PENSOTTI BOILERS LLC

Distinctive Designer Series
Steel Panel Radiators

What are Panel Radiators?

Modern, Stylish European Design Heat Emitters

"Europe's Baseboard"

Advantages of Pensotti Steel Panel Radiators

- 10 year warranty
- Space saving design
- Aesthetically pleasing design fits most decors
- White powder coat finish for a neutral appearance and resilience
- Easy to clean surface and internal flutes
- Perfect for both remodeling and new construction
- Quiet, no expansion noises
- Available in a variety of heights and widths
- Require minimal wall space when compared to baseboard
- Release both radiant and convective heat
- All steel construction resists denting
- Wall mounted and not affected by floor covering changes
- Function very well with both high and low water temperatures
- Ideal Supplemental Heater For Radiant Floor Systems
- Performs well with large temperature drops
- Increased system efficiency through radiant heat output and low temperature operation
- Easily isolated from the piping system using optional valves
- Low water content provides quick heat up and cool down for greater comfort
- Integral provision for thermostatic non-electric operator
- Reversible for ease of piping installation

Contemporary Styling

Flexibility

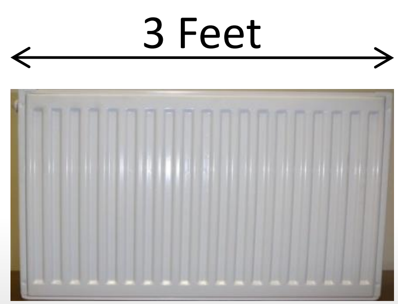
All Temperature Applications

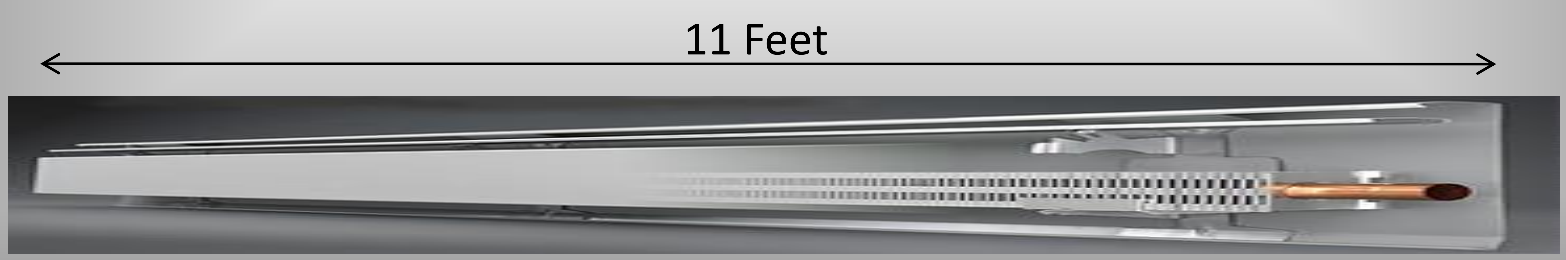
Installation Requirements

- Install in closed-loop hydronic systems only, use in open systems will void warranty
- Maximum operating temperature 250 degrees
- Maximum operating pressure 145 psi
- Can be used in systems containing antifreeze provided the Ph levels are properly maintained
- **Not** for use in steam heating systems

Requires Less Space Than Baseboard

A Pensotti DD20.36DBL, 20” High x 36” Long, emits **6469** Btu/h, equivalent to **11.2** feet of conventional, residential fin tube baseboard





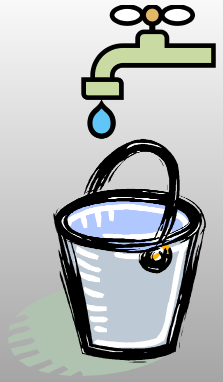
More Comfort

Panel Radiators emit a large portion of their heat output as radiant heat, reducing the stratification of room air and increasing comfort

Fin tube radiation emits almost all its heat through warm air convection, increasing stratification, reducing comfort and increasing heat loss

Low Water Content

Pensotti Steel Panel Radiators hold just a small amount of water which results in low thermal mass, allowing them to respond quickly to changes in room air temperature and internal heat gains



Wall Mounted

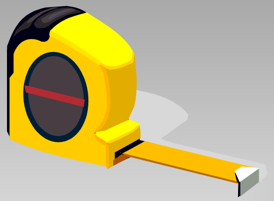
Installed a minimum of four inches above the floor, making room and floor cleaning quick and easy

Changes in floor coverings will not impact the performance of panel radiators

Low Water Temperature

- Pensotti Panel Radiators work effectively at lower water temperatures than are typically used in baseboard systems
- Lower water temperatures increase the efficiency of both the boiler and distribution system
- Panel Radiators work especially well with water temperature reset controls
- Radiant heat output from panel radiators increase as water temperature decreases, providing additional comfort

Physical Sizes



Available in Four Heights

12”, 16”, 20”, 24”, 36”

Lengths

16”, 20”, 24”, 28”, 32”, 36”, 39”, 43”, 47”, 55”, 63”
72”

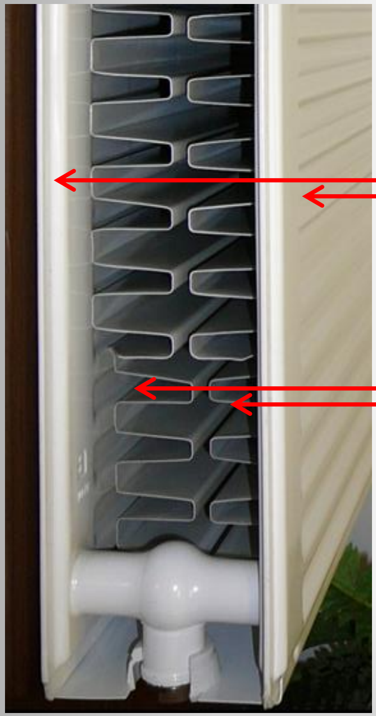
Width – Type 22

4”

Radiator Package

Each radiator is supplied with a pair of wall brackets (EVK Plus/) and 2 starting reducers (A55400T)

Type 22



2 Water Walls (Radiant Heat - Wet)

2 Convective Rows (Convective Heat - Dry)

Weight & Water Volume

Height	Type 22	Weight Per Foot Less Water	Water Content
12”	Double	12 Lbs.	.27 Gals/Ft.
16”	Double	16 Lbs.	.35 Gals/Ft.
20”	Double	20 Lbs.	.38 Gals/Ft.
24”	Double	24 Lbs.	.45 Gals/Ft.
36”	Double	35 Lbs.	.52 Gals/F.

Installed Depth

Type 22

Front/Side View

Thermostatic Valve w/Cover

Removable Side Covers

Water Panel

Front/Side View

Bottom View

Water Panel
Return Tap
Supply Tap
Dry Flutes
Drain Plug
Water Panel

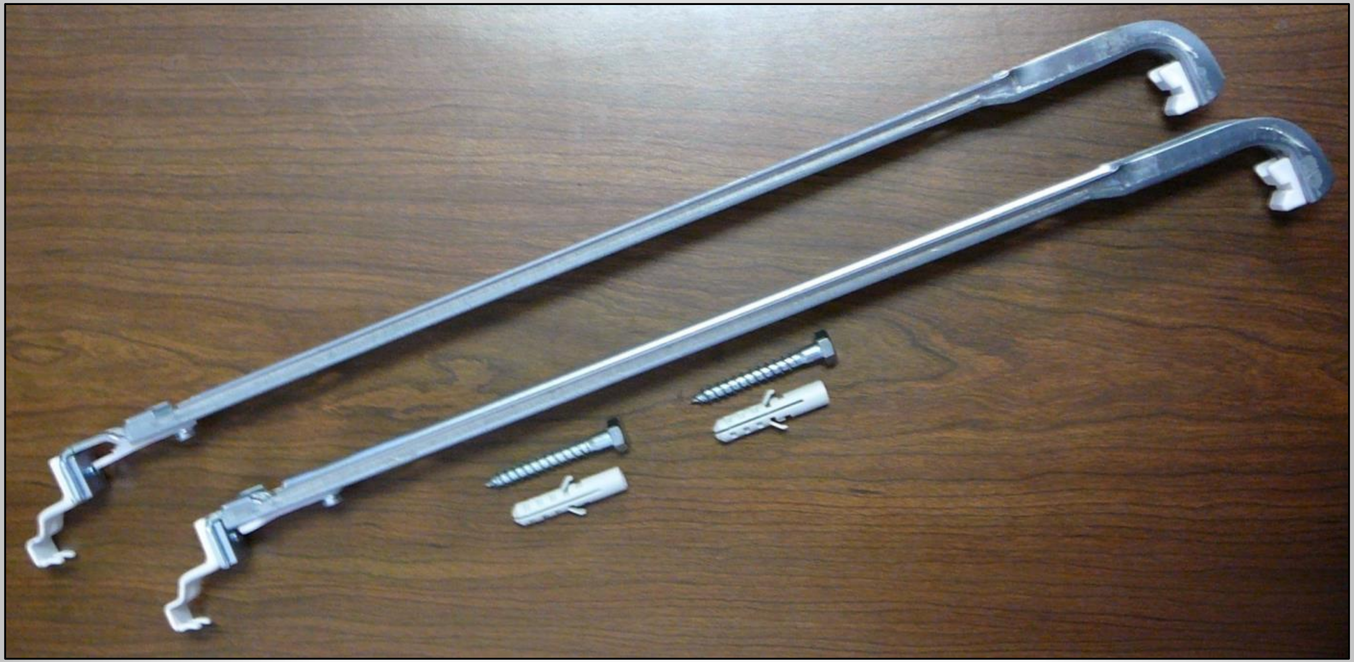
Top View

Removable Grille

Wall Mounting

- Radiators are attached directly to a wall surface using Pensotti Snap Grip mounting brackets
- Brackets need to be affixed securely to studs or masonry walls. They should never supported by sheetrock or plaster alone
- Snap Grip brackets can be attached anywhere along the length of the radiator, allowing fasteners to be inserted into a wall stud

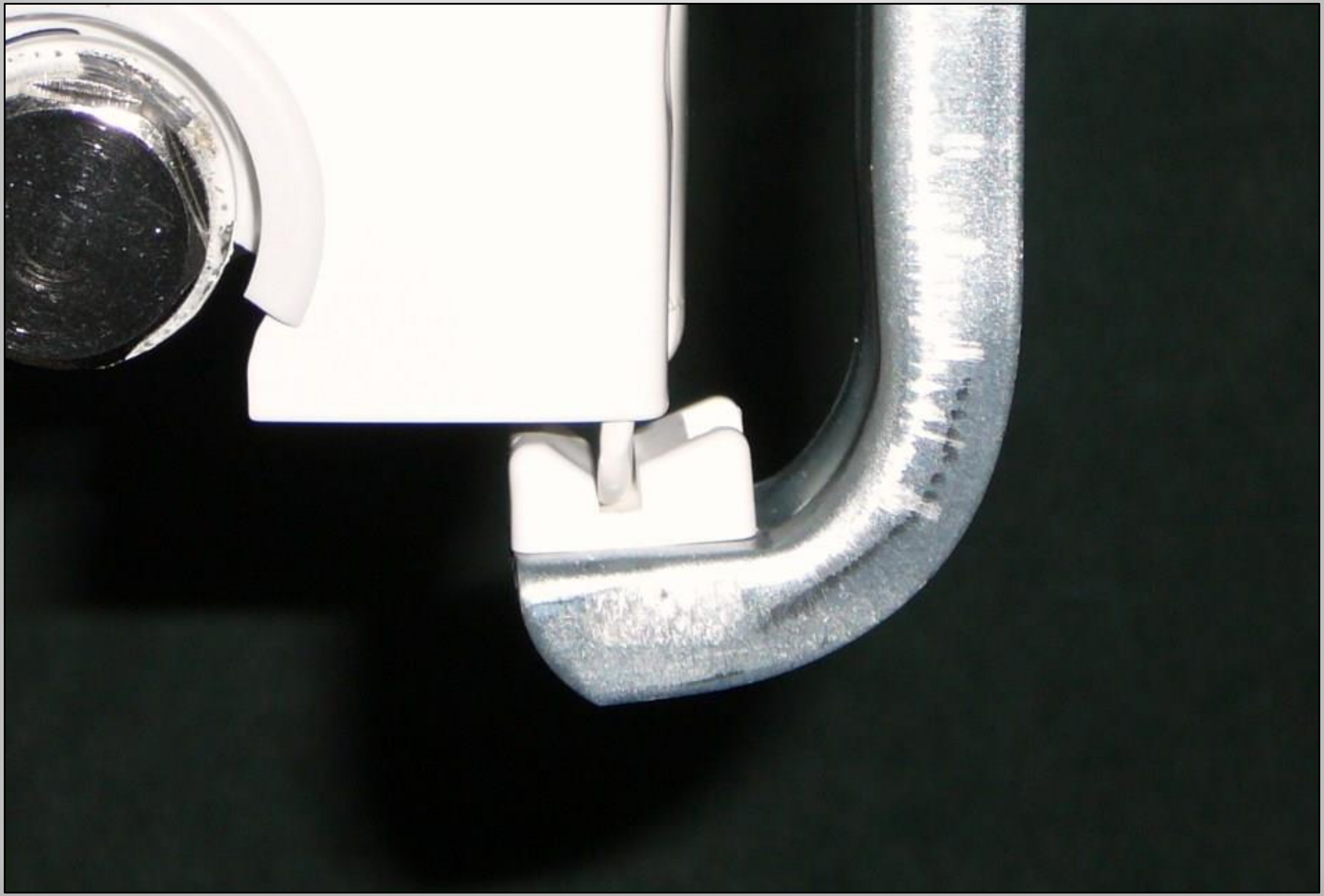
Bracket Kit



- Must be attached to a suitable wall stud using proper fasteners
- Can be attached to masonry wall providing the proper anchors are used
- Must be installed plumb and level
- Each bracket can support up to 100 Lbs.
- Additional brackets are available (sold in pairs only)

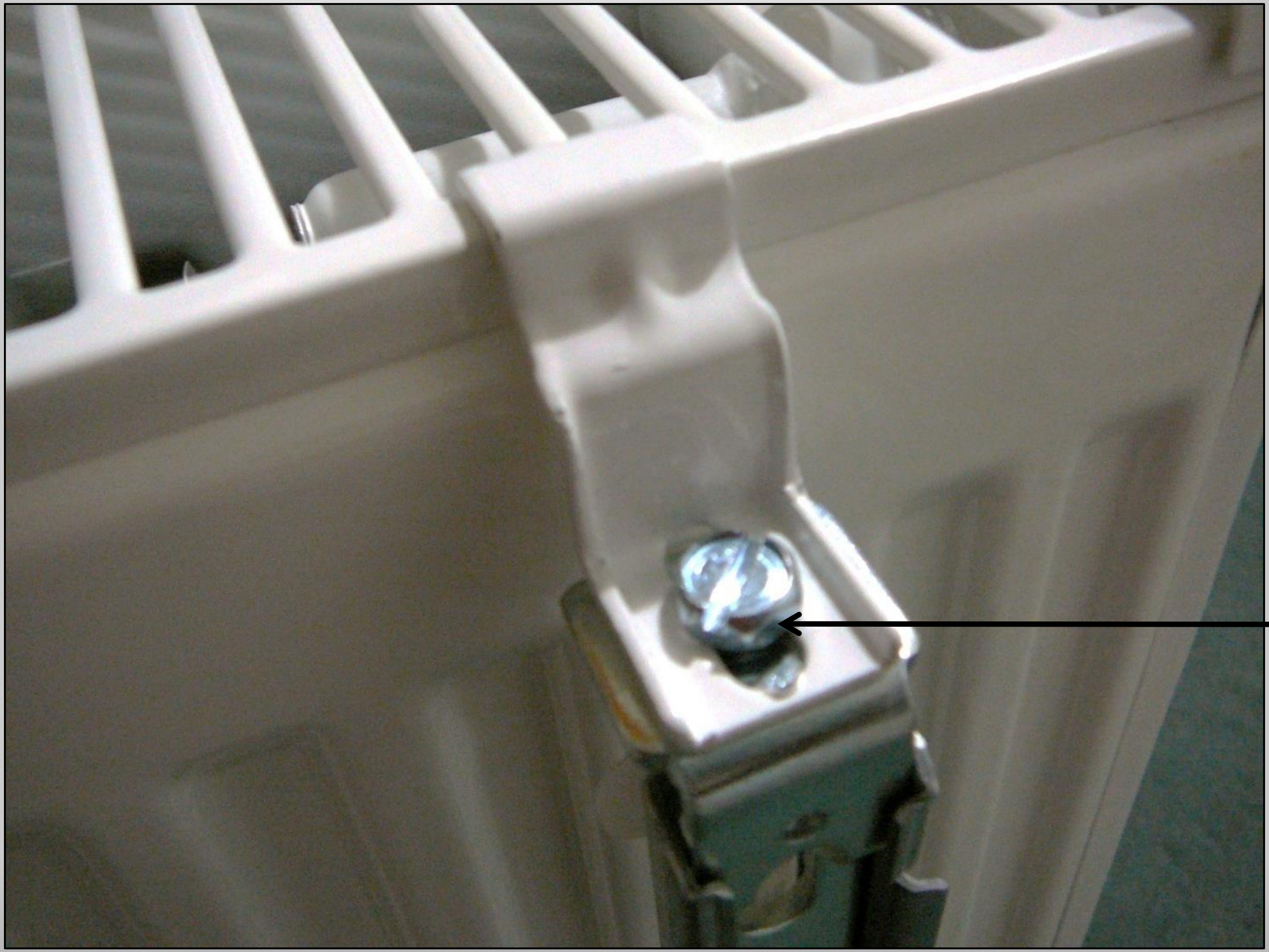
Attached Brackets

Bracket Foot



Plastic foot provides secure support and quiet operation while radiator heats and expands

