



For Buderus Panel Radiator models:

- Model 21
- Model 22

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1. General information

1.1. This manual

This application manual is intended for contractors, engineers, architects and installers as a design manual. It provides specifications and system layout for a hydronic heating system with panel radiators.

This manual describes the basic operation of the Buderus panel radiators, thermostatic controls and piping accessories. It also provides rough in dimensions and installation procedures, as well as size and output information, mounting instructions and piping accessories needed for the installation of the Buderus "NB" towel racks.

Radiator heating capacities are listed by model, height and length and are based on a supply water temperature of 194°F (90°C). The heat output per linear foot is based on an average radiator water temperature of 180°F (75°C) and a room temperature of 68°F (20°C), and is displayed in a graphical form as a function of supply temperature and temperature drop (ΔT) through the radiator. This information is useful in the design of low temperature heating systems.

Performance information is provided for model 21 and 22 radiators.

General guide lines are discussed with respect to sizing and radiator selection. The design and radiator selection process for one and two pipe heat distribution systems are provided including examples. Quick and easy "rules of thumb" for trouble free installation and operation are present.

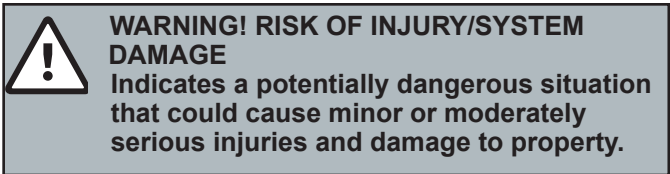
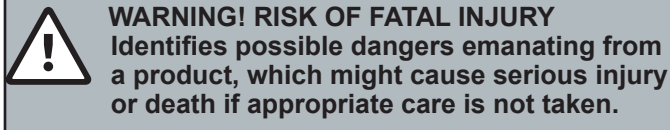
1.2. Standards, regulations and directives

It is the responsibility of the installer to ensure that the system corresponds to all current regulations and rules.

2. Safety

2.1. Layout of the instructions

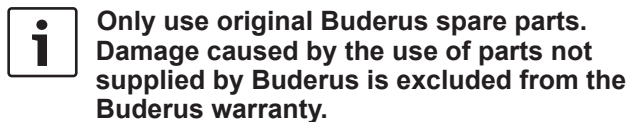
Two levels of danger are identified and signified by the following terms:



Additional symbols for identification of dangers and user instructions:



2.2. Please follow these instructions



2.3. Tools, materials and accessories

For the installation of panel radiators and towel racks, you will need standard tools used for central heating, boiler and DHW water systems.

2.4. Disposal

- Dispose of the packaging in an environmentally responsible manner.
 - Dispose of defunct components through an authorized agent in an environmentally responsible manner.

3. Description of System Components

Buderus Panel Radiators

Buderus “solidoflux N” panel radiators are manufactured from 18 Gauge (0.049”/0.125mm) steel panels. They consist of water filled steel welded panels with convector channels mounted on the back. These layers are combined and arranged into four basic models: model # 11 (2.5”), model # 21 (2.5”), model # 22 (4.0”), model # 33 (6.0”).

Standard equipment with each radiator include bottom piping connections, built in manual air vents, a drain plug and a flow setter valve with a protective cover over it.

All stocking models have the flow setter (control) valve and piping on the right side, which are reversible by turning the radiator a 180°.

Piping Connections

Each stocking radiator has 20 mm (approx. 3/4) metric male tappings on the bottom right side. Figure 3 shows supply and return connections. These connections cannot be reversed. Buderus can supply most size compression fittings for most applications.

Available Models

* **Model # 11** (right hand connection only)

—Height: 12”, 20”, 24”

—Length: 24”, 36”

Output ratings: 1570 to 3887 BTU/hr per linear foot at 180°F (75°C) average radiator water temperature.

