULD BE SEPARATED BY LEVELS AT A MINIMUM (THIS WORKS GREAT IN PASSIVE HOUSE)
- ROOM BY ROOM ZONING IS TYPICALLY NOT NECESSARY, BUT IT'S A GOOD PRACTICE TO SEPARATE AREAS THAT RECEIVE SIGNIFICANTLY DIFFERENT LEVELS OF SOLAR GAIN
- RESULT= HAPPIER CLIENTS

# ZONING METHODS

- USER INTERFACE

THERMOSTATS



TRV  
(THERMOSTATIC RADIATOR VALVES)  
NON-ELECTRIC VALVES, THAT  
REGULATE THE RADIATOR OR  
BASEBOARD HEATER, BASED ON  
ROOM TEMPERATURE AND USER  
SETTING. EXTREMELY SIMPLE!



# ZONING METHODS

- MECHANICAL ROOM ZONING

ZONE VALVES:  
OK WITH A CENTRAL PRESSURE  
REGULATED PUMP

CIRCULATION PUMPS:  
TYPICAL IN A MODERN HYDRONIC  
SYSTEM.  
NOT TYPICALLY NEEDED FOR A LOW  
ENERGY HOUSE



# ZONING METHODS

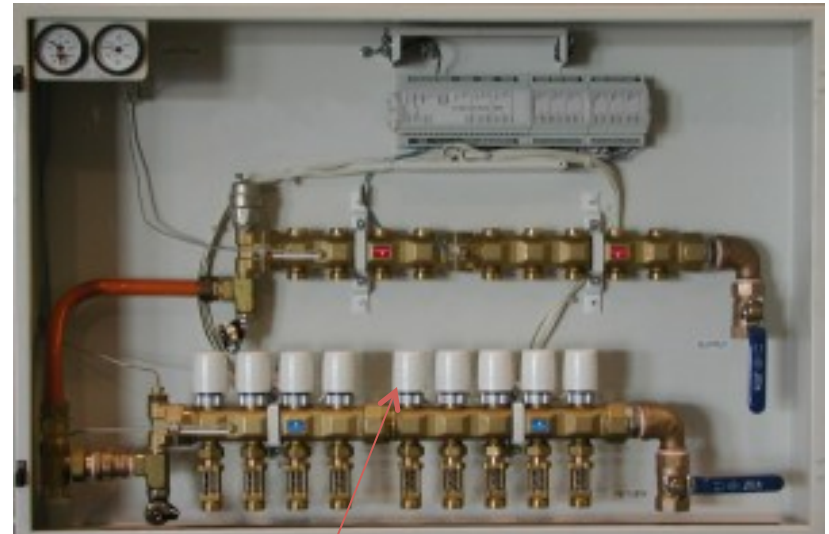
## MANIFOLD MOUNTED ACTUATORS

### PROS:

MANIFOLDS ARE ALREADY USED FOR (HOME RUN) DISTRIBUTION PIPING

ADDING A 24V ACTUATOR AT EACH CIRCUIT CREATES A SIMPLE ZONE

THERMOSTATS, AND ACTUATORS WIRED TO A ZONE CONTROL IS FAIRLY SIMPLE INSTALL



THESE ARE THE ACTUATORS

# PUMPS

- VARIABLE SPEED CIRCULATION PUMPS: THE KEY TO EFFICIENT DISTRIBUTION AND POWER CONSUMPTION

THESE ECM BASED PUMPS SENSE HEAD PRESSURE AND ADJUST THE OUTPUT BASED ON HOW MANY ZONES ARE CALLING FOR HEAT





# THE IDEAL SYSTEM

- THE SIMPLEST SYSTEM WOULD UTILIZE ONE VARIABLE SPEED CIRCULATOR AND THERMOSTATIC RADIATOR VALVES (TRV) AT EACH EMITTER LOCATION.
- JOHN SIEGENTHALER CALLS THIS “HYDRONICS HEAVEN”



# SUMMARY

- PANEL RADIATORS AND BASEBOARD RADIATORS WORK GREAT WHEN PLACED UNDER WINDOWS
  - FURNITURE ISN'T NORMALLY PLACED TIGHT TO WINDOWS
- KICK SPACE FAN CONVECTORS ARE AN OPTION FOR BATHS, LAUNDRY AREAS, AND KITCHENS
  - THE ABILITY TO PLACE AND DISGUISE A HEATER UNDER THE CABINET TOE KICK IS GREAT USE OF SPACE