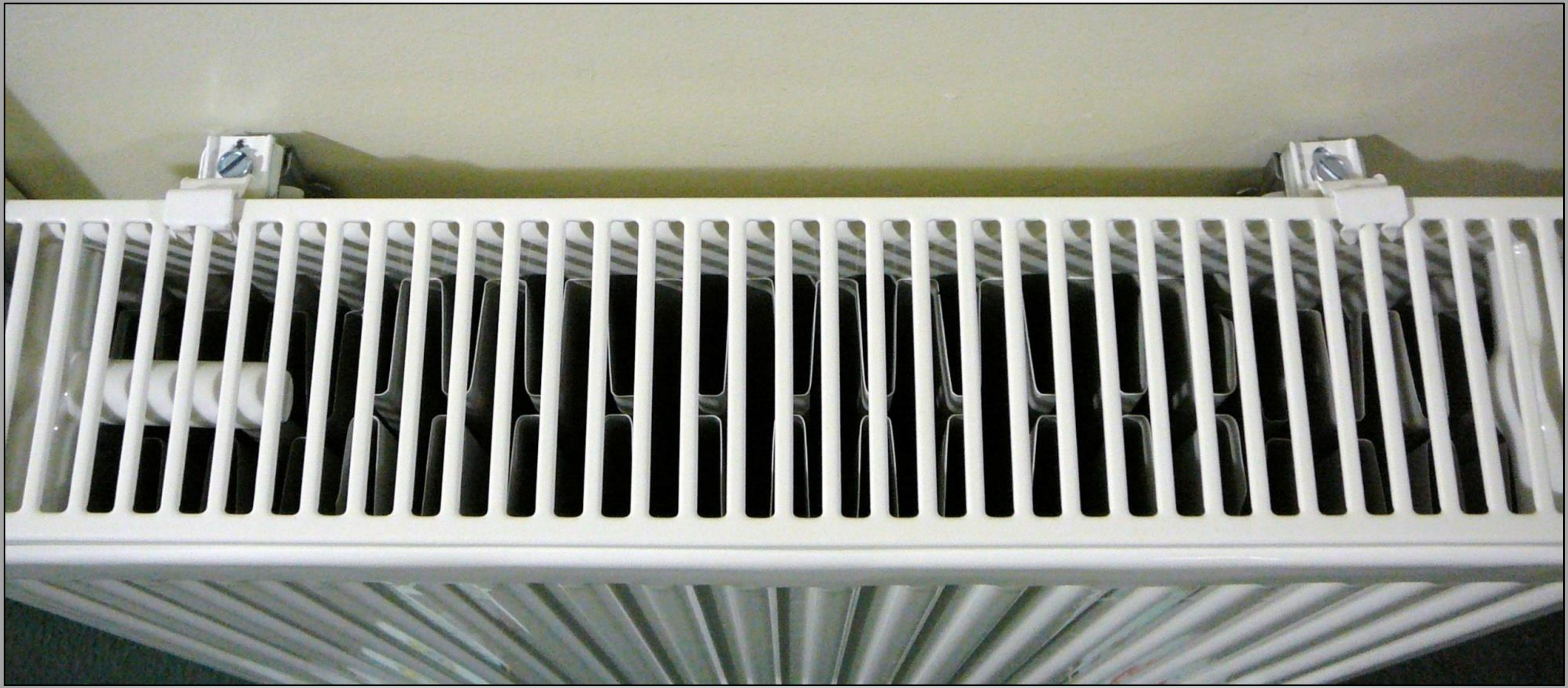
Bracket Top



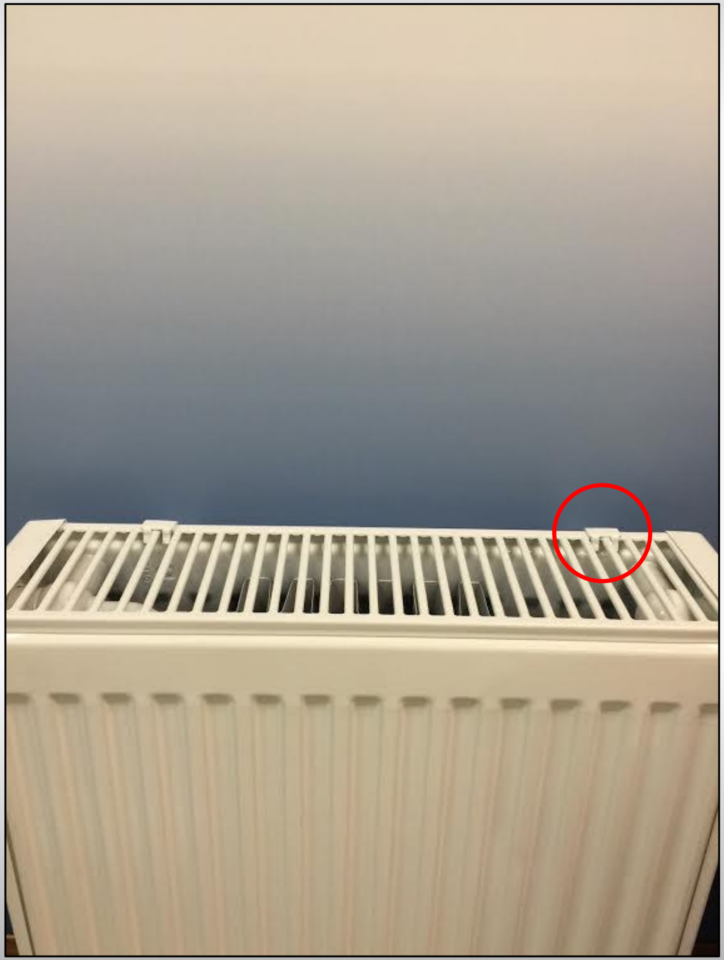
Top Clamp Adjustment

Adjusts forward and backwards to attach the top of the radiator securely

Installed Radiator

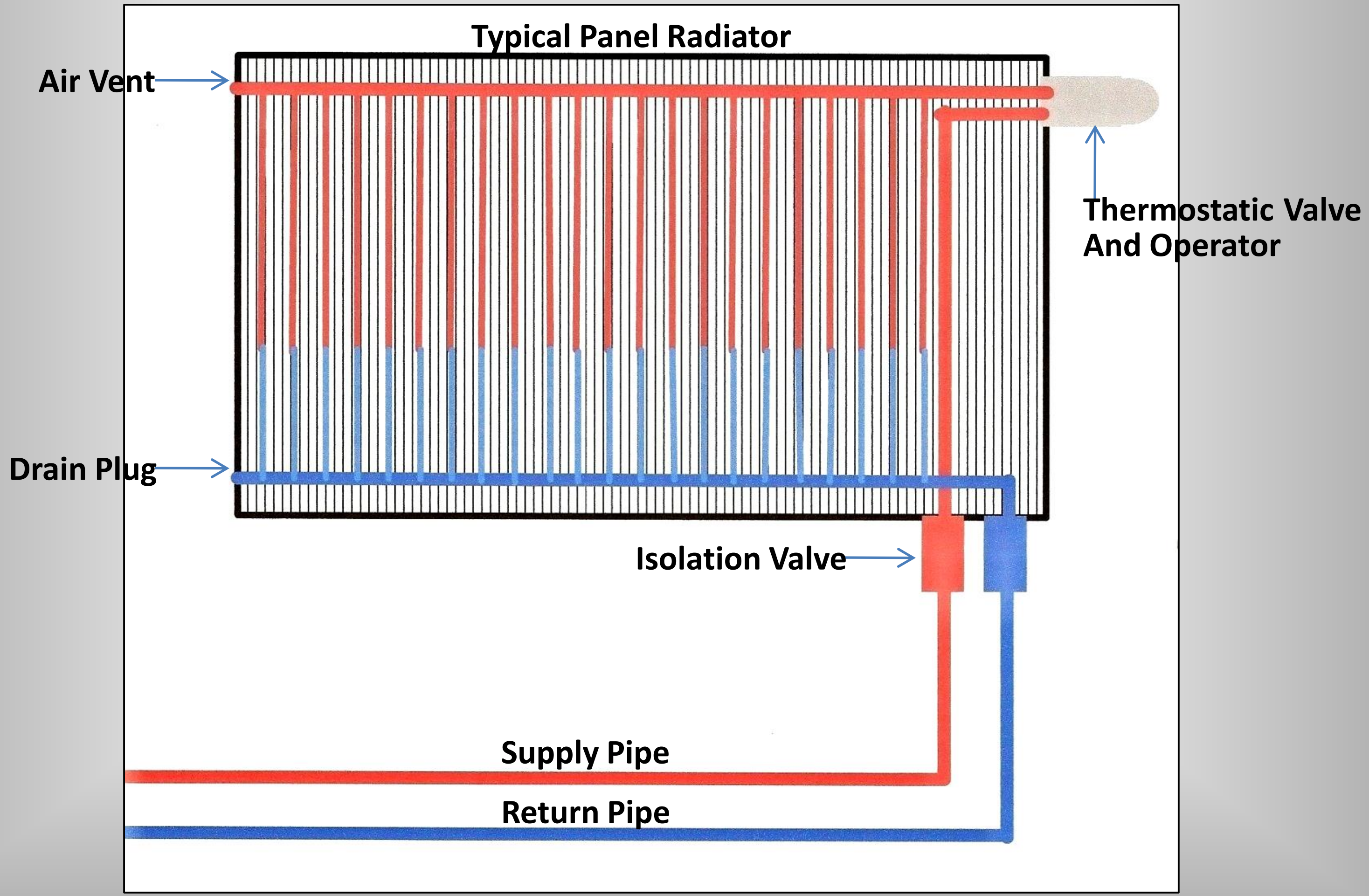


Installed Brackets



From several feet away the brackets are barely detectable

Water Flow / Components



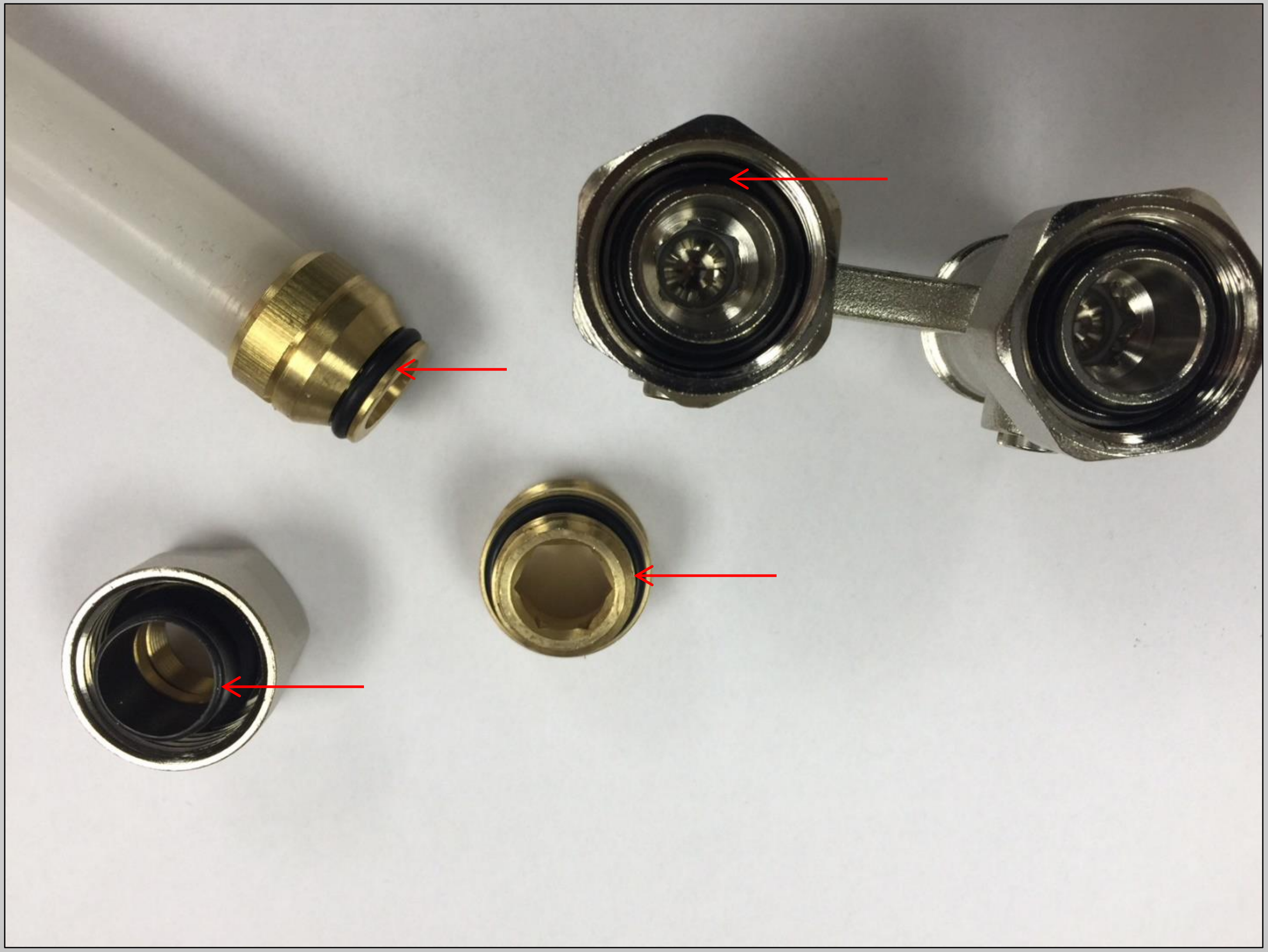
Supply connection is always the inner connection

Piping Materials

Pensotti Panel Radiators are compatible with copper pipe and PEX tubing

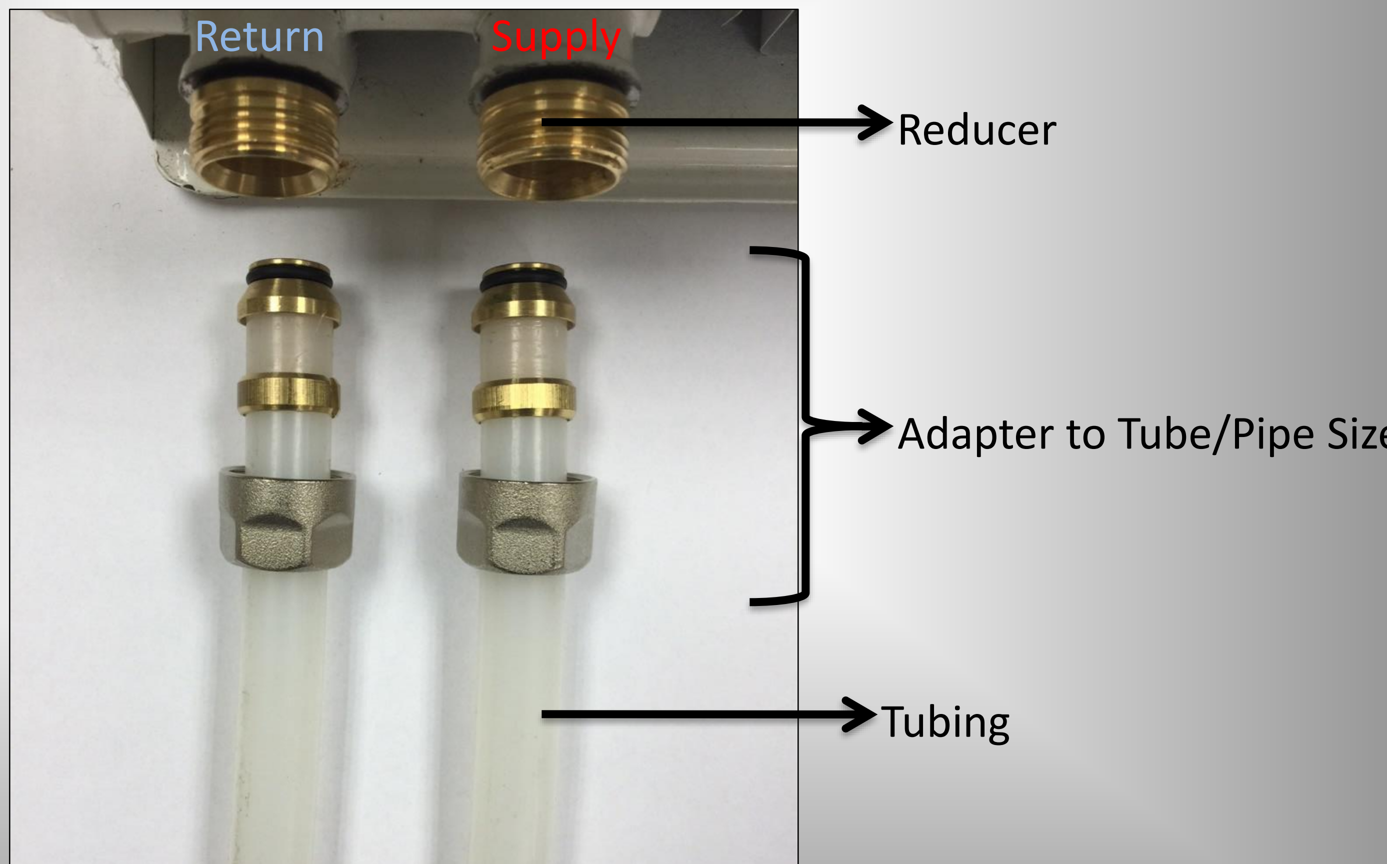
- Compression adapter fittings allow 1/2” copper pipe, 3/8”, 1/2” and 5/8” Pex tubing to connect to the radiators
- Only Pex tubing with an oxygen barrier meeting the DIN4726 standard should be used

Radiator Adapters & Valves



All Pensotti radiator fittings and valves are o-ring sealed; no tape or thread sealant is required

Piping Connections - No Valves



As shown: Pex tubing adapters - available in 3/8”, ½” and 5/8” sizes

Piping Connections - No Valves

Tighten

Finished

Piping Connections - No Valves

One piece ½” copper pipe adapter

Isolate Each Radiator

- Pensotti Panel Radiators can be temporarily isolated from the distribution system using available valves
- This permits easy removal from the wall for room maintenance, such as painting