Stocking Model # 21

—Height: 12”, 20”, 24”, 36”*

—Length: 24”, 36”, 48”, 59”, 71”

Stocking Model # 22

—Height: 12”, 20”, 24”, 36”*

—Length: 16”, 24”, 36”, 48”, 59”, 71”

* **Model # 33**

—Height: 12”, 20”, 24”, 36”

—Length: 24”, 36”, 48”, 59”, 71”

Output Ratings: Up to 5000 BTU/hr per linear foot for the 36” high model # 33 at 180°F (75°C) average radiator water temperature

* Non-stockung radiators are special order and will take 10 to 12 weeks lead time.

Chapter 4 has detailed radiator output ratings, weights and water capacities are in table and graphical form.

Radiator Accessories

Buderus offers a variety of accessories for installation and control of the radiators for different piping arrangements.

Mounting Brackets

Buderus supplies brackets for the floor and wall mounting of the radiators. The model #11 radiator can only mounted on the wall. Rough in instructions and mounting guidelines are present in chapter #3. Screws are not provided for securing brackets to the wall. Specify the height and radiator model when ordering brackets.

Compression fittings are available from Buderus in sets of two (see table 1). These fittings are normally secured to the piping connection on the radiator. When diverter valves are used, the compression fitting mounts on the diverter valve.

Compression fittings		Table 1
Pipe size and style	BBTNA order #	
1/2" copper	6198924	
12 x 2 mm	1016870	
20 x 2 mm	1016879	
5/8" copper	1646851	
16 x 2 mm (1/2" PEX)	1016874	

There are additional radiator accessories available that will help with the installation of the panel radiator as well as the application in which it is installed. These accessories are listed in the table below with their part numbers.

Valves/Accessories		Table 2
Radiator valves and Accessories	Part Numbers	
Radiator diverter valve - Angle	1016312	
Radiator diverter valve - Straight	1016311	
Radiator Cross over valve	1016362	
Pressure bypass valve 3/4"	3L602502	
Radiator drain	82911060	
Isolation valve - Angle	80262172	
Isolation valve - Straight	80262170	

Floor Brackets		Table 3
Floor Brackets for Radiator model numbers: 11, 21, 22, & 33's	Part Number	
Model numbers: 11, 22, & 33's	817-BUD	
Model numbers: 21	817-BUD-1	
Optional covers for brackets	81606400	

Thermostatic Actuators		Table 4
Radiator Thermostatic Actuators	Part Number	
Radiator Manual Adjuster	013G5002	
Danfoss Radiator Sensor Head	013G8250	
Radiator Remote Sensor Oventrop	81606400	
Oventrop Radiator Sensor Head - Buderus	81606400	

Flow Setter Valve:

Each radiator is equipped with a flow setter valve mounted in the panel radiator on the right side. This valve consists of two part integral components for temperature control and flow balancing.

Flow Balancing:

Flow balancing is done by adjustment of the numbering ring (marked 1-7 and N) on the flow setter valve and lining the desired setting with the dimple in the first ring. Turning of the ring internally changes the cross sectional area available for water flow. The N marking indicates a fully open setting; the 1 marking indicates nearly full restriction. The pressure drop diagram on page 9 shows the pressure drop across the radiator as a function of the flow rate and setting on the flow setter.

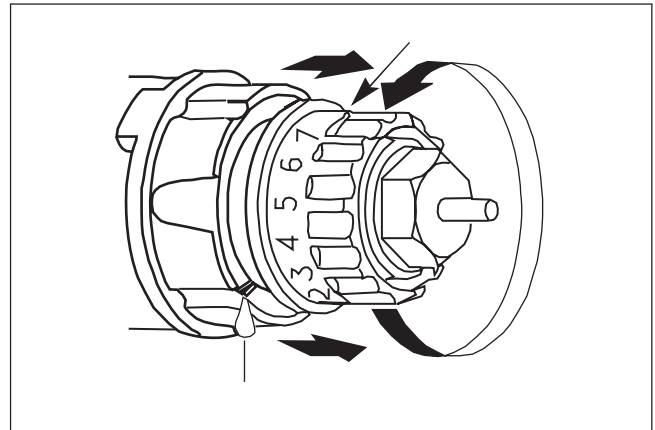


Fig. 1 Flow setter valve adjustment

Air Vent and Drain Plug

Each radiator is equipped with a manual air vent (1/2") and removable drain plug (3/4") for draining the radiator. A flat headed screw driver is needed to open the air vent.