# SUMMARY

- HEATED CONCRETE FLOORS CAN WORK IN LOW ENERGY HOMES IF DESIGNED PROPERLY



# PINEBROOK RESIDENCE

## PARK CITY , UT

### CLIMATE ZONE 6

- 3210 sq ft
- DESIGN HEATING LOAD OF 8 BTU/HR/SF (PER MANUAL J)
- 25,680 BTU/HR PEAK HEAT LOSS
- FAMILY OF 4 ASSUMED USE OF 68 GALLONS OF DHW PER DAY
- COST OF SYSTEM, INCLUDING WATER HEATER \$7.50 SF. MINUS COST OF WATER HEATER (\$3200) \$6.52 SF

# SYSTEM SPECS

- HTP PHOENIX 100k BTU 55 GALLON COMMERCIAL WATER HEATER
- GRUNDFOS MAGNA VARIABLE SPEED CIRCULATION PUMP
- MYSON RCV DÉCOR SERIES BASEBOARD RADIATORS
- MYSON WHISPA KICKSPACE FAN CONVECTORS
- HOT WATER RECIRCULATION SYSTEM



**NOTE: THIS IS NOT THE ONLY HEAT SOURCE FOR THIS BATH**



# MECHANICAL ROOM





# PIPING SCHEMATIC

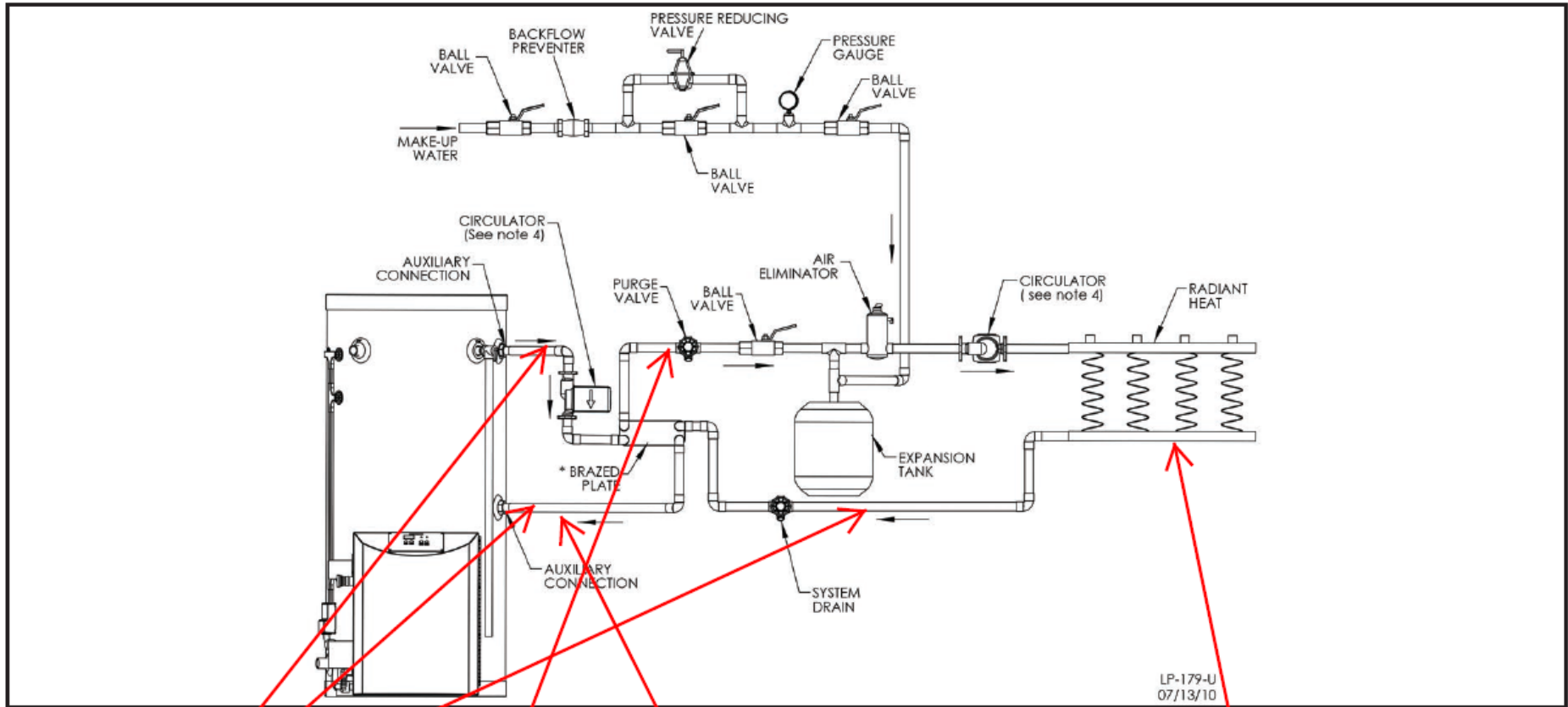