Piping Connections – Optional Isolation Valves & Adapters

Reducer

Isolation Valve

Adapter To Tube/Pipe Size

Optional Isolation Valves & Adapters

Completed Assembly

Valve Options

Straight

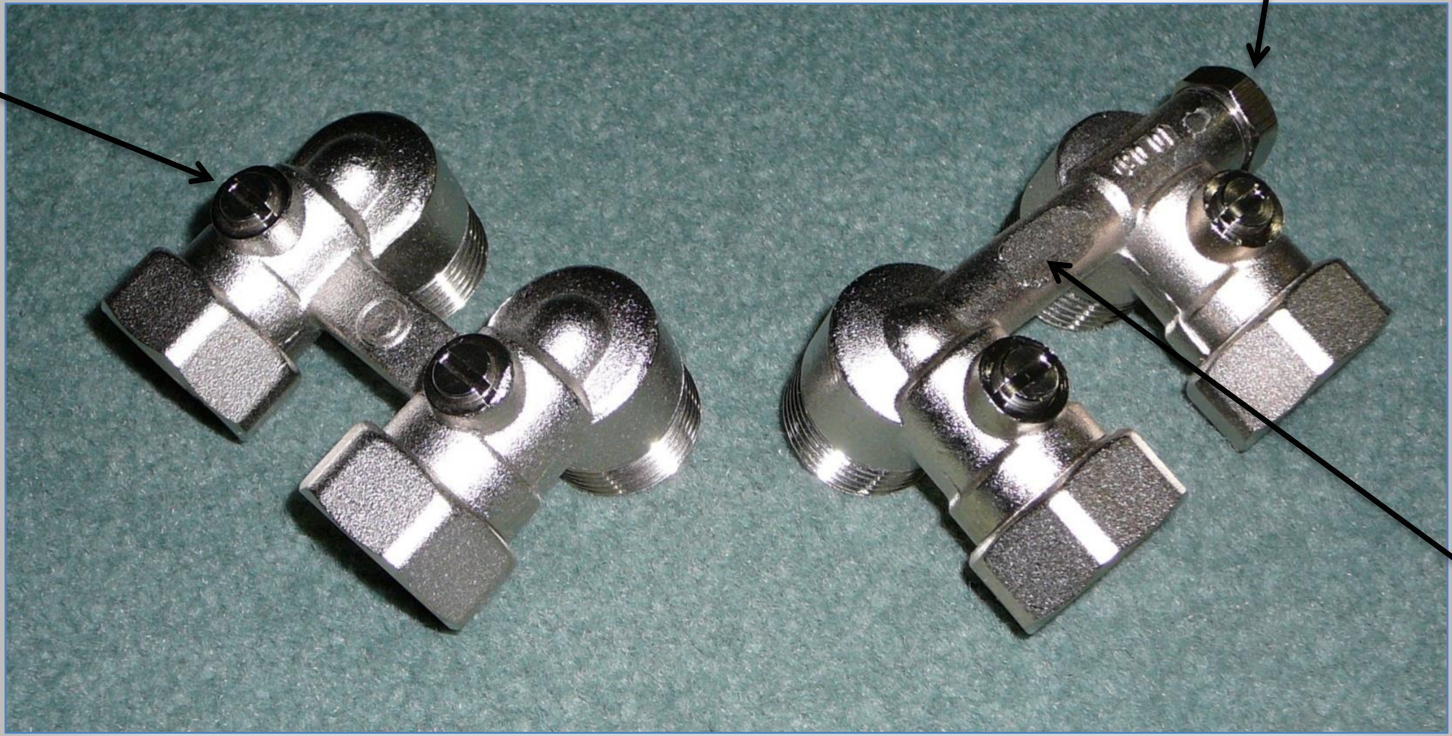
Bypass Valve

Ball Valves

Bypass Tube

Valve Options

Angle

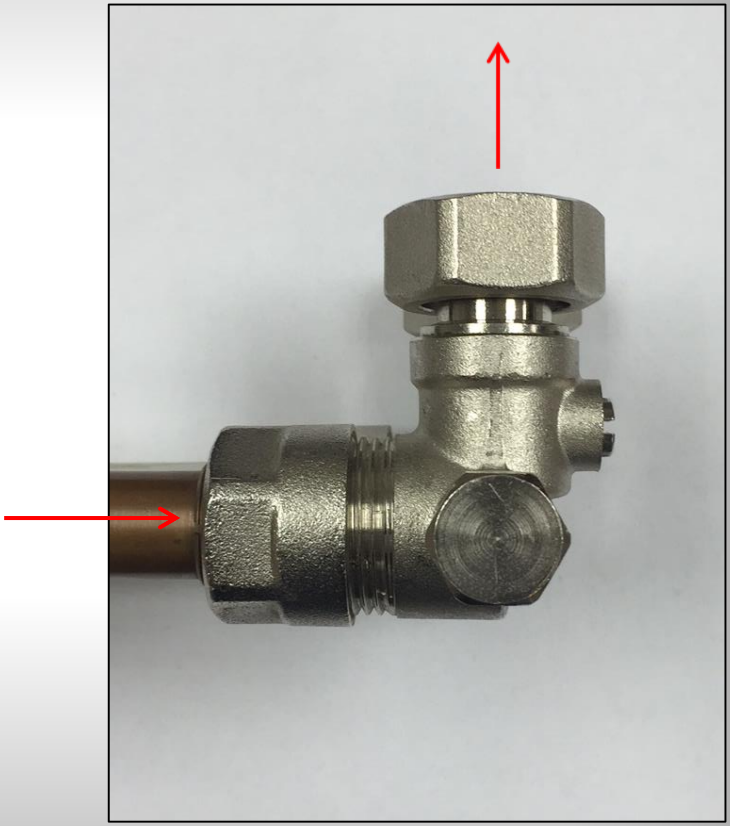


Valve Options

Straight

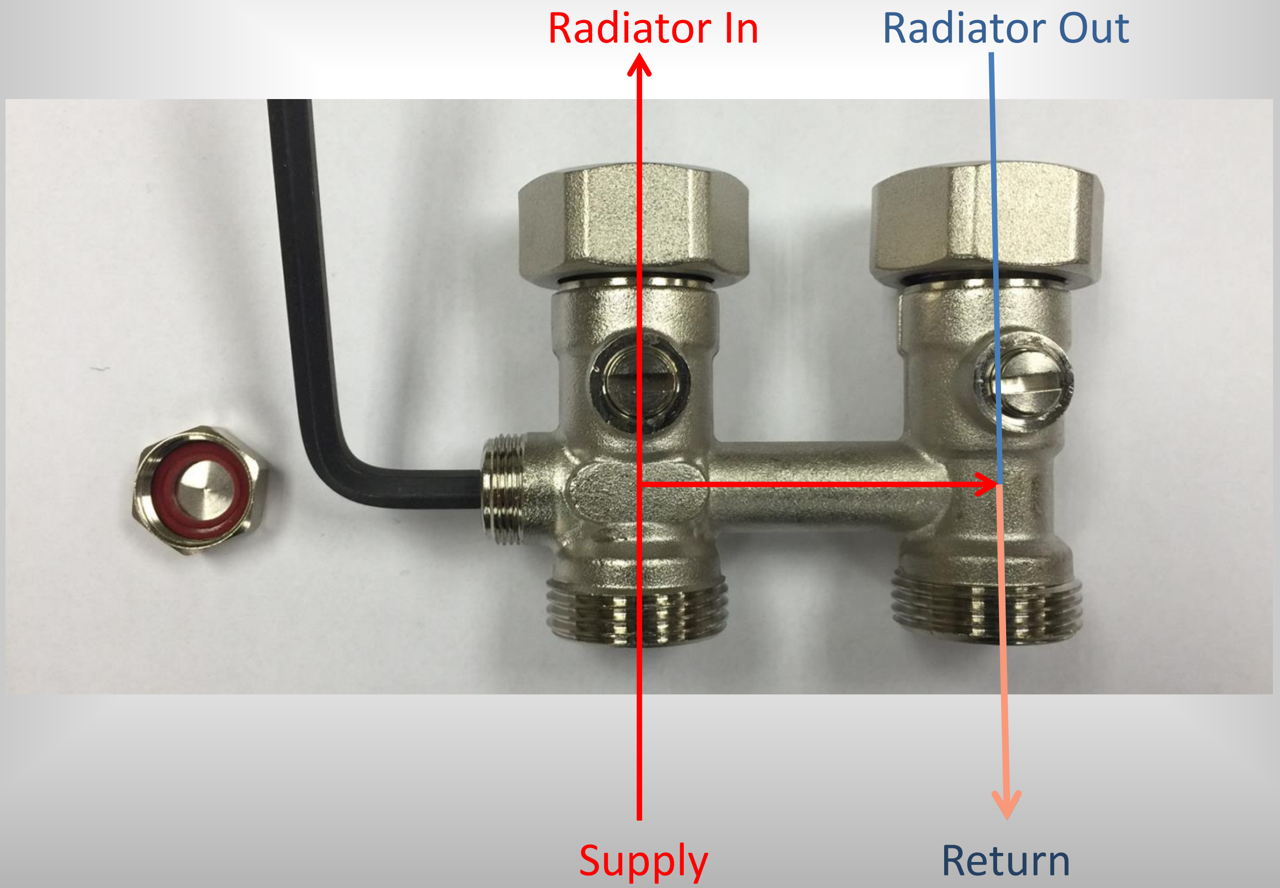
Supply and return pipes
through the floor

Angled



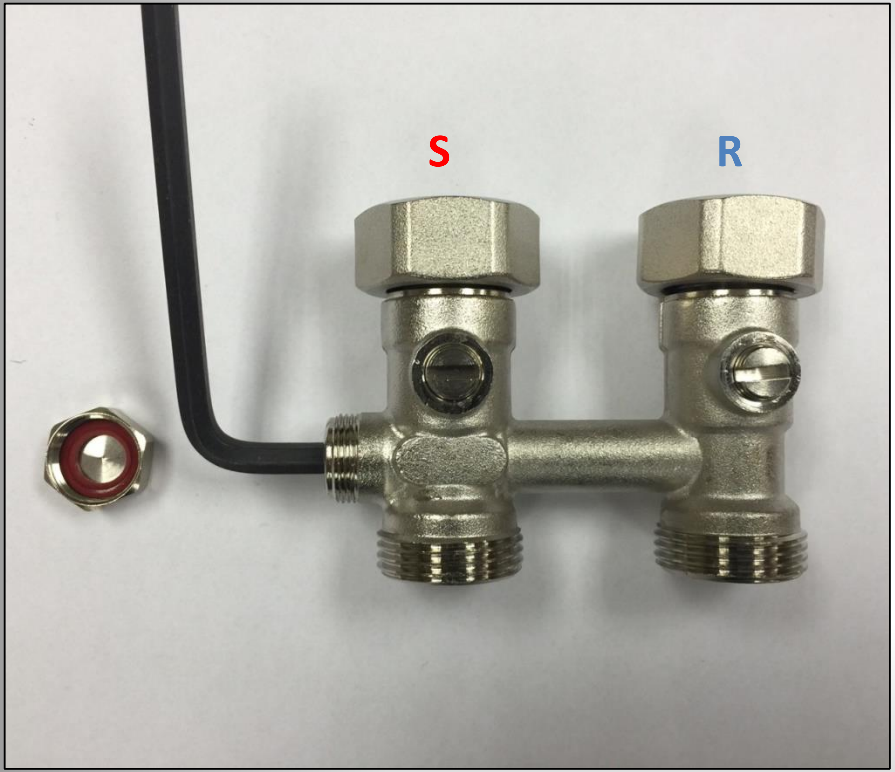
Supply and return pipes
through the wall

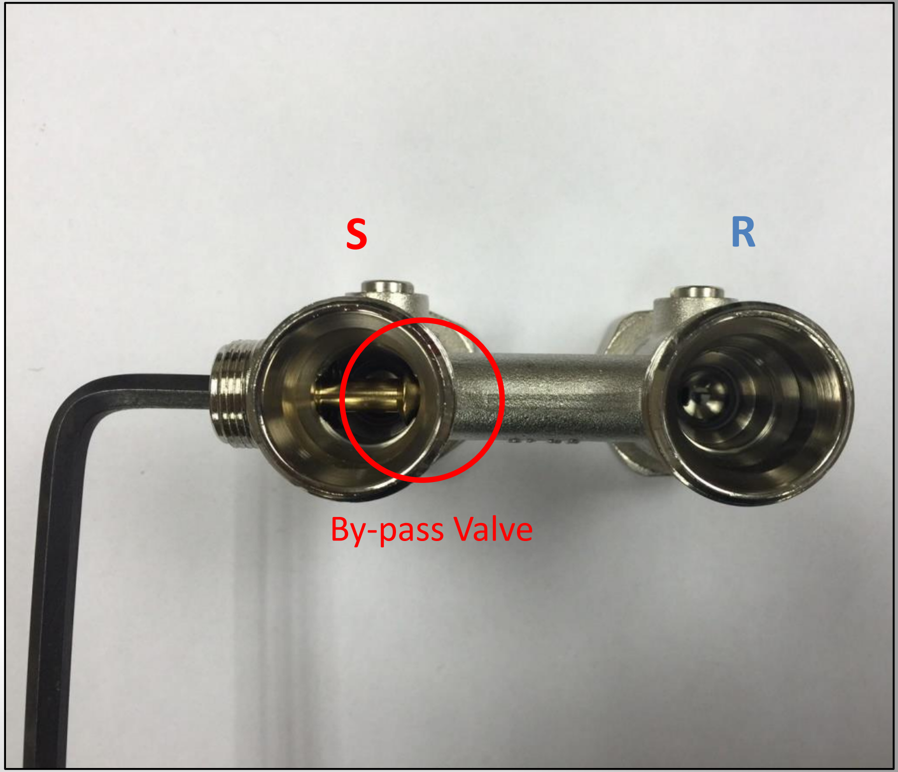
By-Pass Valves



Flow Path

By-Pass Valves

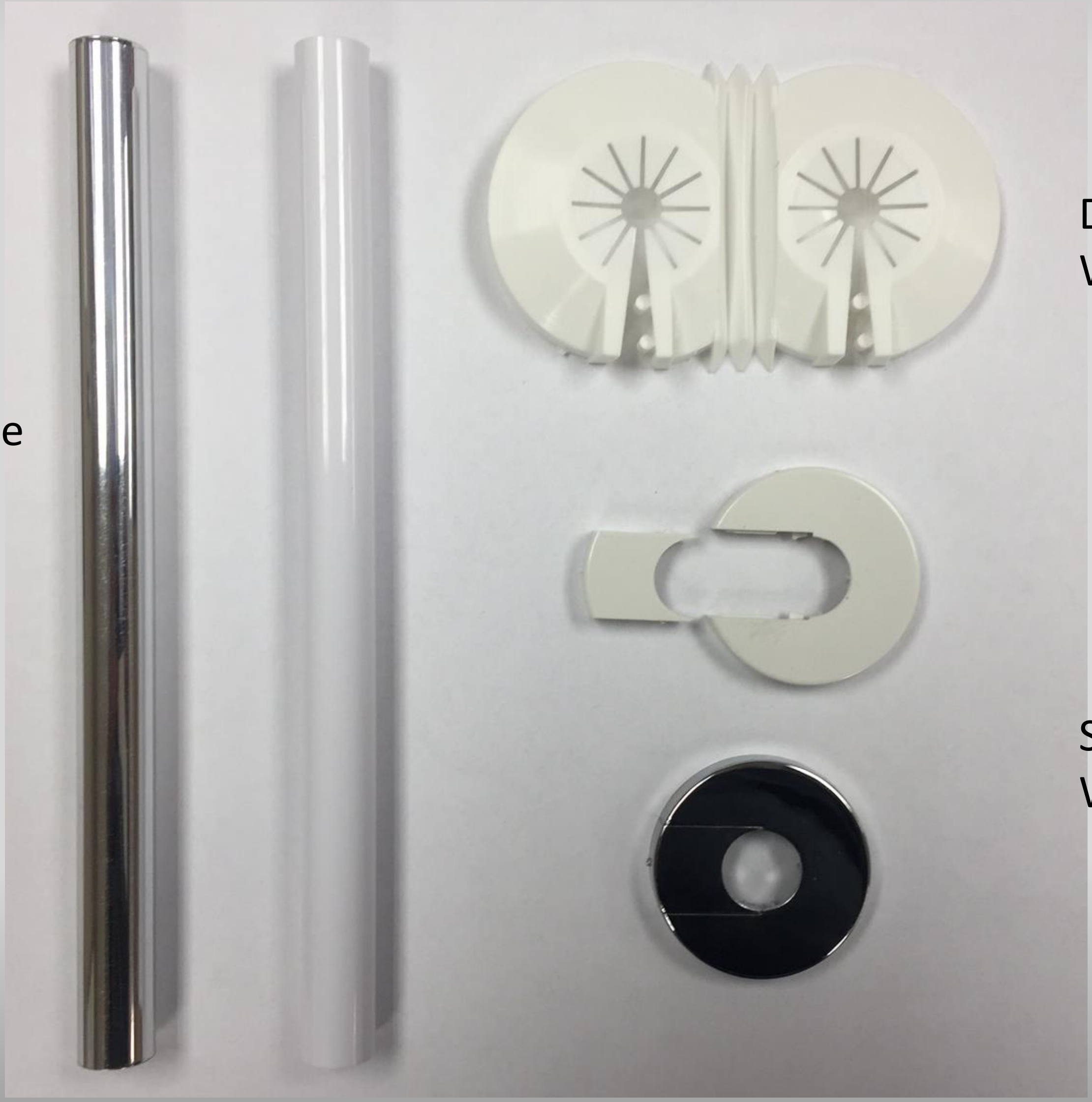




By-pass valves can be adjusted using a 5mm allen wrench. They are factory set at 35% flow through the radiator and 65% flow through the by-pass

Accessories

PVC Pipe Covers
White and Chrome
8” Long



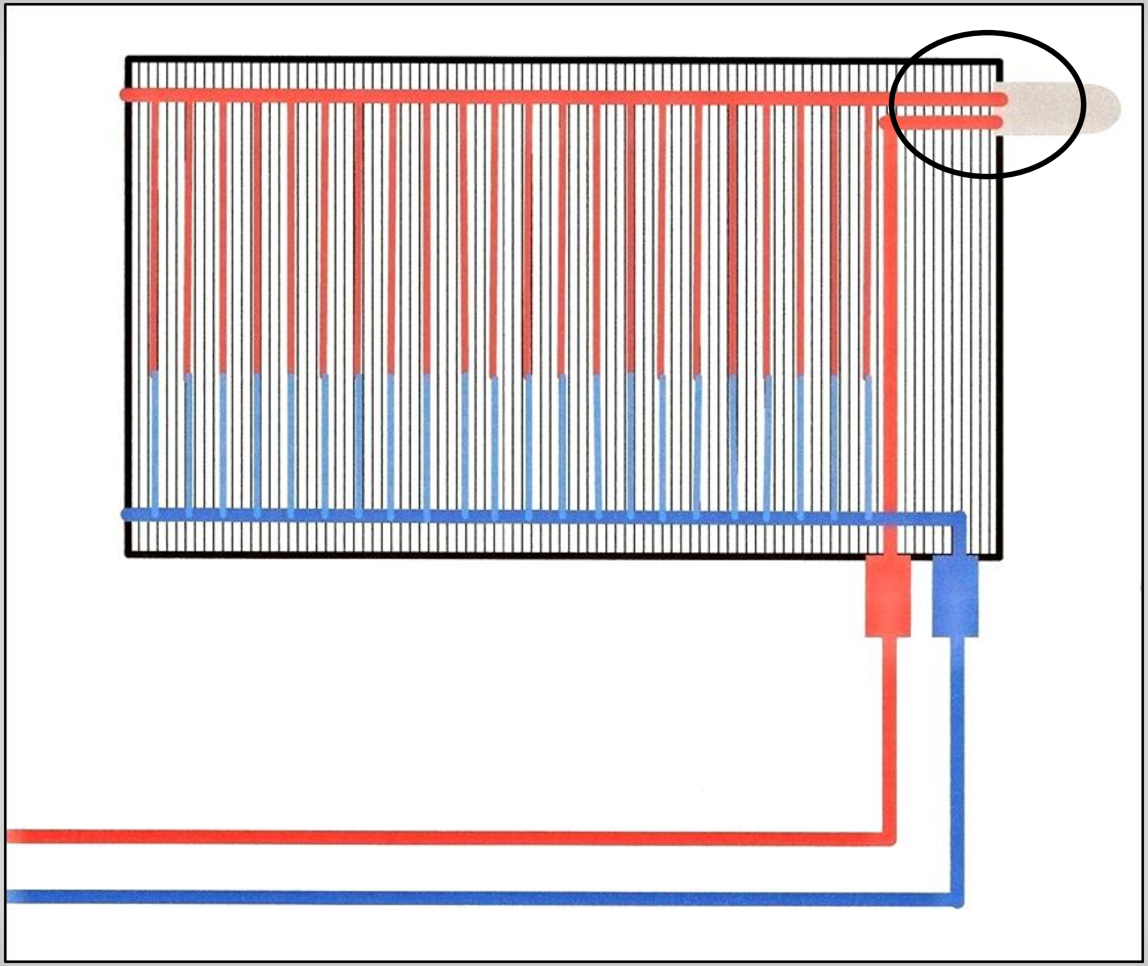
Dual Escutcheon
White Only

Single Escutcheon
White and Chrome

Zoning For Comfort And Efficiency

- Integral thermostatic valve and optional thermostatic operator provide for individual control of each panel radiator resulting in individual room zoning
- Radiators may also be installed using customary zoning styles