Diverter Valves:

Straight (part number 1016311) and angled (part number 1016312) diverter valves are available from Buderus for use in a one pipe system (fig. 6). Shut offs are located on the supply and return branches to the radiator, isolating the radiator from the piping system. This will enable you to remove the radiator after draining it to do any maintenance needed to the wall behind it.

Each diverter valve is factory set for 35 % flow through the radiator and 65% through the bypass. Other flow percentages are easily set according to the diagram (fig. 7). To adjust the bypass, turn the spindle clockwise to the fully closed position. Then open the bypass spindle the desired number of turns from the fully closed position. Refer to the chart that is on page 30, It explains the pressure drop for a one pipe system with diverter valves for detailed pressure drop information when using diverter valves in one pipe systems. You will need to add pressure drop of radiator and diverter valve together when sizing circulator

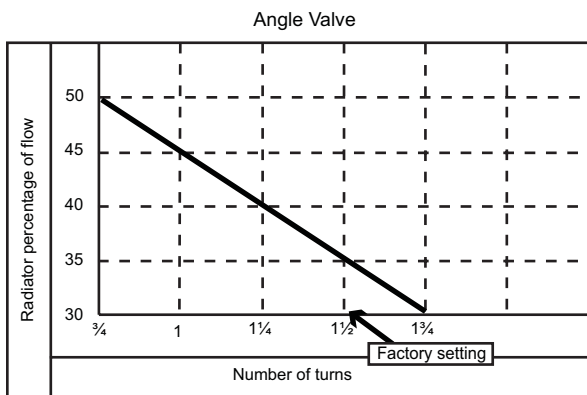
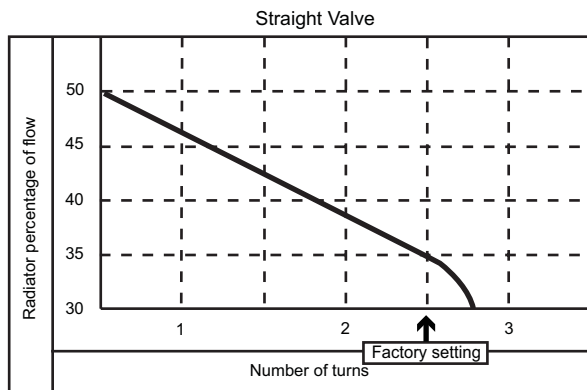