Figure 10 - Piping with Closed Loop for Radiant Heating

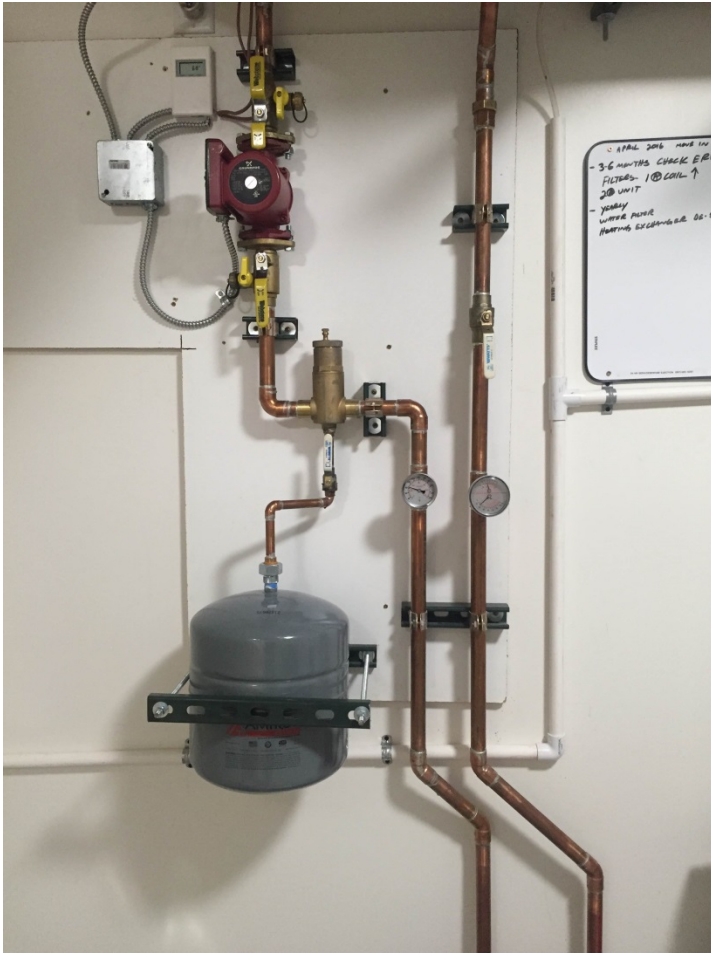
TEMP GAUGE

TEMP AND PRES GAUGE

DHW RECIRC RETURN

12 PORT MANIFOLD WITH ACTUATORS

# ERV FAN COIL



500' "GEO" LOOP AROUND FOUNDATION, ERV PRECONDITIONING

# TIPS FOR LOWER COST INSTALL

- LIMIT ZONING TO THE BASICS
- USE TRV's
- USE FEWER, LARGER RADIATORS
- SITE BUILT MANIFOLDS WITH PEX FITTINGS  
(HOME RUN PIPING)
- BRAZED PLATE HEAT EXCHANGER
- COULD BE IN THE \$4-5 SQ FT RANGE +/-

# DISCUSSION

- ADDITIONAL THOUGHTS FOR A LOWER INSTALLED COST
- WHEN DO ASHPs MAKE MORE SENSE?

# CREDITS

- JOHN SIEGENTHALER : HYDRONIC HEATING FOR LOW ENERGY HOUSES
- HEAT TRANSFER PRODUCTS (HTP)