Thermostatic Valve

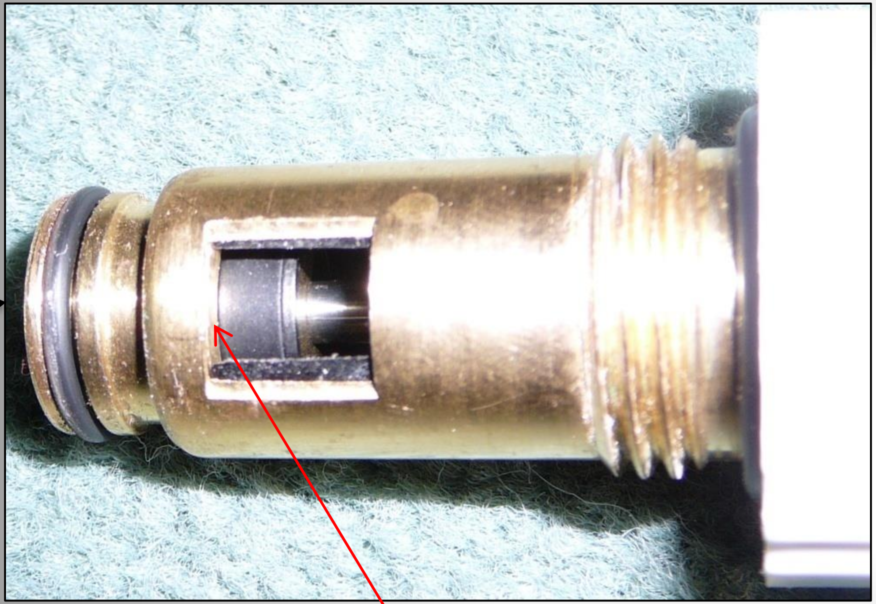


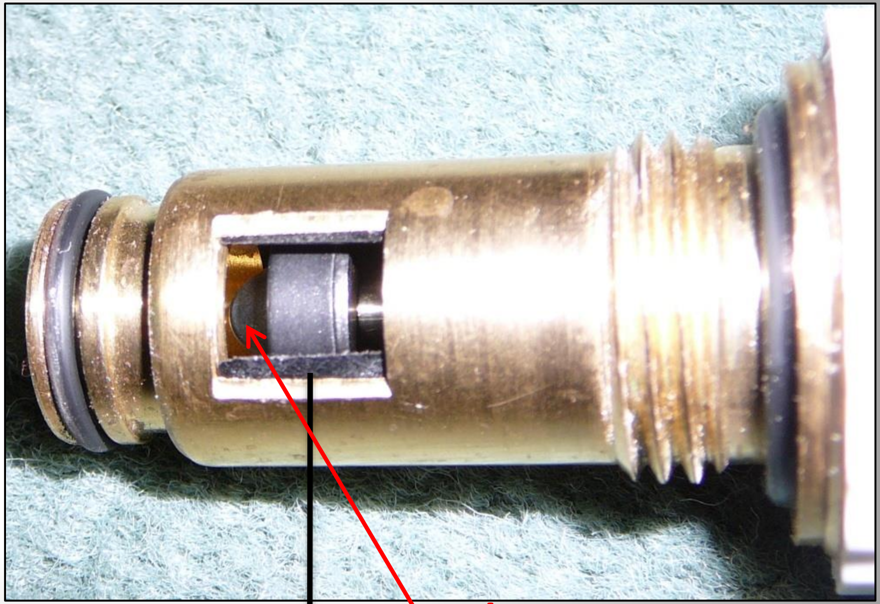
Upon entering the radiator **all** water passes through the thermostatic valve before entering the heat transfer water panels.

Thermostatic Valve

Water Flow

Water flow - In





Water Flow – Out to Heat Transfer Water Panels

Closed

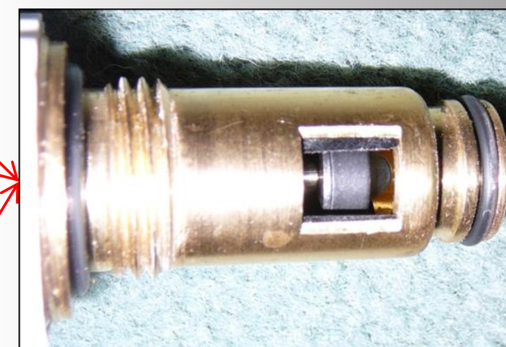
White Cap Tight

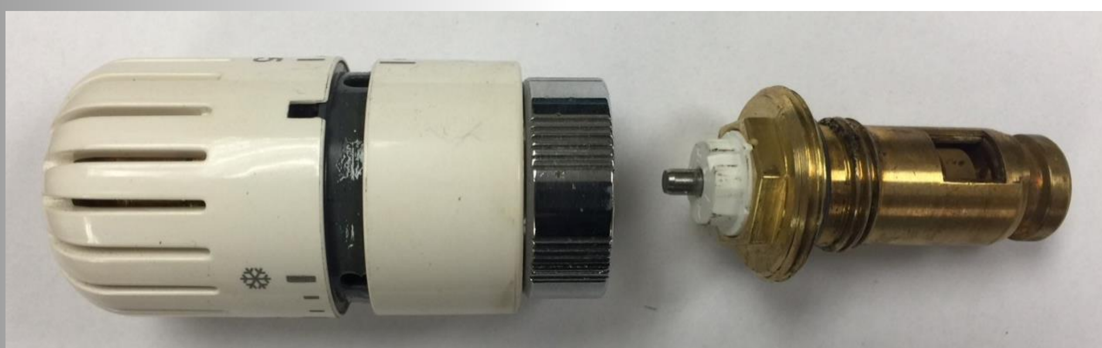
Open

White Cap Loose

Thermostatic Operator

Factory Installed Cap





Optional, Automatic, Thermostatic Operator

Both the cap and the thermostatic operator will increase, decrease or stop flow through the thermostatic valve. Both do so by depressing the pin, the further the pin is pushed the more flow is reduced. Factory caps should be left slightly loose to allow 100% flow through the valve.

Thermostatic Operator

Thermostatic Operator

Carlo Poletti A41700A (A40400A) Thermostatic Operating Head

- Accurate
- White ABS Plastic Construction
- Compact Styling
- Low Hysteresis Wax Sensor (Quick Response)
- Easy to Read Numbered Scale (Snowflake,1,2,3,4,5,6)
- Frost Protection
- Maximum Temperature 130 F

Setting	**Temperature F (**Approx)
Snowflake	44
1	52
2	61
3	68
4	75
5	82

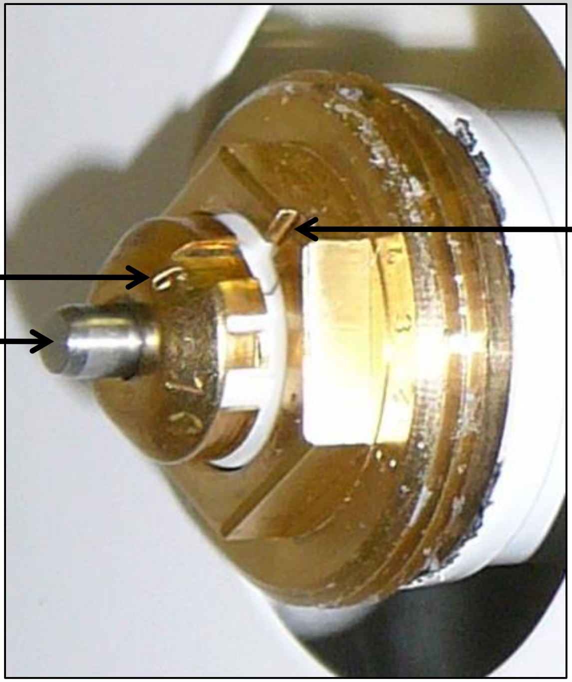
Dimensions

Height – 3 1/16" (Avg.)
Width – 1 7/8"
Thread – 30mm

The Thermostatic Operator piston contains a wax that expands when warmed and contracts when cooled. This movement applies or reducers pressure on the pin of the thermostatic valve, increasing or reducing water flow through the radiator.

Thermostatic Valve

Internal Flow Balancing Settings



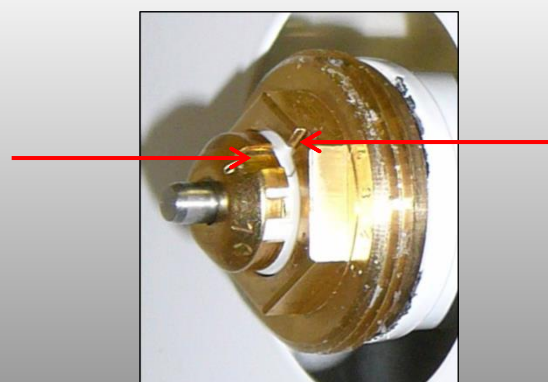
Number	Percentage Open
1	10
2	20
3	30
4	40
5	50
6	100

Thermostatic Valve

Internal Flow Settings

Orifice Change

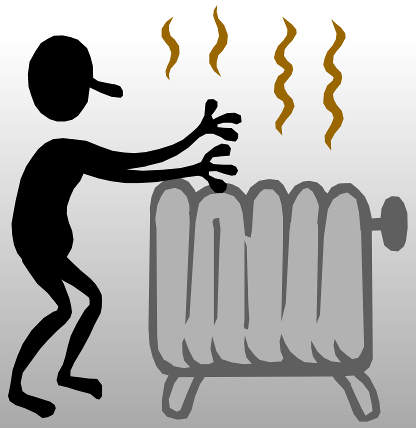
6 – 100% | 5 – 50% | 4 – 40% | 3 – 30% | 2 – 20% | 1 – 10%



Heat Output Ratings

Depends on several factors, most importantly:

- Radiator size
- Water temperature supplied
- Room air temperature



Example - 20" High Panels

@ Standard Conditions

		68 F Room	Baseboard Equivalent
Height	Width	180 F Avg. Water Temp.	180 F Avg. Water Temp.
20"	16"	2876 Btu	5.0'
20"	20"	3593 Btu	6.2'
20"	24"	4313 Btu	7.4'
20"	28"	5033 Btu	8.7'
20"	32"	5749 Btu	9.9'
20"	36"	6469 Btu	11.2'
20"	40"	7186 Btu	12.4'
20"	44"	7906Btu	13.6'
20"	48"	8626 Btu	14.9'

Heat Output Correction

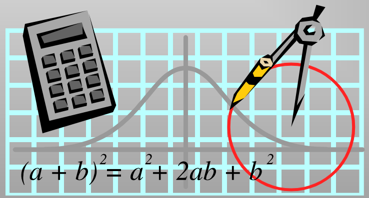
Standard Conditions Are Based On

- An Average Water Temperature of 180 Degrees

&

A Room Temperature of 68 Degrees

- Deviations From These Standards Require Correction to Determine the Adjusted Heat Output of the Radiator



Heat Output Ratings

MODEL	BTU OUTPUT 180 F AVG. WATER 192 F / 168 F	BTU OUTPUT 170 F AVG. WATER	BTU OUTPUT 160 F AVG. WATER	BTU OUTPUT 150 F AVG. WATER	BTU OUTPUT 140 F AVG. WATER	BTU OUTPUT 130 F AVG. WATER	BTU OUTPUT 120 F AVG. WATER	BTU OUTPUT 110 F AVG. WATER
DD12.16DBL	1934	1696	1477	1269	1068	874	727	519
DD12.24DBL	2900	2542	2218	1900	1600	1310	1037	781
DD12.32DBL	3866	3392	2958	2535	2133	1747	1382	1041
DD12.40DBL	4831	4237	3695	3170	2661	2184	1726	1300
DD12.48DBL	5800	5087	4436	3804	3200	2620	2074	1559
DD12.56DBL	6766	5933	5175	4439	3733	3057	2419	1819
DD12.64DBL	7732	6783	5913	5074	4265	3494	2763	2081
DD16.16DBL	2418	2119	1849	1583	1331	1092	863	648
DD16.20DBL	3022	2651	2310	1982	1665	1365	1078	812
DD16.24DBL	3626	3180	2771	2378	1999	1638	1293	972
DD16.28DBL	4231	3709	3235	2774	2330	1911	1512	1136
DD16.32DBL	4835	4241	3695	3170	2665	2184	1726	1297
DD16.36DBL	5440	4770	4159	3566	2996	2457	1941	1460
DD16.40DBL	6044	5302	4620	3961	3330	2726	2156	1621
DD16.44DBL	6648	5831	5083	4357	3665	2999	2371	1784
DD16.48DBL	7253	6360	5545	4753	3995	3272	2590	1945
DD20.16DBL	2876	2521	2197	1883	1583	1300	1024	771
DD20.20DBL	3593	3153	2747	2354	1979	1621	1279	962
DD20.24DBL	4313	3780	3295	2825	2375	1945	1535	1153
DD20.28DBL	5033	4412	3845	3296	2771	2269	1791	1347
DD20.32DBL	5749	5043	4392	3767	3166	2593	2047	1539
DD20.36DBL	6469	5670	4942	4238	3562	2914	2303	1733
DD20.40DBL	7186	6302	5490	4709	3958	3238	2559	1924
DD20.44DBL	7906	6933	6040	5179	4354	3562	2815	2115
DD20.48DBL	8626	7561	6590	5650	4746	3886	3071	2310
DD24.16DBL	3310	2900	2528	2167	1819	1488	1177	884
DD24.20DBL	4135	3627	3160	2706	2276	1863	1471	1105
DD24.24DBL	4964	4350	3793	3248	2730	2235	1764	1327
DD24.28DBL	5790	5077	4424	3791	3183	2607	2057	1546
DD24.32DBL	6619	5800	5057	4336	3641	2979	2354	1767
DD24.36DBL	7445	6527	5688	4872	4094	3351	2648	1989
DD24.40DBL	8270	7250	6318	5415	4548	3722	2941	2211
DD24.44DBL	9100	7977	6952	5957	5002	4094	3235	2429
DD24.48DBL	9926	8704	7583	6496	5459	4466	3528	2651

Correction Factor Table

Delta T Average Water Temperature – Room Temperature (F)	Correction Factor
37	.24
41	.28
46	.32
50	.36
55	.41
59	.45
63	.50
68	.54
73	.59
77	.64
82	.69
86	.74
91	.79
95	.84
100	.89
104	.95
108	1.00
113	1.06
117	1.11
121	1.17
125	1.22
130	1.27
135	1.32
140	1.38

Example

- Assume The Calculated Heat Loss Is 2,300 Btuh
- System Design Requires A Supply Water Temperature Of 160 Degrees And A Delta T Of 30 Degrees Through The Radiator
- Maximum Room Temperature Of 70 Degrees
- Arbitrarily We Picked A 20" x 24" Panel With An Output Of 4,296 Btuh @ 176 Degree Average Water Temperature
- What Is the Radiators Actual Output @ Design Specifications?

Example

- 30 Degree Delta T / 2 = 15 Degrees (F)
- 160 Degree Water Temp - 15 = 145 Degrees (F) Average Water Temperature In The Radiator
- 145 (Avg. Water Temp) – 70 (Room Temp) = 75 (Delta T)
- 75 Delta T = .59 Factor (From Correction Chart)

Delta T	Correction Factor
73 →	.59

- .59 x 4,296 Standard Output = 2,535 Corrected Output

Calculation Review

- Radiator Chosen Had An Output Of 4,296 Btuh @ Standard Conditions
- Using The Table we Determined The Correction Factor To Be .59

4,296 Btuh x .59 = 2,535 Btuh

The Selected 20” x 24” Radiator @ 2,535 Btuh Is The Correct One, Slightly Exceeding Our Calculated Heat Loss of 2,300 Btuh

Larger Water Temperature Drop

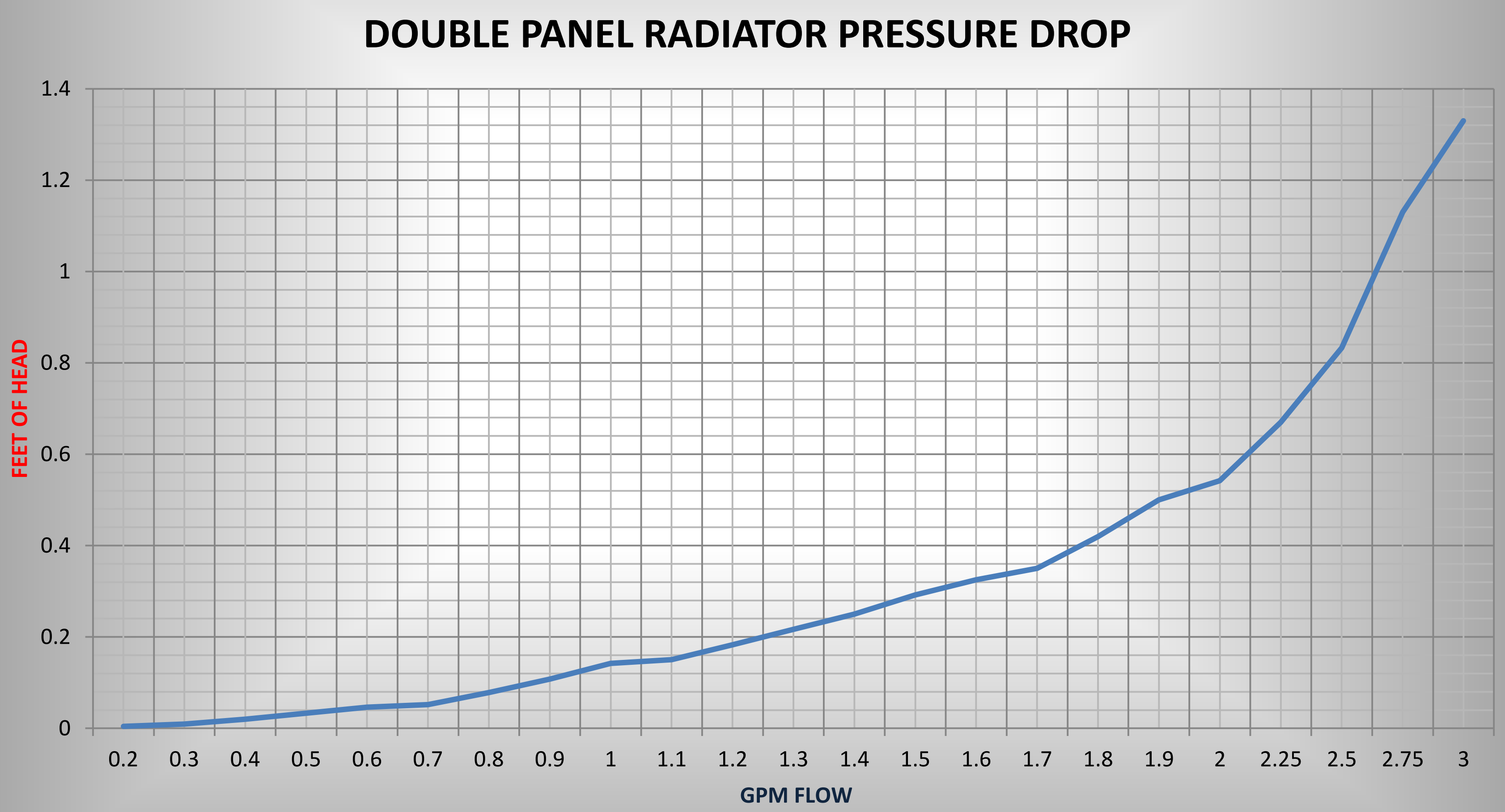
- Designing systems with a larger temperature drop across the radiator permits smaller diameter pipe or tubing to be used, reducing installation costs