Fig. 2 Setting for Straight and Angled diverter valves

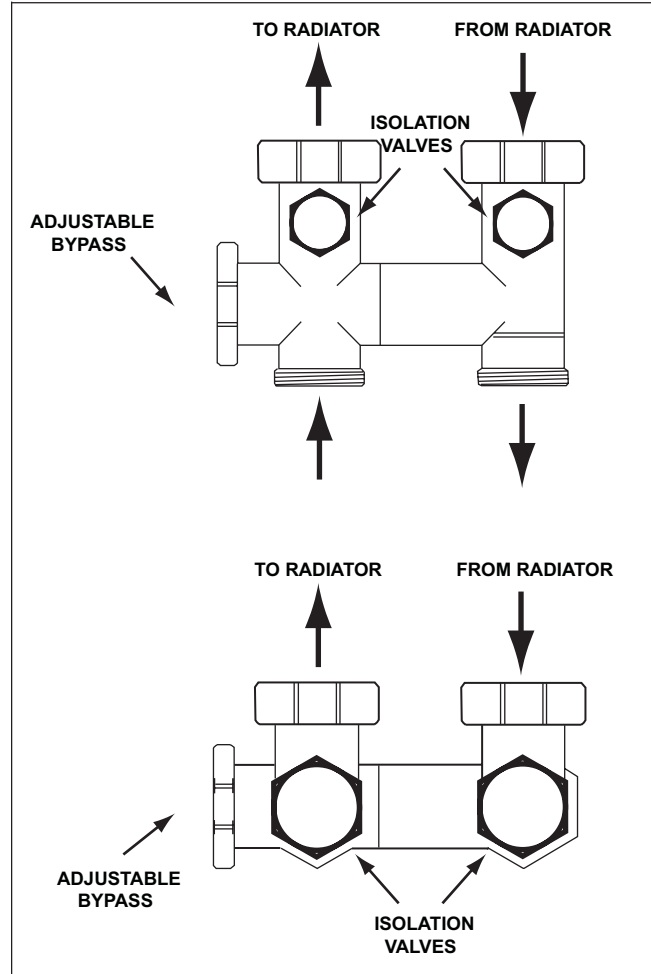


Fig. 3 Straight and Angled Diverter Valves

Installation considerations:

1. The valve mounts directly to the supply and return of the radiator. The compression fittings will now connect to the diverter valve connections.
2. Allow 5" floor clearance below the radiator for the straight; 4" for the angled diverter valve.
3. Due to its projection towards the mounting wall, the angle diverter valve cannot be used on the model #11 radiators unless a small recess is cut into the wall.

Thermostatic Sensor head:

A thermostatic head is easily installed on the flow setter valve. This feature permits the ultimate in zone control as it makes each radiator its own zone.

Temperature Control:

Thermostatic control head can be mounted on the flow setter valve and through its capillary expansion controls the flow rate and therefore the heat output of the panel. When using the thermostatic head the flow setter valve needs to be in the N position. A moveable, spring-loaded seat assembly inside the flow setter valve regulates the water flow through thermostatic action of the control head. This thermostatic head is required for individual temperature control at each radiator. The sensor indicator numbers correspond to the following approximate temperatures:

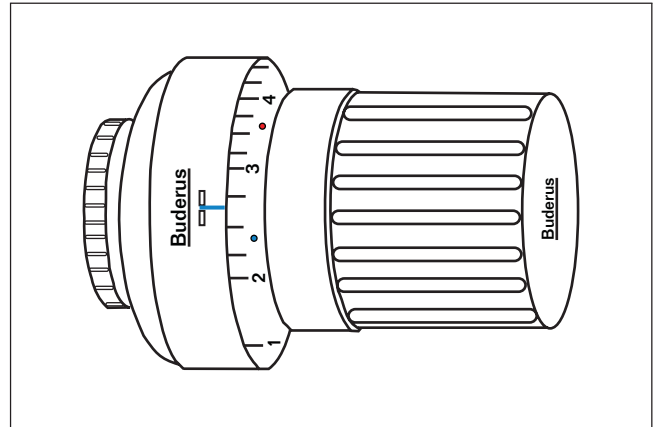


Fig. 4 Thermostatic Sensor Head

Thermostatic Sensor Head Setting		Table 5				
Dial	*	1	2	3	4	5
Room Temperature °F	40	57	63	68	73	79
Room Temperature °C	5	14	17	20	23	26

4. Mounting Guidelines

Panel Radiator Installation

Model 22 and 33 radiators can be wall or floor mounted. Model 11 radiators can be wall mounted only. All wall brackets must be secured to studs or other supports of sufficient strength for panel radiator weight. Radiators with a length of 71" or less require 2 brackets (1 set); lengths 79" or larger require 2 sets.

Note: Do not attempt to mount radiators to sheet rock or similar material.

Radiator Clearance Requirements:

Clearance for right hand radiators		Table 6
Clearance dimensions	Minimum clearance	Reason
Floor	2" (51mm)	- No diverter valves (all models)
	4" (102mm)	- Angled diverters (models 22 and 33)
	5" (127mm)	- Straight diverters (all models)
	5" (127mm)	- Cross-over valves
Right Side	5" (127mm)	Thermostatic Sensor Head
Left Side	2" - 4" (51-102mm)	Access to manual air bleeder
Top	2" - 4" (51-102mm)	Access to the top of wall bracket

Model 11 Wall Mounting

Each model 11 radiator is supplied with 2 sets of clips that attach to the convector fins on the back. These clips have pre-drilled holes for mounting screws. Remove the top grille from the radiator. Mount the four clips (2 at the bottom, 2 at the top) on the fins and align the pre-drilled holes with wall studs. The radiator must be supported at the proper location while the clips are secured to the wall studs with the screws provided. These clips will be positioned at least 8" in from the piping side of the radiator and at least 7" in from the air vent side.