- A panel radiator operating at a 30 degree F temperature drop will emit 15,000 Btu/h for each gallon per minute flow, compared to 10,000 for a 20 degree drop

Larger Water Temperature Drop

- A 12,000 Btu/h panel radiator requires a flow rate of 1.2 gpm at a 20 degree F temperature drop and .8 gpm at 30 degrees
- The 1.2 gpm flow rate requires ½" tubing, .8 gpm can be easily supplied with 3/8"

Low Pressure Drop

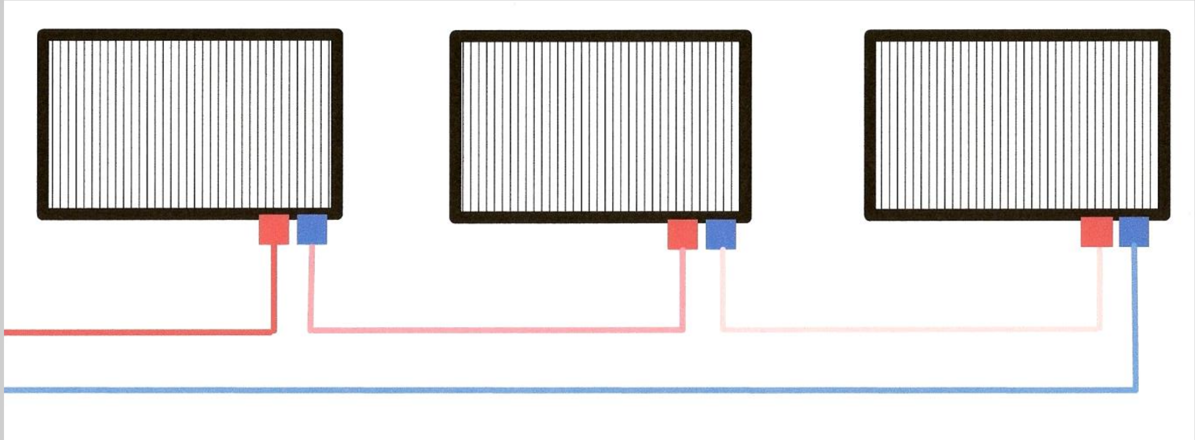


Distribution Systems

Several types of piping distribution systems can be used with panel radiators

- Series Circuit
- Series Circuit – Bypass Valve
- Diverter Tee (Monoflo)
- Homerun
- 2 Pipe Reverse Return
- 2 Pipe Direct Return

Series Circuit



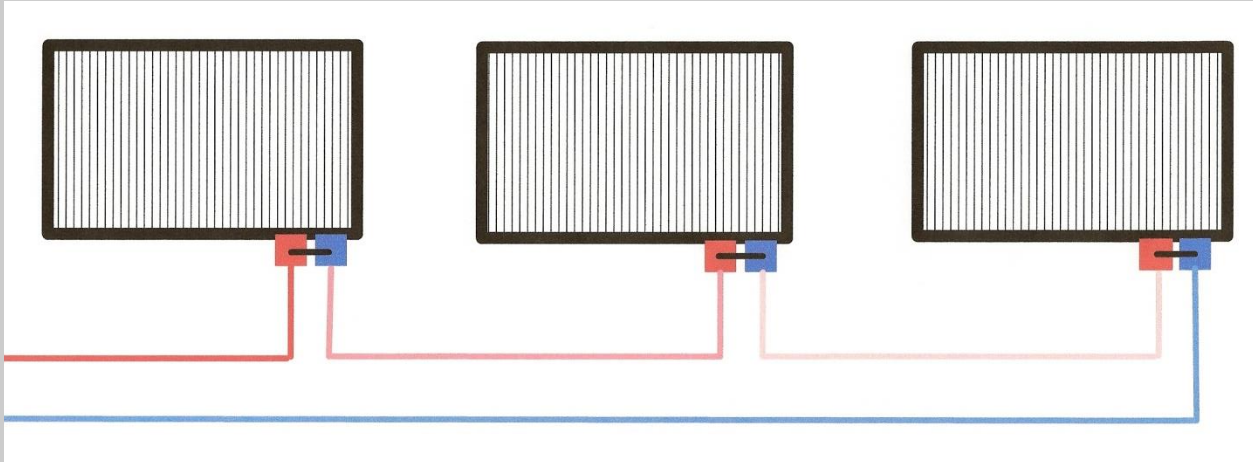
Advantages

- Easy Installation – Like Baseboard

Disadvantages

- Unable To Control Each Radiator Individually
- Unable To Balance System
- Water Temperature Decreases To Each Downstream Radiator
- High Pressure Drop – Increases With Each Radiator Added To The Circuit
- Maximum 2 Gpm Circuit Flow Rate And/Or 4 radiators

Series Circuit – Bypass Valve



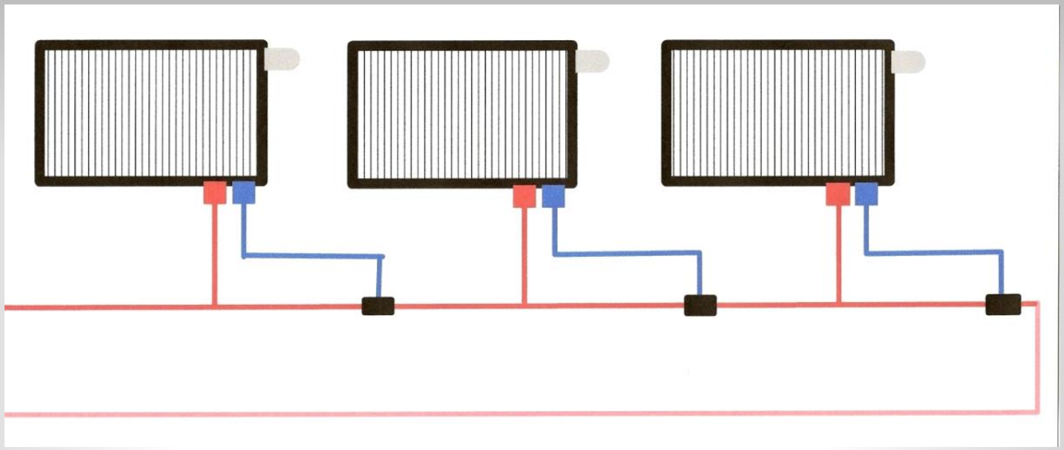
Advantages

- Easy Installation – Like Baseboard
- Thermostatic Valves And Optional Thermostatic Operators Can Be Used To Provide Room To Room Zoning
- Individual Radiators Can Be Shut-off And Removed From The Wall Without Affecting Flow To The Remaining Radiators
- Single Zone Systems Can be Balanced

Disadvantages

- Water Temperature Decreases To Each Downstream Radiator
- High Pressure Drop – Increases As Radiators And Bypass Valves Are Added
- Maximum 2 GPM Circuit Flow Rate And/Or 4 Radiators

Diverter Tee



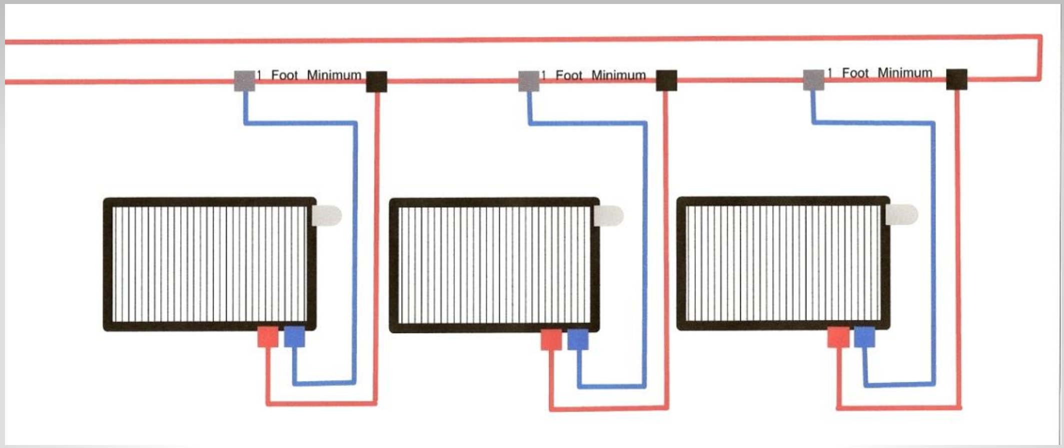
Advantages

- Individual Radiator Control Through The Use Of Installed Thermostatic Radiator Valves And Optional Thermostatic Operators
- Single Zone Systems Can Be Balanced

Disadvantages

- Water Temperature Decreases To Each Downstream Radiator
- Diverter Tees Create A High Pressure Drop
- Proper Diverter Tee Placement
- Thermostat Controlling The Zone Will Need To Be Set 2 To 3 Degrees Higher Than The Desired Temperature To Ensure Water Flow When Thermostatic Valve Opens
- Bypass Valve Is Required On Circuits Where All Radiators Have Thermostatic Operators

Down-Flow Diverter Tee



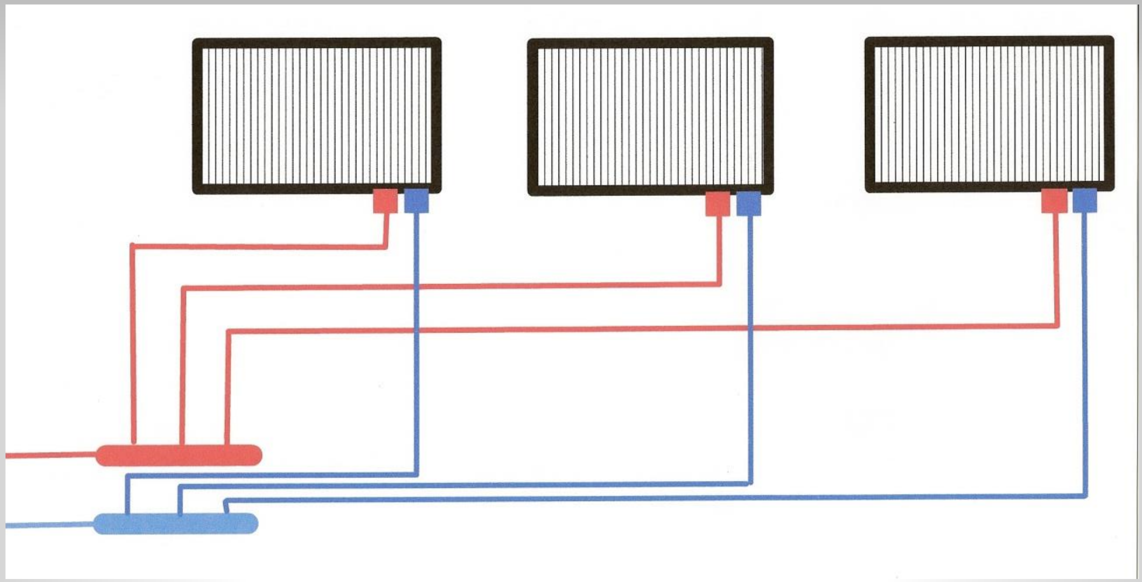
Advantages

- Individual Radiator Control through Use Of Thermostatic Radiator Valves And Optional Thermostatic Operators
- Single Zone Systems Can Be Balanced

Disadvantages

- Water Temperature Decreases To Each Downstream Radiator
- 2 Diverter Tees Per Radiator Create High Pressure Drops
- Proper Diverter Tee Placement
- Difficult To Purge Air From Radiators
- Thermostat Controlling The Zone Will Need To Be Set 2 To 3 Degrees Higher Than The Desired Temperature To Ensure Water Flow When Thermostatic Valve Opens
- Bypass Valve Is Required On Circuits Where All Radiators Have Thermostatic Operators

Simple Homerun



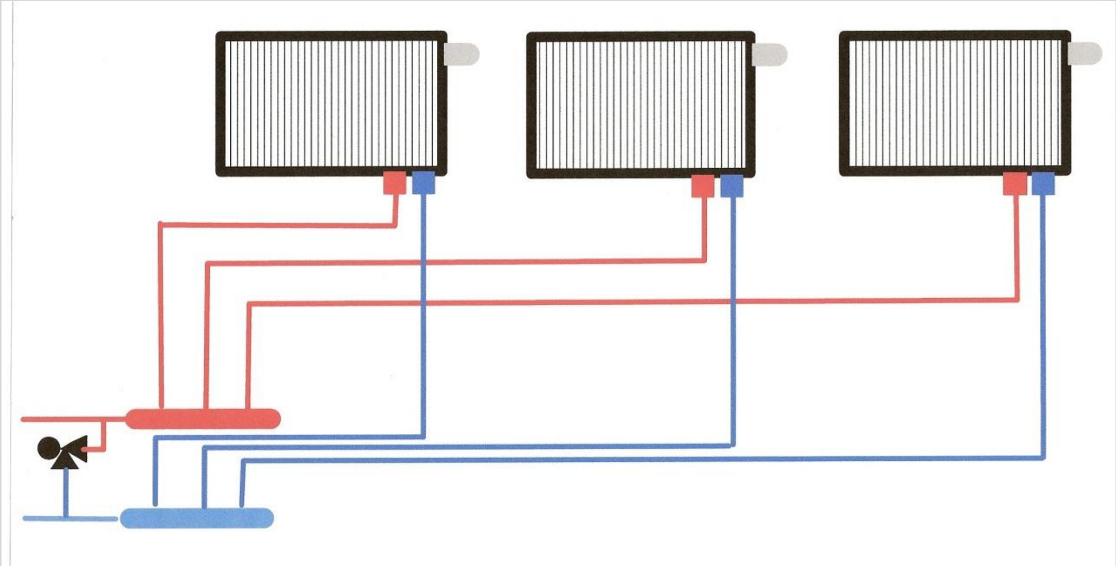
Advantages

- Simple Piping Layout
- Same Water Temperature Is Supplied To Each Panel Radiator
- Single Zone Systems Can Be Balanced
- Flow Rates Are Lower Resulting In Smaller Tubing Sizes
- Individual Radiators Can Be Controlled In Various Ways
- All Piping Begins And Ends In One Small Central Location

Disadvantages

- Requires Long Runs Of Smaller Diameter Tubing

Homerun With Thermostatic Operators



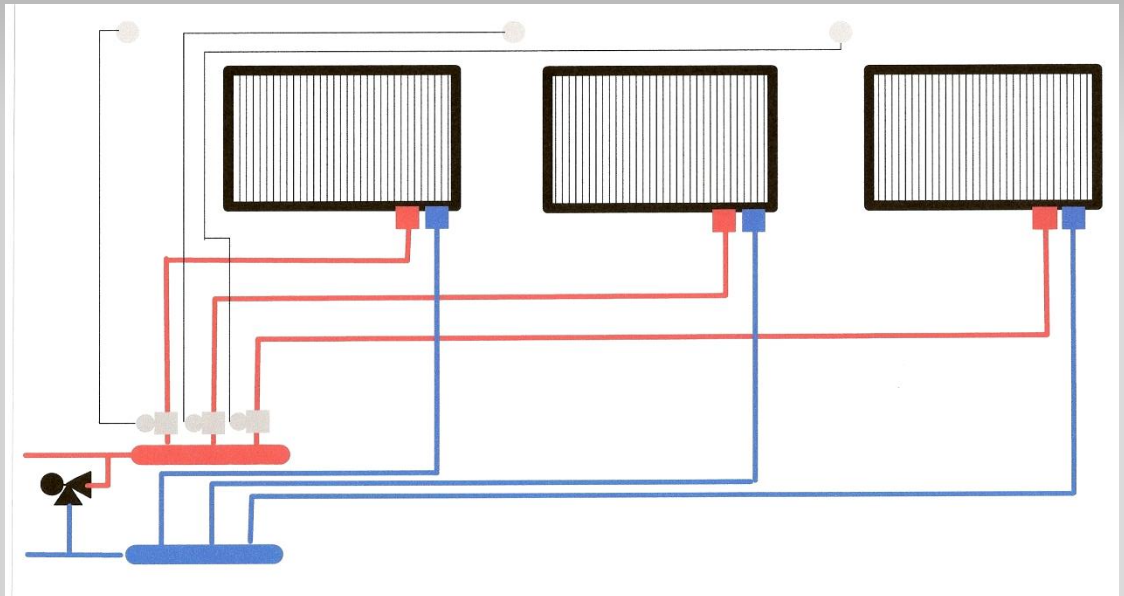
Advantages

- Same As A Simple Homerun System
- Individual Control Of Each Radiator Through Thermostatic Radiator Valves And Optional Thermostatic Operators

Disadvantages

- Addition Of A Differential Pressure Bypass Valve Is Required

Homerun With Electric Zone Valves

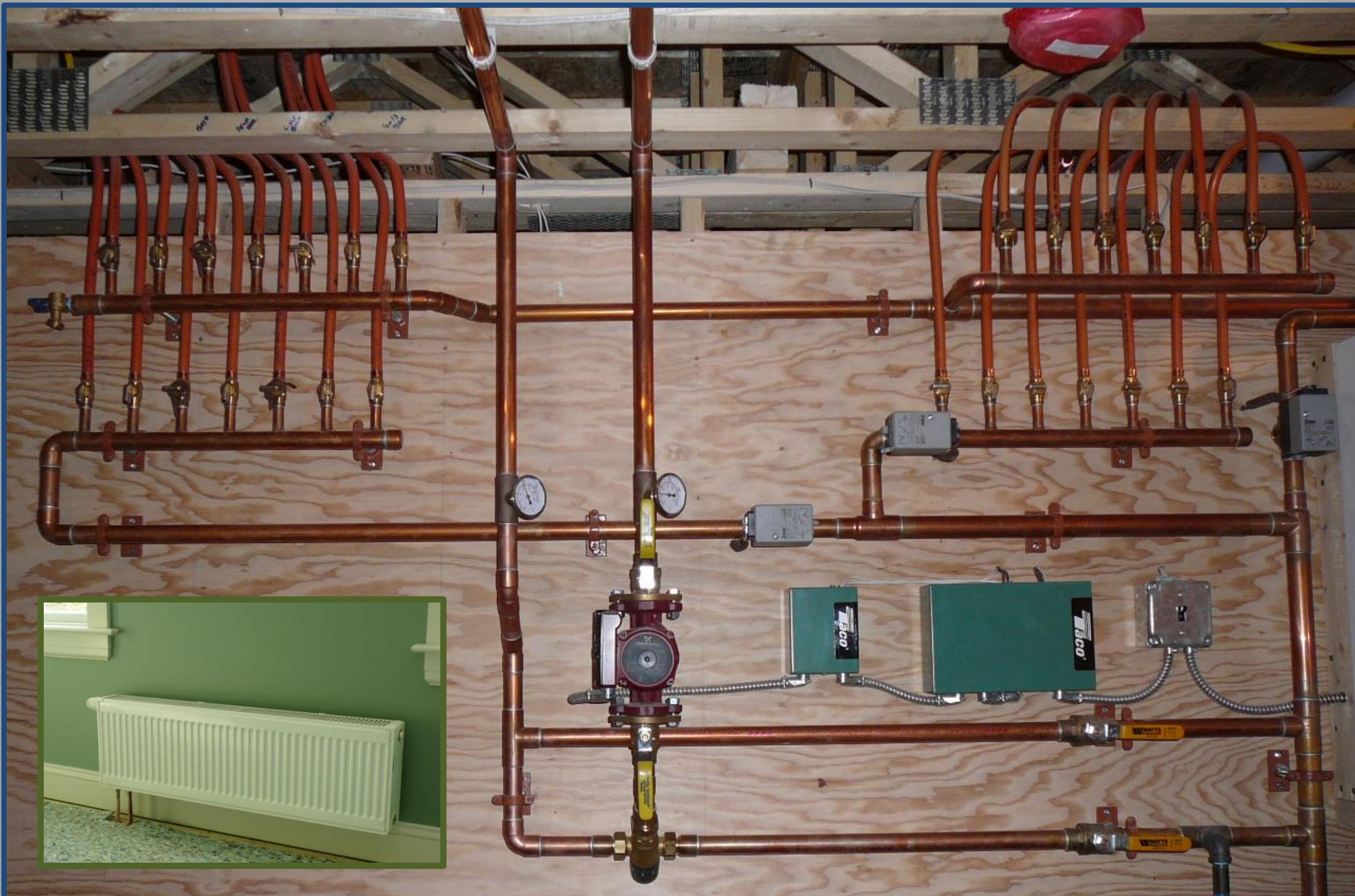


Advantages

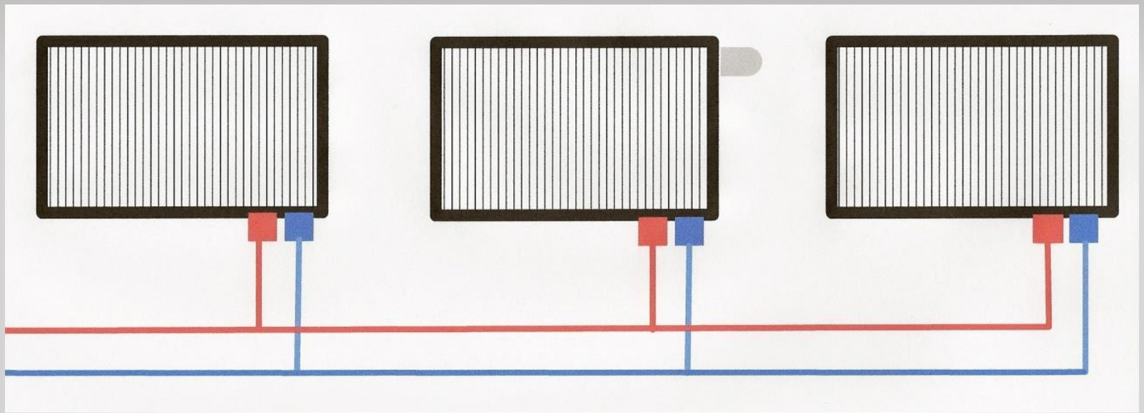
- Same as Simple And Thermostatic Valve Homerun Systems
- Individual Control Of Each Panel Radiator Through Electric Zone Valves, Or Thermal and Motorized Valve Actuators On Radiant Tube Manifold Assemblies

Disadvantages

- Same As Simple And Thermostatic Valve Homerun Systems
- Addition Of A Differential Bypass Valve Is Required
- Requires Installation Of An Electrical Circuit To Operate Valves
- Additional Labor


Taco
Taco

2 Pipe Direct Return



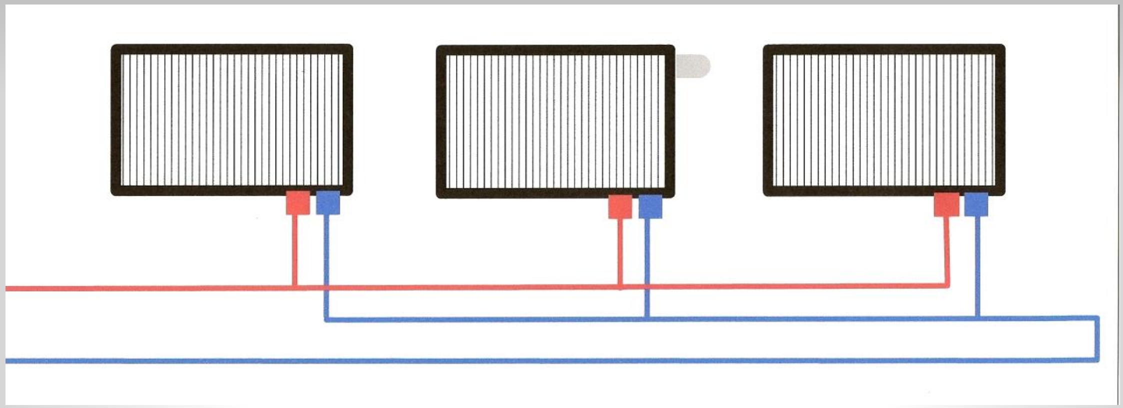
Advantages

- Each Radiator Will Receive Relatively The Same Supply Water Temperature
- Pressure Drop Through The System Is Significantly Less Than A Series Loop Or Diverter Tee Circuit
- Single Zone Systems Can Be Balanced
- Individual Radiator Control Through The Use Of Installed Thermostatic Radiator Valves And Optional Thermostatic Operators (If Desired)

Disadvantages

- Slightly More Complicated Piping Arrangement
- Increased Materials Cost
- Increased Labor
- If Using Optional Thermostatic Operators, The Thermostat Controlling The Zone Will Need To Be Set 2 To 3 Degrees Higher Than The Desired Temperature To Ensure Water Flow Through The Open Thermostatic Valve
- Bypass Valve Is Required On Circuits With Thermostatic Operators Installed On All Radiators

2 Pipe Reverse Return



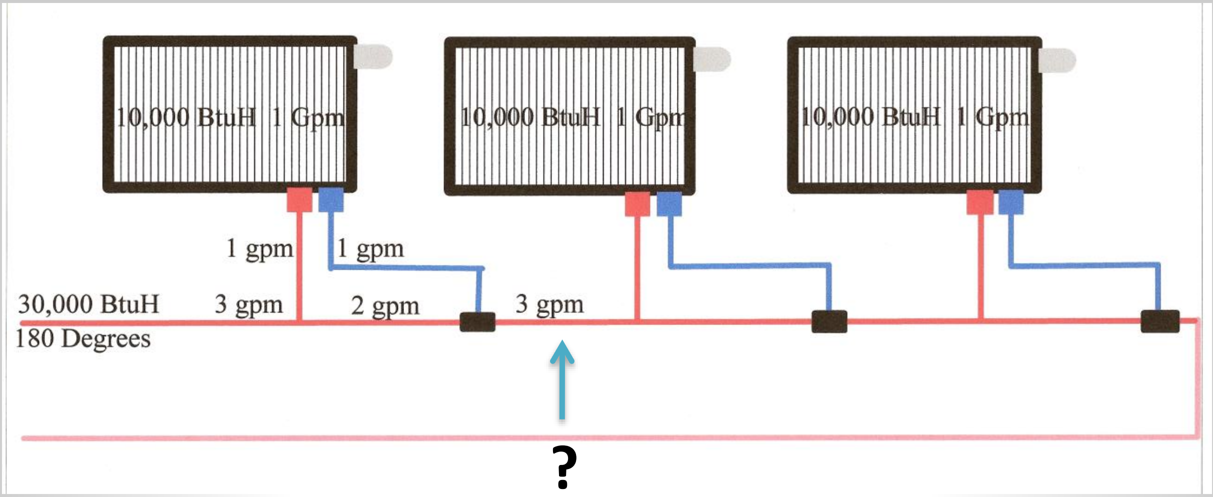
Advantages

- Each Radiator Will Receive Relatively The Same Water Temperature
- Piping Circuit Length To Each Panel Is The Same – System Is Automatically Balanced
- Individual Radiators Can Be Balanced
- Pressure Drop Is Significantly Less Than A Series Loop Or Diverter Tee Method
- Individual Radiator Control Through The Use Of Installed Thermostatic Valves And Optional Thermostatic Operators (If Desired)

Disadvantages

- More Complicated Piping Arrangement
- Increased Material Cost
- Increased Labor
- If Using Optional Thermostatic Operators, The Zone Thermostat Setting Will Need To Be Set 2 To 3 Degrees Higher Than The Desired Temperature To Ensure Water Flow Through The Open Thermostatic Valve
- Bypass Valve Is Required On Circuits With Thermostatic Operators Installed On All Radiators

What Is The Water Temperature ?



- 2 Gpm Of 180 Degree Water Is Entering The Run Of The Diverter Tee
- 1 Gpm Of Water Is Flowing Through The Panel Radiator
- The Panel Radiator Has A 20 Degree Temperature Drop, So The Water Is Exiting At 160 Degrees
- 3 Gpm Is The Combined Flow Rate Leaving The Diverter Tee

$$(2\text{ gpm}) \times (180\text{ Degrees}) + (1\text{ gpm}) \times (160\text{ Degrees}) = (3\text{ gpm}) \times (?\text{ Temp})$$

$$360 + 160 = 3X$$

$$520 = 3x$$

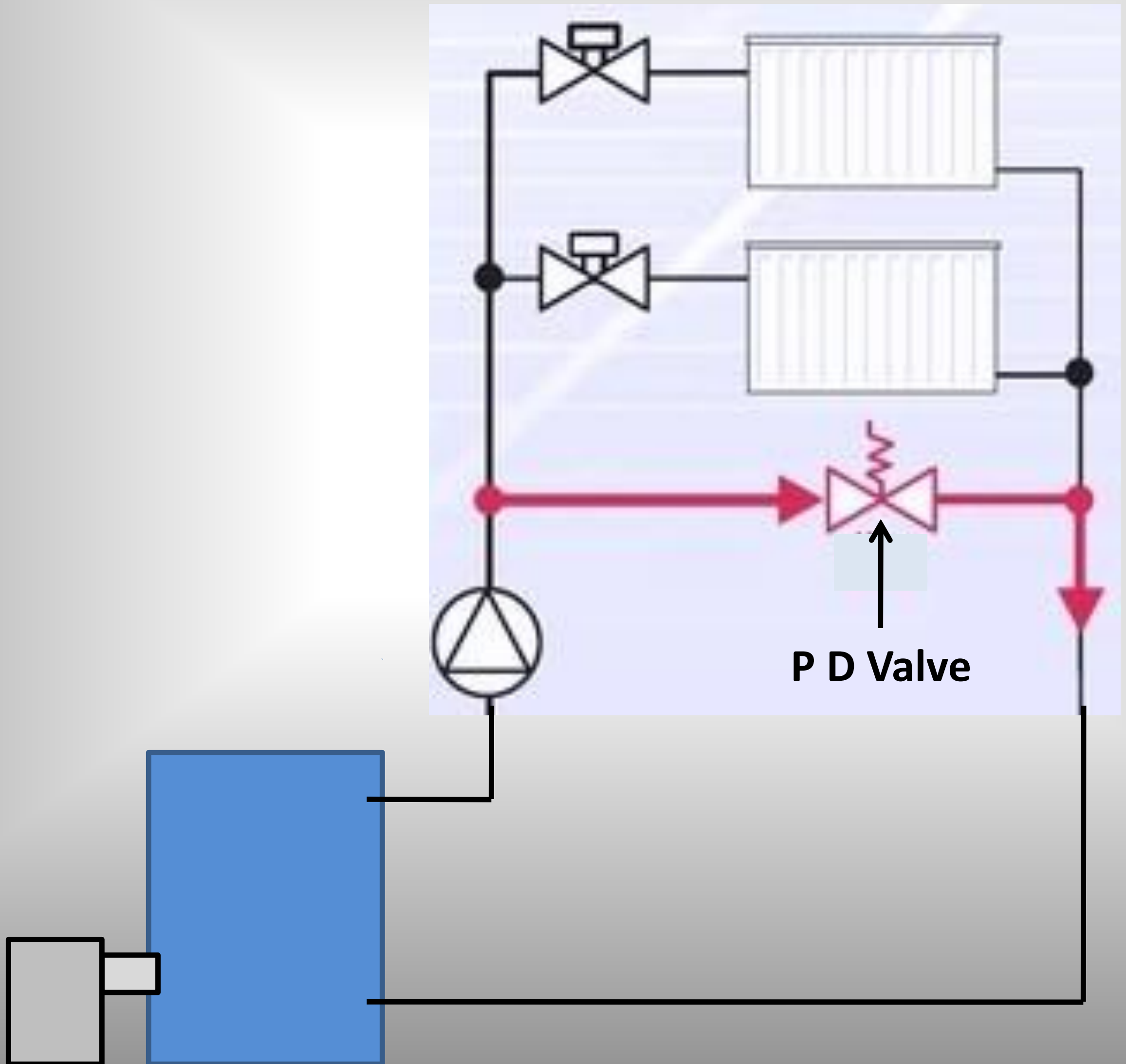
$$\frac{520}{3} = x$$

$$173.3 = x$$

Pressure Differential Bypass Valve

- Maintains a constant differential pressure between the supply and return piping
- Reduces flow noise, particularly as zone valves and thermostatic operators open and close
- Eliminates potential 'dead-heading' of circulators

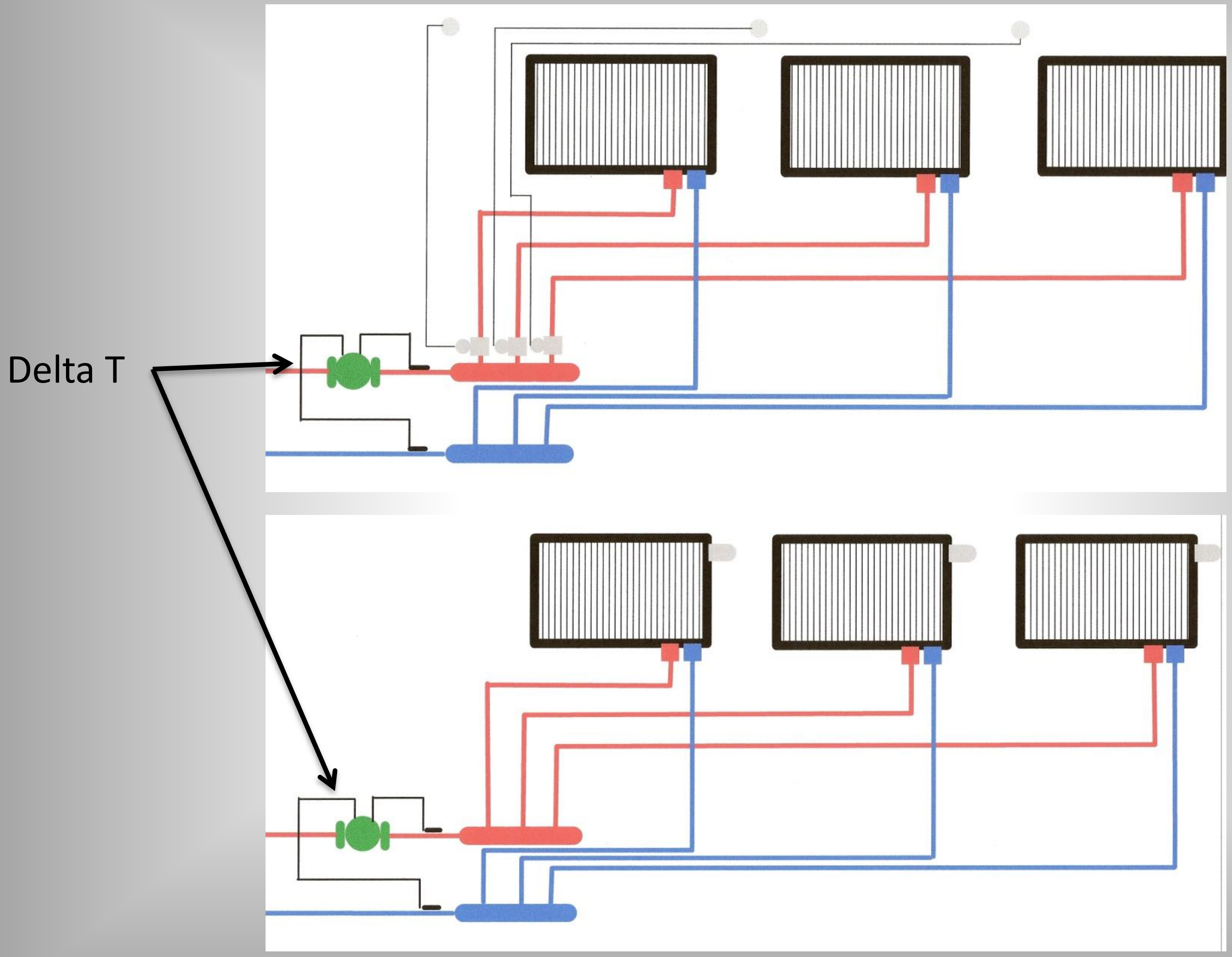
Pressure Differential Bypass Valve Piping