Note: Only a single set of clips is required for the 16" long models. (16" long model 11 radiators to be discontinued after stock is depleted).

Note: The angled diverter valve can not be used for the model 11 radiators.

Rough-in dimensions place piping connections at 1-3/16" (return) and 3-3/16" (supply) inward from the valve side of the radiator. The piping wall offset is 1-5/16". For left hand radiator, measure these dimensions from the left side. **Note:** see the following pages for rough in dimensions.

Model 22 and 33: Wall Mounting

Each bracket is supplied with a slotted plastic locating clip. Position brackets evenly along the radiator and at least 3" to 4" in from either side for aesthetic reasons. The bottom of the radiator rests 5/8" above the bottom edge of the bracket. The radiator wall clearance can be set at 1 9/16" or 2 1/16" depending on the orientation of the plastic locating clips. Piping connections are located at 1 3/16" return and 3 3/16" (supply) in from the valve side of the radiator. The piping wall offset is 3 9/16" or 4 1/16" for both Model 21, 22 and 33 radiators. For left hand radiators, measure these dimensions from the left side.

Model 22 and 33: Floor Mounting

Floor brackets permit placement of Model 21, 22 and 33 radiators in front of windows, etc. These brackets include a floor pedestal mount, radiator support, channel section and tightening assembly. The top grille of the radiator must be removed to install the channel section and tightening assembly. Radiators are adjustable in height from 4" to 8" bottom clearance.

- Place two clips/brackets on the bottom of the convector fins aligned with stud markings. (Fig. 5)