Variable Speed Circulators

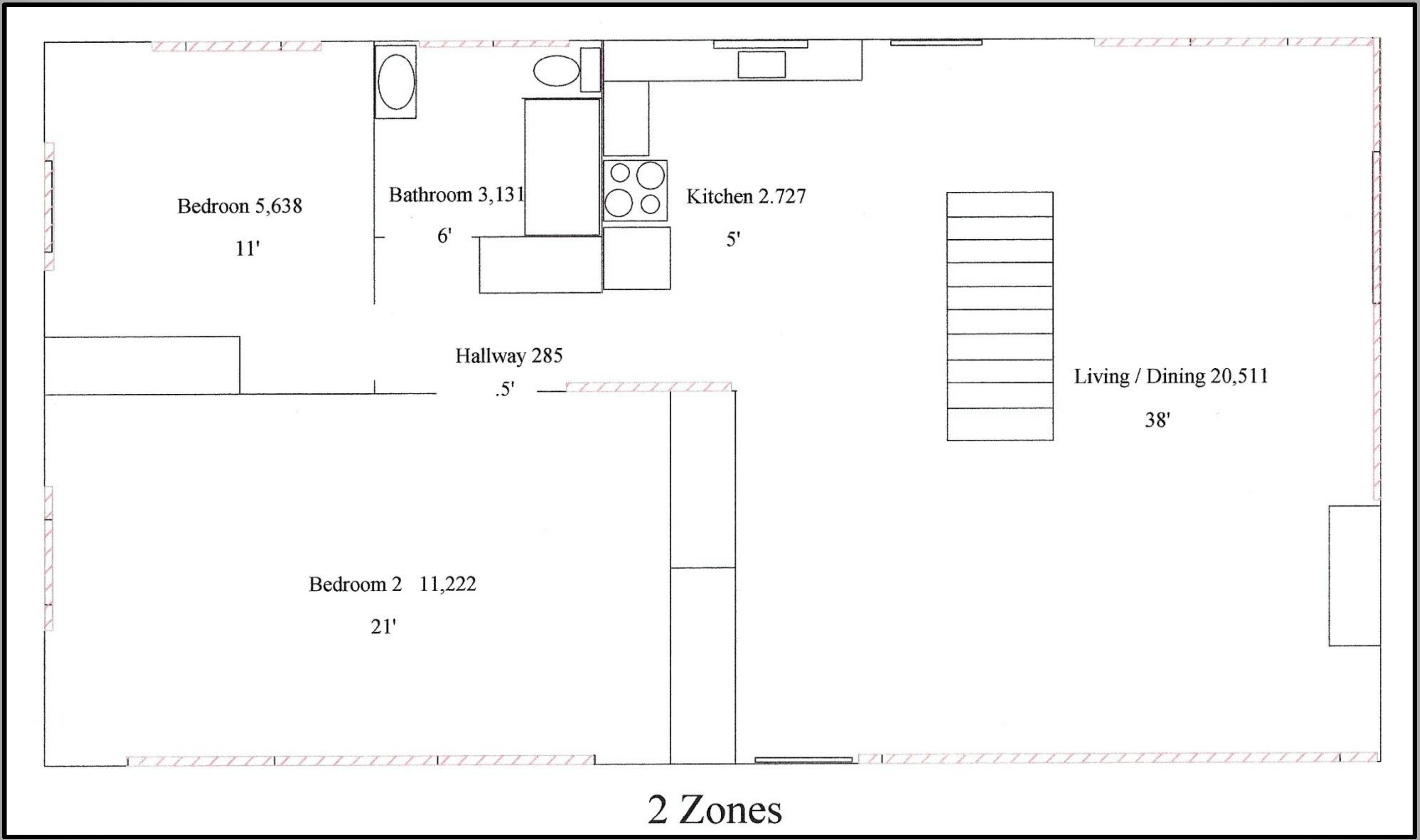
Armstrong Variable Speed Setpoint Circulator

Temperature Differential System



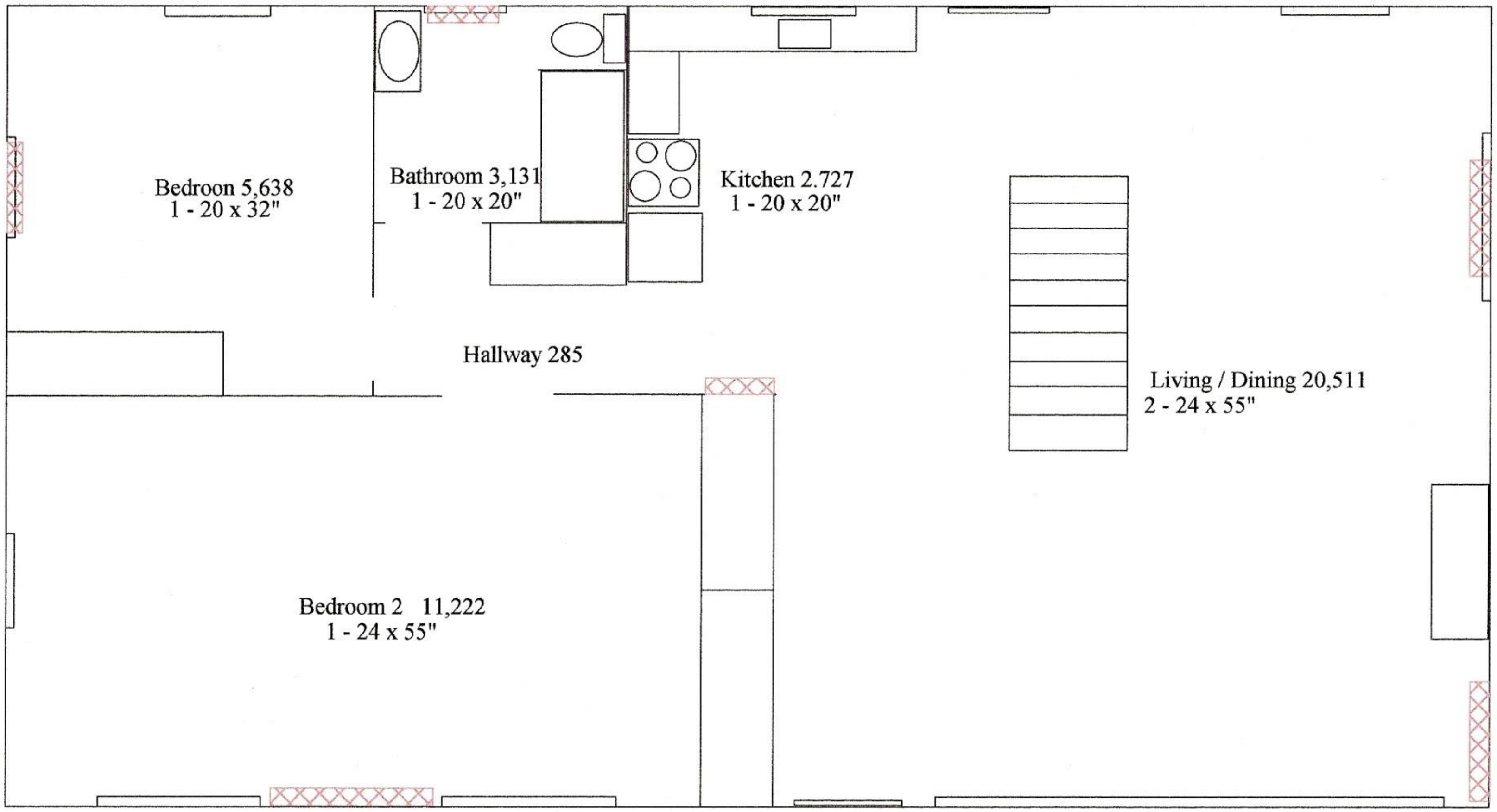
Set Circulator Control to △T Operation

Comparison



Baseboard System

Comparison



Each Panel Is A Zone

Steel Panel Radiators

Comparative Cost

Baseboard System $4,367.00 (to contractor)

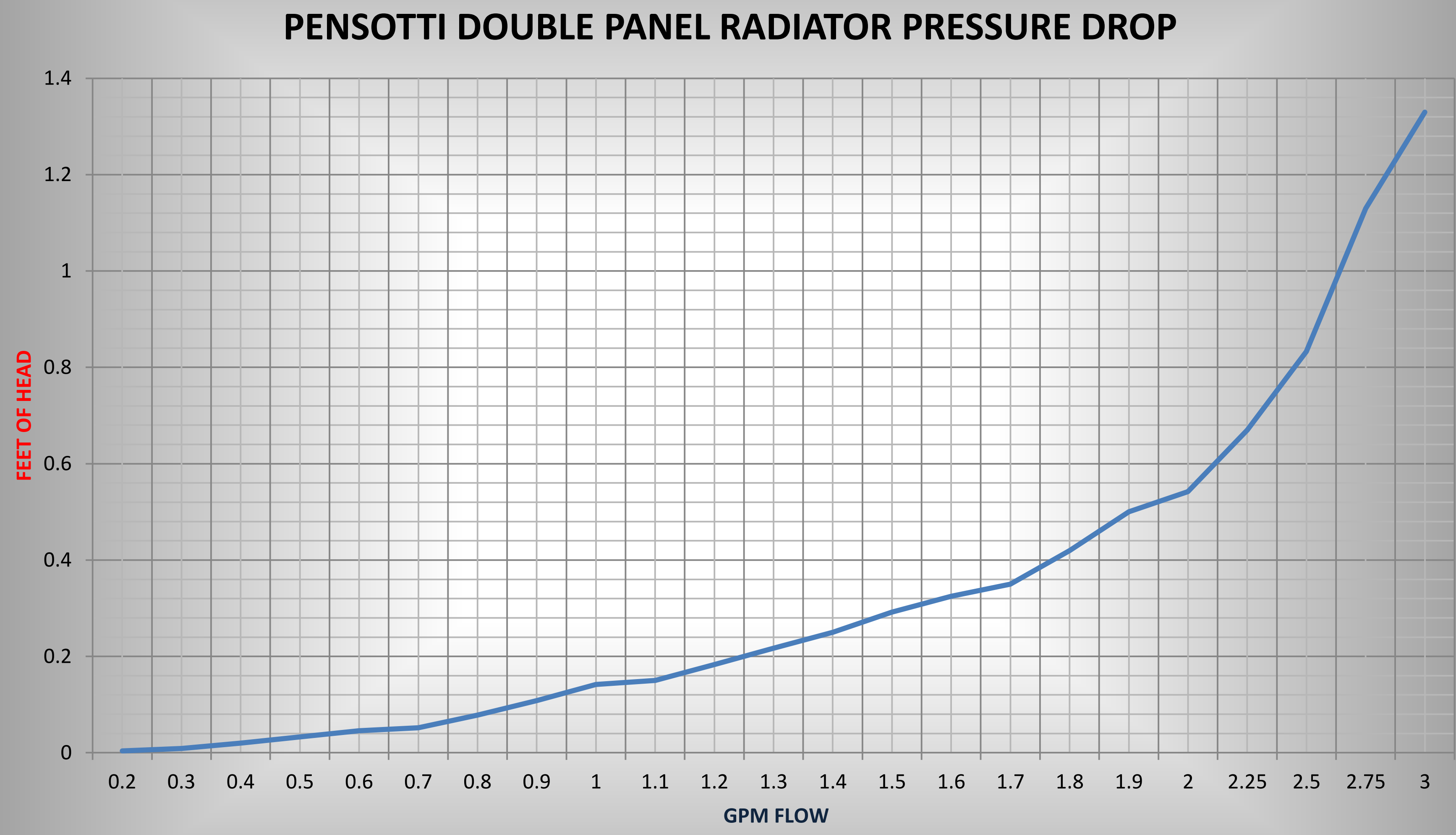
- Two Heating Zones With Circulators
- Standard Residential Baseboard
- Boiler, Boiler Trim, Wiring Trim, Outdoor Reset Control, Smoke Pipe, 275 and Trim, Series Pex Piping System.

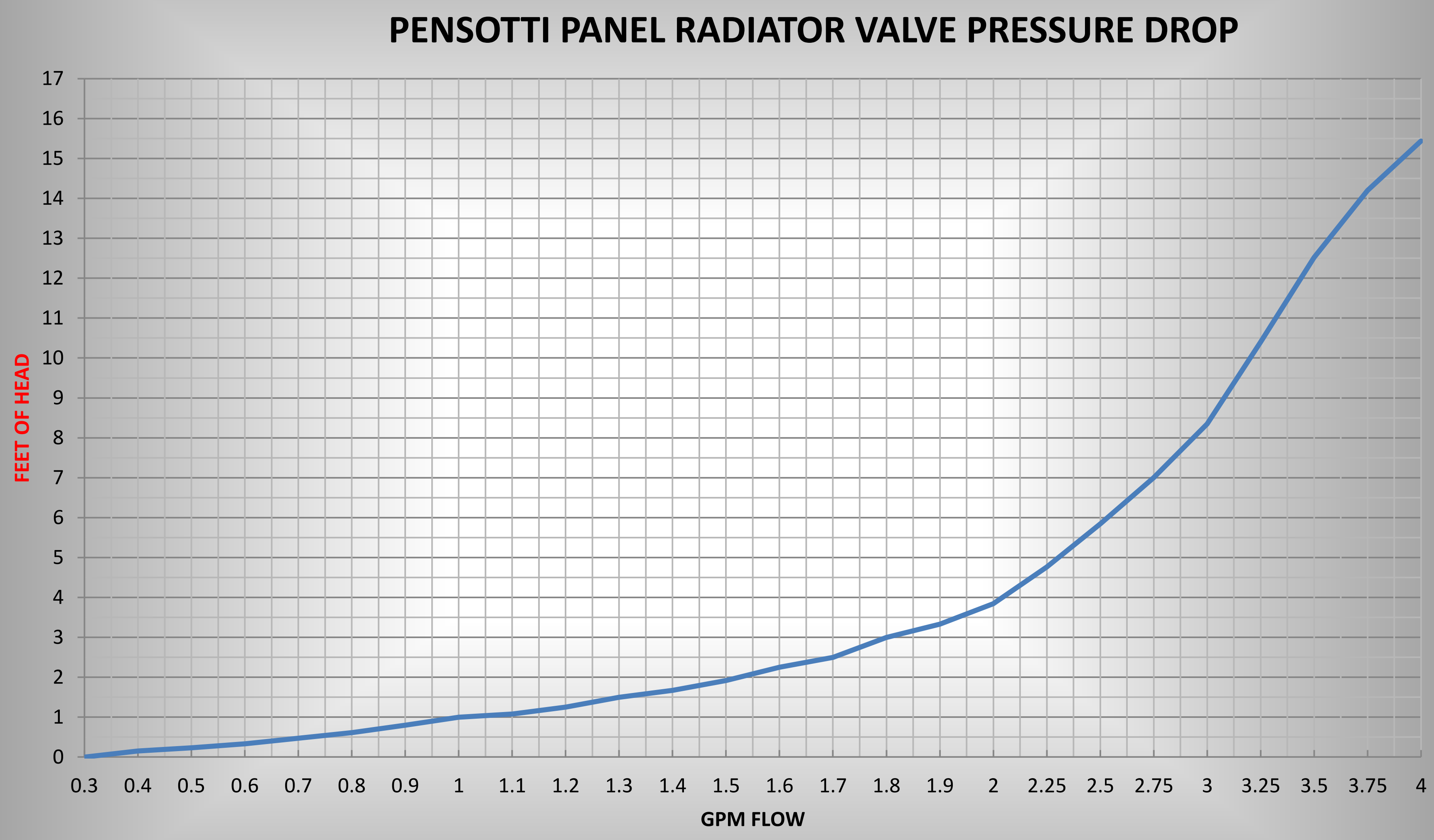
Panel Radiator System $4,919.00 (to contractor)

- Each Panel Radiator is a Zone (Actuators) With One Circulator
- Homerun Pex Piping System With Pressure Differential Valve and Copper Manifolds With Isolation Valves.
- Same Trim as Baseboard System

$ 552.00 Difference - 11%

System Design


PENSOTTI DOUBLE PANEL RADIATOR PRESSURE DROP
FEET OF HEAD
GPM FLOW
0
0.2
0.4
0.6
0.8
1
1.2
1.4
0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2 2.25 2.5 2.75 3


PENSOTTI PANEL RADIATOR VALVE PRESSURE DROP
FEET OF HEAD
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2
2.25
2.5
2.75
3
3.25
3.5
3.75
4
GPM FLOW

Series Circuit Design

System designer and/or installer are responsible to determine whether proper radiator and/or system operation will result based on individual system and piping circuit design.

Simple Piping, Single Zone, Cannot Be Balanced, Sequential Temperature Drop, High Head Loss, Cannot Use Thermostatic Operators.

1. Calculate heat load of each room that will be connected to the same piping circuit.
2. Determine the circuit supply temperature.
3. Determine the tentative circuit temperature drop (Delta T).
4. Calculate the total circuit flow rate in GPM

   $$\text{Total Circuit Flow Rate (GPM)} = \frac{\text{Btu/hr load of the circuit}}{500 \times \text{Delta T}}$$

5. Based on the total circuit flow rate determined in step 4, select the proper pipe or tube size from the following chart.

Size / Type	Minimum Flow Rate	Maximum Flow Rate
½″ Copper	1.4 Gpm	2.8 Gpm
3/8″ Pex	.5 Gpm	1.25 Gpm
½″ Pex	1.25 Gpm	2.25 Gpm
5/8″ Pex	1.75 Gpm	3.25 Gpm

6. Calculate the average water temperature in the first radiator

   $$\text{Average Temp} = \text{Supply Temp} - \frac{\text{Btu/hr load of the radiator}}{500 \times 2 \times \text{total circuit flow rate (GPM)}}$$

7. Choose the correct radiator based on the heat load and average water temperature from the specification tables.
8. Calculate the head loss of the chosen panel radiator(s) based on the total circuit flow rate (step 4) using the Pensotti Double Panel Radiator Pressure Drop Graph.
9. If the optional isolation valve(s) are used calculate the head loss of the valve(s) using the Pensotti Panel Radiator Valve Pressure Drop Graph.
10. Add the radiator and valve head losses together
11. Calculate the outlet temperature of the radiator

    $$\text{Outlet Temp} = \text{Supply Temp to the Radiator} - \frac{\text{Btu/hr load of the radiator}}{500 \times \text{Total Circuit Flow Rate (GPM)}}$$

12. This outlet temperature becomes the inlet temperature of the next radiator in the circuit. Repeat steps 6-11 for all remaining radiators in the circuit.
13. Determine radiator locations within the structure
14. Based on the radiator location(s) determine the total tubing lengths, fittings, valves etc. to connect the radiators into a complete circuit.
15. Calculate the head loss of the piping circuit. This includes the head loss of the tubing, tubing fittings, boiler, boilers accessories, valves, zone valves etc. Add up all the head losses to determine total piping head loss.
16. Calculate the head loss of the complete piping circuit including radiators. Add totals for step 10 and 15 together.
17. If antifreeze is to be used multiply the calculated head lose by 1.20 for a 30% antifreeze solution and 1.35 if a 50% solution is used.
18. Select a circulator based on the circuit flow rate and total circuit head loss. If the circulator is serving more than on piping circuit; size the circulator based on the total circuit flow **rates** and the largest head loss of any **single** circuit.

Series Circuit Design

PENSOTTI NORTH AMERICA

AMERICA'S BEST HEATING VALUE

PANEL RADIATOR SERIES CIRCUIT WORKSHEET

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	ROOM HEAT LOAD	CIRCUIT SUPPLY TEMP	CIRCUIT DELTA T	TOTAL CIRCUIT FLOW RATE	PIPE OR TUBE SIZE	AVERAGE WATER TEMP. IN RADS.	RADIATOR SIZE	RAD. HEAD LOSS	VALVE HEAD LOSS (IF USED)	RADIATOR AND VALVE HEAD LOSS 8 + 9	RADIATOR OUTLET TEMP. - NEXT RAD. INLET TEMP.	RADIATOR INLET TEMP.	RADIATOR LOCATION	EQUIV. LENGTH OF THE PIPING CIRCUIT	HEAD LOSS OF THE PIPING CIRCUIT	HEAD LOSS OF THE COMPLETE CIRCUIT 10 + 15	ANTIFREEZE CORRECTION (IF USED)	CIRC. SIZE AND MODEL (BASED ON 4 AND 16)
RAD #1																		
RAD #2												RAD #2						
RAD #3												RAD #3						
RAD #4												RAD #4						
RAD #5												RAD #5						
RAD #6												RAD #6						
TOTAL																		

JOB NAME________________________________

ZONE____________________________________

DATE____________________________________

By-Pass Valve Design

System designer and/or installer are responsible to determine whether proper radiator and/or system operation will result based on individual system and piping circuit design.

Maximum Flow Rate 2 GPM, Maximum Of 4 Radiators, Simple Piping System, Can Be Balanced, Thermostatic Operators Can Be Used For Multiple Zones.

1. Calculate heat load of each room that will be connected to the same piping circuit.
2. Determine the circuit supply temperature.
3. Determine the tentative circuit temperature drop (Delta T).
4. Calculate the total circuit flow rate in GPM

   $$\text{Total Circuit Flow Rate (GPM)} = \frac{\text{Btu/hr load of the circuit}}{500 \times \text{Delta T}}$$

5. Confirm that the flow rate does not exceed the maximum 2 GPM. If it is too high consider reducing the number of radiators in the circuit or increasing the Delta T.
6. Calculate the average water temperature in the first radiator

   $$\text{Average Temp} = \text{Supply Temp} - \frac{\text{Btu/hr load of the radiator}}{500 \times 2 \times \text{total circuit flow rate (GPM)}}$$

7. Choose the correct radiator based on the average water temperature from the specification table.
8. Calculate the percentage of flow that will pass through the radiator

   $$\text{\% of Flow} = \frac{\text{Btu/hr load of the radiator}}{\text{Btu/hr load of the entire circuit}}$$

9. Based on the % of flow, determine the preliminary By-Pass Valve setting from the following table

% Of Flow	# Of Turns Open (From Closed Position, Full Clockwise Rotation)
100	0
50	1
47	1 ¼
45	1 ½
42	1 ¾
40	2
39	2 ¼
37	2 ½
35	2 ¾
33	3
31	3 ¼
29	3 ½
27	3 ¾
25	4
23	Fully Opened

10. Determine the head loss of the radiator
11. Determine the head loss of the radiator valve
12. Add the radiator and valve head losses together

By-Pass Valve Design

13. Calculate the outlet temperature of the radiator

$$\text{Outlet Temp} = \text{Supply Temp to the Radiator} - \frac{\text{Btu/hr load of the radiator}}{500 \times \text{Total Circuit Flow Rate (GPM)}}$$

14. This outlet temperature becomes the inlet temperature of the next radiator in the circuit. Repeat steps 6-13 for all remaining radiators in the circuit.
15. Determine radiator locations within the structure
16. Determine the total tubing lengths, fittings, valves etc. to connect the radiators into a complete circuit.
17. Calculate the head loss of the completed circuit. This includes the head loss of the radiators, radiator valves, tubing, tubing fittings, boiler, boilers accessories, valves, zone valves etc. Add up all the head losses to determine total circuit head loss.
18. If antifreeze is to be used multiply the calculated head lose by 1.20 for a 30% antifreeze solution and 1.35 if a 50% solution is used.
19. Select a circulator based on the circuit flow rate and total circuit head loss. If the circulator is serving more than on piping circuit; size the circulator based on the total circuit flow rates and the largest head loss of any single circuit.
20. Additional system flow balancing can be achieved by adjusting each radiators individual flow setter in the integral thermostatic valve.

Number	Percentage Open
1	10
2	20
3	30
4	40
5	50
6	100

By-Pass Valve Design

PENSOTTI NORTH AMERICA

AMERICA'S BEST HEATING VALUE

PANEL RADIATOR BY-PASS VALVE CIRCUIT WORKSHEET

	1	2	3	4	6	7	8	9	10	11	12	13	14	16	17	18	19	20
	ROOM HEAT LOAD	CIRCUIT SUPPLY TEMP.	CIRCUIT DELTA T	TOTAL CIRCUIT FLOW RATE (MAX. 2 GPM)	AVG. WATER TEMP. IN RAD.	RAD. SIZE	% OF FLOW THROUGH RADIATOR	BY-PASS VALVE SETTING (TURNS)	RAD. HEAD LOSS	RADIATOR VALVE HEAD LOSS	RADIATOR & RADIATOR VALVE HEAD LOSS 10 + 11	RADIATOR OUTLET TEMP.	RADIATOR INLET TEMP.	PIPE, FITTINGS, VALVES ETC. HEAD LOSS	TOTAL HEAD LOSS (TOTAL OF 12 & 16)	ANTIFREEZE HEAD LOSS CORRECTION	CIRCULATOR SIZE AND MODEL (STEPS 4 AND 17)	FLOW SETTER NUMBER
RAD #1																		
RAD #2																		
RAD #3																		
RAD #4																		
TOTAL																		

JOB NAME________________________________

ZONE___________________________________

DATE___________________________________

Homerun Design

System designer and/or installer are responsible to determine whether proper radiator and/or system operation will result based on individual system and piping circuit design.

Separate Supply And Return Pipes To Each Radiator, Simple Piping System, Small Diameter Pipe And/Or Tubing, Can Be Balanced, Thermostatic Operators Can Be Used, Multiple Zoning Methods, By-Pass Valves Or Variable Speed Pumps Are Required.

1. Calculate heat load of each room that will be connected to the homerun piping circuit.
2. Determine the supply water temperature.
3. Determine the system temperature drop (Delta T).
4. Calculate the total system flow rate in GPM entering the common manifold.

   Total Circuit Flow Rate (GPM) = $\frac{\text{Btu/hr load of the system (manifold)}}{500 \times \text{Delta T}}$
5. Calculate the flow rate through each individual radiator.

   Radiator Flow Rate (GPM) = GPM (Step 4) x $\frac{\text{Required Btuh Output of the Radiator}}{\text{Total Btuh Output of the Manifold}}$
6. Based on each radiator's flow rate (GPM), select the proper supply and return pipe or tubing size using the following chart.

Size / Type	Minimum Flow Rate	Maximum Flow Rate
½" Copper	1.4 Gpm	2.8 Gpm
3/8" Pex	.5 Gpm	1.25 Gpm
½" Pex	1.25 Gpm	2.25 Gpm
5/8" Pex	1.75 Gpm	3.25 Gpm

7A+7B Choose the correct radiators based on the average water temperature from the specification table (all radiators will receive approximately the same water temperature).

Average Temperature = Supply Temperature – .5 x Delta T (step 3)

8. Using a floor plan sketch of the building accurately estimate the supply and return tubing lengths of each homerun radiator circuit.
9. Calculate the head loss of the homerun piping circuit to each radiator (use pressure loss charts or tables provided by the pipe and/or tubing manufacturer).
10. Determine the head loss of each radiator using Pensotti's radiator pressure drop graph.
11. Determine the head loss of each radiator's isolation valve, if used, using Pensotti's radiator valve pressure drop graph.
12. Add each radiator's piping circuit head loss, radiator head loss and radiator valve head loss together to determine the total circuit head loss.
13. Determine which radiator circuit has the greatest head loss and record that value.
14. Determine the pipe size of the supply and return piping to and from the common manifold serving the panel radiators based the GPM flow rate calculated in step 4.
15. Estimate the total equivalent length of both supply and return piping to and from the manifold.
16. Calculate the head loss of the piping circuit serving the manifold. Be sure to include pipe, fittings, valves, flowcheck, manifold, boiler, heat exchanger etc.
17. Add the greatest radiator head loss from step 13, and the head loss the piping serving the manifold, step 16 together to determine the total circuit head loss.
18. If antifreeze is to be used multiply the calculated head loss by 1.20 for a 30% antifreeze solution and 1.35 if a 50% solution is used.

Homerun Design

19. Choose a circulator that has a performance curve that matches the system requirements; GPM in step 4 and total head loss from step 17 (or 18).

Homerun Design

PENSOTTI NORTH AMERICA

AMERICA'S BEST HEATING VALUE

PANEL RADIATOR HOMERUN CIRCUIT WORKSHEET

	1	2	3	4	5	6	7A	7B	9	10	11	12	13	14	15	16	17	18	19
	ROOM HEAT LOAD	CIRCUIT SUPPLY TEMP	CIRCUIT DELTA T	TOTAL CIRCUIT FLOW RATE	FLOW RATE THROUGH EACH RAD (GPM)	PIPE OR TUBE SIZE	AVERAGE WATER TEMP. IN RADIATOR	RAD. SIZE	HEAD LOSS OF PIPING CIRCUIT TO EACH RAD.	RADIATOR HEAD LOSS	RADIATOR VALVE HEAD LOSS (IF USED)	TOTAL RAD. HEAD LOSS 9 + 10 + 11	SINGLE RADIATOR WITH THE GREATEST TOTAL HEAD LOSS	COMMON S & R PIPE SIZE TO MANIFOLD	EQUIV. LENGTH OF S & R PIPING	HEAD LOSS OF S & R PIPING	TOTAL HEAD LOSS 13 + 16	ANTIFREEZE CORRECTION (IF USED)	CIRC. SIZE AND MODEL (BASED ON 4 AND 17)
RAD #1																			
RAD #2																			
RAD #3																			
RAD #4																			
RAD #5																			
RAD #6																			
RAD #7																			
RAD #8																			
RAD #9																			
RAD #10																			
TOTAL																			

JOB NAME______________________________

ZONE______________________________

DATE______________________________

Diverter Tee System

System designer and/or installer are responsible to determine whether proper radiator and/or system operation will result based on individual system and piping circuit design.

More Complicated Piping System, Diverter Tee Placement Is Critical, Can Be Balanced, Thermostatic Operators Can Be Used For Multiple Zones, Each Subsequent Radiator Will Have A Lower Entering Water Temperature.

1. Calculate heat load of each room that will be connected to the same piping circuit.
2. Determine the circuit supply temperature.
3. Determine the tentative circuit temperature drop (Delta T) typically 20 degrees F.
4. Calculate the total circuit flow rate in GPM

   $$\text{Total Circuit Flow Rate (GPM)} = \frac{\text{Btu/hr load of the circuit}}{500 \times \text{Delta T}}$$

5. Based on the total circuit flow rate (step 4), select a circulator with a curve that meets the GPM requirements and also has a head pressure, at the GPM required, in excess of 3 feet of head. Record the head pressure.
6. Using a floor plan of the building accurately estimate the location of the radiators, main piping circuit and piping circuits to each radiator. Be sure to record the number of elbows, valves, fittings, etc. along with the length of the pipes, the boiler and accessories.
7. Count the number of Diverter Tees to be installed in the main piping circuit. Determine their total equivalent length using the following table:

Total Circuit Flow Rate (step 4)	Size At The Connection To The Main	Equivalent Length
3 to 6 Gpm	¾″	65
5.2 to 10.2 Gpm	1″	47
8 to 16 Gpm	1 ¼″	33
12 to 23 Gpm	1 ½″	33
20 to 40 Gpm	2″	30

8. Determine the total equivalent pipe length of the main circuit in feet.
9. Using the following table, size the main circuit pipe.
   A. Find the recorded head pressure from step 5
   B. Move across the table until you intersect the equivalent pipe footage from step 8
   C. Move up the column and record the column header letter (**A, B, C, ETC.)**
   D. Move down the same lettered column to the **BTU Capacity** table until you intersect The MBTU that is equal too, or slightly greater than the total circuit flow rate from step 4.
   E. Move to the far left column to determine the proper pipe size for the main circuit.

Diverter Tee System

Total Equivalent Length Of Pipe From Step 8

Head In Feet (step 5)	A	B	C	D	E	F	G	H	I
3	60	70	90	100	120	145	180	240	360
3.5	70	85	105	120	140	170	210	280	420
4	80	95	120	140	160	190	240	320	480
4.5	90	110	135	155	180	215	270	360	540
5	100	120	150	170	200	240	300	400	600
5.5	110	130	165	190	220	265	330	440	660
6	120	145	180	205	240	290	360	480	720
6.5	130	155	195	225	260	310	390	520	780
7	140	170	210	240	280	335	420	560	840
7.5	150	180	225	255	300	360	450	600	900
8	160	190	240	175	320	385	480	640	960
8.5	170	205	255	290	340	410	510	680	1020
9	180	215	270	310	360	430	540	720	1080
9.5	190	230	285	325	380	455	570	760	1150
10	200	240	300	345	400	480	600	800	1200
10.5	210	250	315	360	420	505	630	840	1250
11	220	265	330	375	440	530	660	880	1325
11.5	230	280	345	395	460	550	690	920	1380
12	240	290	360	410	480	575	720	960	1440
15	300	360	450	515	600	720	900	1200	1800
20	400	480	600	685	800	960	1200	1600	2400

BTU Capacity of Copper Tube and Pipe (MBH)

Pipe Size	A	B	C	D	E	F	G	H	I
¾"	42	39	35	31	30	27	24	20	16.5
1"	80	71	64	59	53	48	42	37	31
1 ¼"	170	160	140	130	120	100	90	78	63
1 ½"	260	240	210	185	175	155	140	120	95
2"	500	450	410	360	320	295	260	225	180

10. Determine the flow rate of each radiator:

$$\text{Flow Rate (GPM)} = \frac{\text{Btu/Hr load of the radiator}}{\text{Delta T (step 3)}}$$

11. Calculate the average water temperature in the first radiator

$$\text{Average Temp} = \text{Supply Temp} - \frac{\text{Btu/hr load of the radiator}}{500 \times 2 \times \text{total circuit flow rate (GPM)}}$$

12. Choose the proper radiator based on the Btu load and average water temperature.

13. Calculate the return water temperature from the radiator where it connects back to the main circuit (second tee). This water temperature is also the entering water temperature to the next radiator.

$$\text{Return Water Temp.} = \text{Supply Temp. to the Radiator} - \frac{\text{Btu/hr of the radiator}}{500 \times \text{Circuit Flow Rate Gpm (step 4)}}$$

14. Repeat steps 10 through 13 for all subsequent radiators. Remember, the return water temperature from the previous radiator is the entering temperature for the next.

Diverter Tee System

15. Determine the size of the radiator risers using the following table:
    1. Locate column using information from step 9C **(A, B, C, ETC.)**
    2. Move down the column to the appropriate application
    3. Locate the MBH that meets or closely exceeds the radiator capacity
    4. Move to the left to determine the proper pipe size

Capacity Of Risers With 1 Diverter Tee (MBH)									
Upfeed Riser To First Floor									
Pipe Size	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
½″	16	15	13	12	11	10.5	10	9.2	8
5/8″	22.5	21	19	18	16	14.5	14	13	11.5
Upfeed Riser To Second Floor									
½″	11	10	9	8	7	7	6	6	4
5/8″	15.5	14.5	13	12	10	10	9	8.5	7.5
Upfeed Riser To The Third Floor									
½″	9	8	7	7	6	6	6	5	4
5/8″	13.5	12	10	10	9	9	8.5	12	6.5
Capacity Of Risers With 2 Diverter (MBH)									
Downfeed Risers									
½″	16	15	14	12	11	9	8	X	X
5/8″	24	22	20	18	15	13.5	11	X	X

Notes:
Upfeed risers to first floor are based on a total of 9′ of pipe, 6 elbows, and 1 valve. For an additional 10′ of pipe move 2 columns to the right.
Upfeed risers to the second floor are based on 26′ of pipe, 8 elbows, and 1 valve. For an additional 10′ of pipe move 2 columns to the right.
Upfeed risers to the third floor are based on 46′ of pipe. 8 elbows, and 1 valve. For an additional 10′ of pipe move 2 columns to the right.
Downfeed risers are based on a total of 20′ of pipe, 6 elbows, and 1 valve. For every additional 2 feet of vertical drop, move 1 column to the right. A Diverter tee must be installed on both the supply and return riser.
Upfeed riser tees must be spaced at least 1 foot apart.
Downfeed riser diverter tees should be spaced as wide as the radiator they service.
Keep all risers as short as possible.

Diverter Tee System

PENSOTTI NORTH AMERICA
AMERICA'S BEST HEATING VALUE

PANEL RADIATOR DIVERTER TEE CIRCUIT WORKSHEET

	1	2	3	4	5	8	9	10	11	12	13	13	12	15
	ROOM HEAT LOAD	CIRCUIT SUPPLY TEMP	CIRCUIT DELTA T	TOTAL CIRCUIT FLOW RATE	HEAD PRESURE OF CIRC.	TOTAL EQUIVALENT PIPE LENGTH - MAIN CIRCUIT	MAIN CIRCUIT PIPE SIZE	RADIATOR FLOW RATE GPM	AVERAGE WATER TEMP IN RADS.	FIRST RADIATOR MODEL #	RETURN WATER TEMP FROM RADS.	ENTERING WATER TEMP TO RADS. THEN BACK TO 11	RADIATOR MODEL #	RAD RISER SIZE
RAD #1														
RAD #2														
RAD #3														
RAD #4														
RAD #5														
RAD #6														
RAD #7														
RAD #8														
RAD #9														
RAD #10														
TOTAL														

JOB NAME______________________________

ZONE__________________________________

DATE__________________________________

Additional Information Is Available On our Website

www.pensottiboiler.com
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Questions?