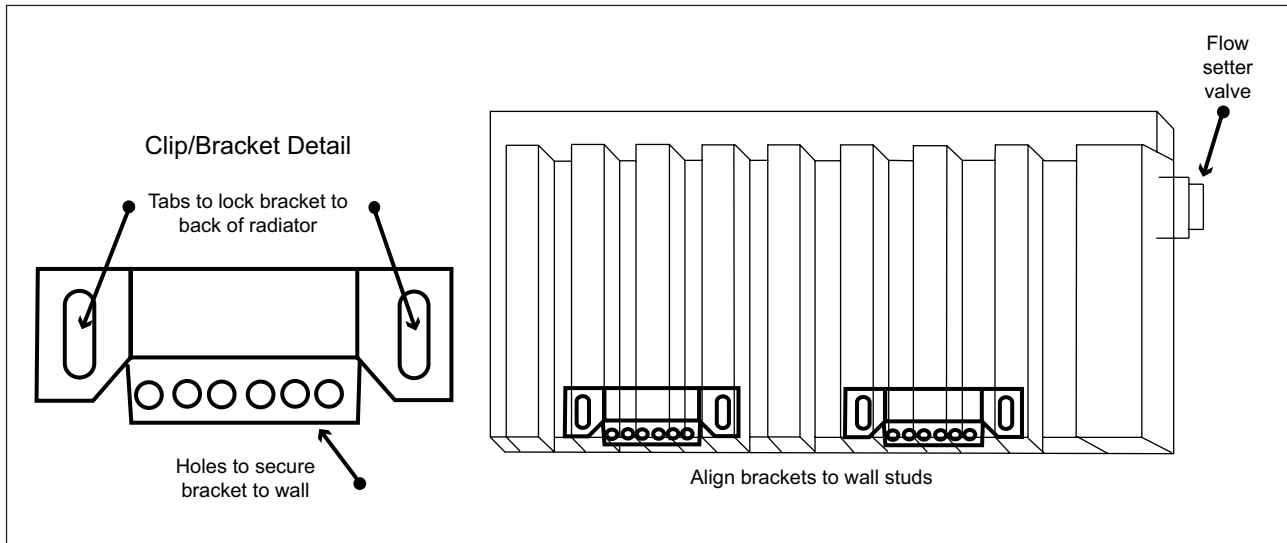


Fig. 5 Rear of Model 11 Buderus Panel Radiator

- Make two wooden blocks with the desired floor to radiator clearance to support the weight of the radiator.
- Place the radiator on the wooden blocks (see Fig. 6). Using the screws provided, fasten the two bottom clips/bracket to the wall.
- Use two screws per bracket for added security

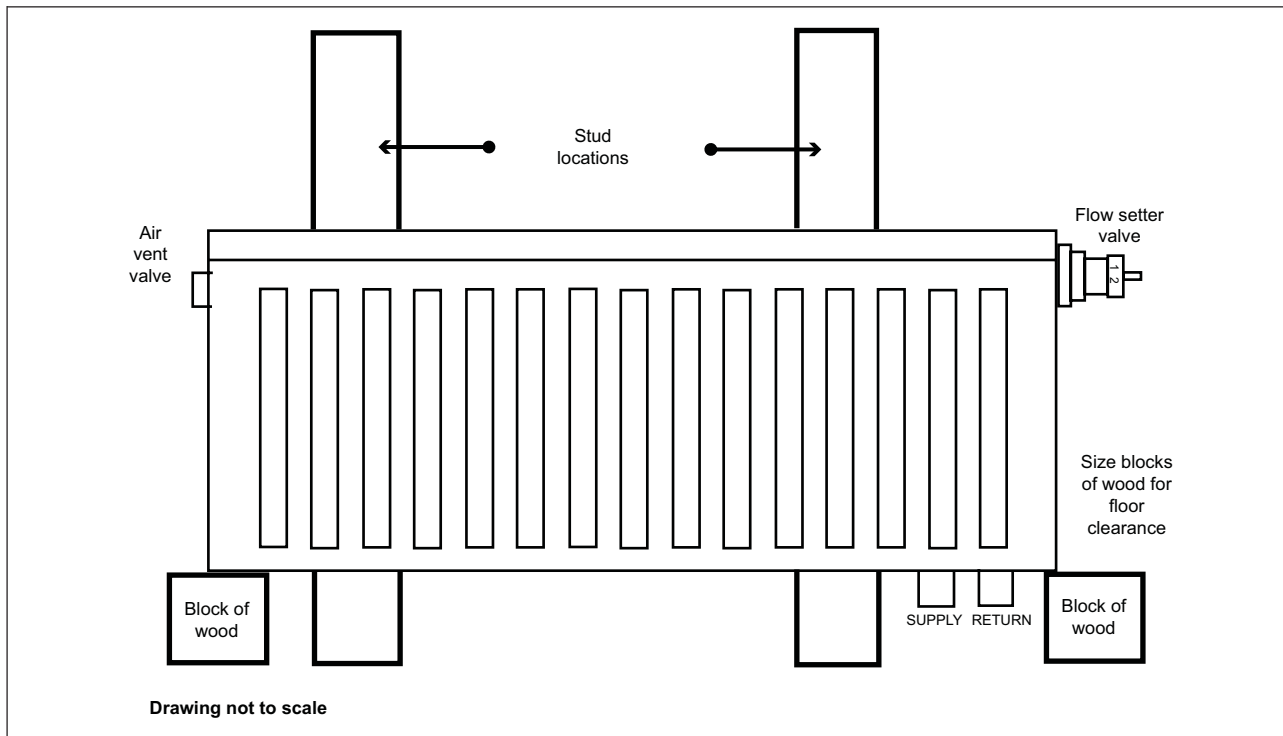


Fig. 6 Front view of radiator: Mounting of top clips

- Support the Panel Radiator parallel to the wall. Slide the top clips in place and secure with screws provided.
- Reinstall the top grill. Complete the installation by making piping connections and adding the desired sensor head.

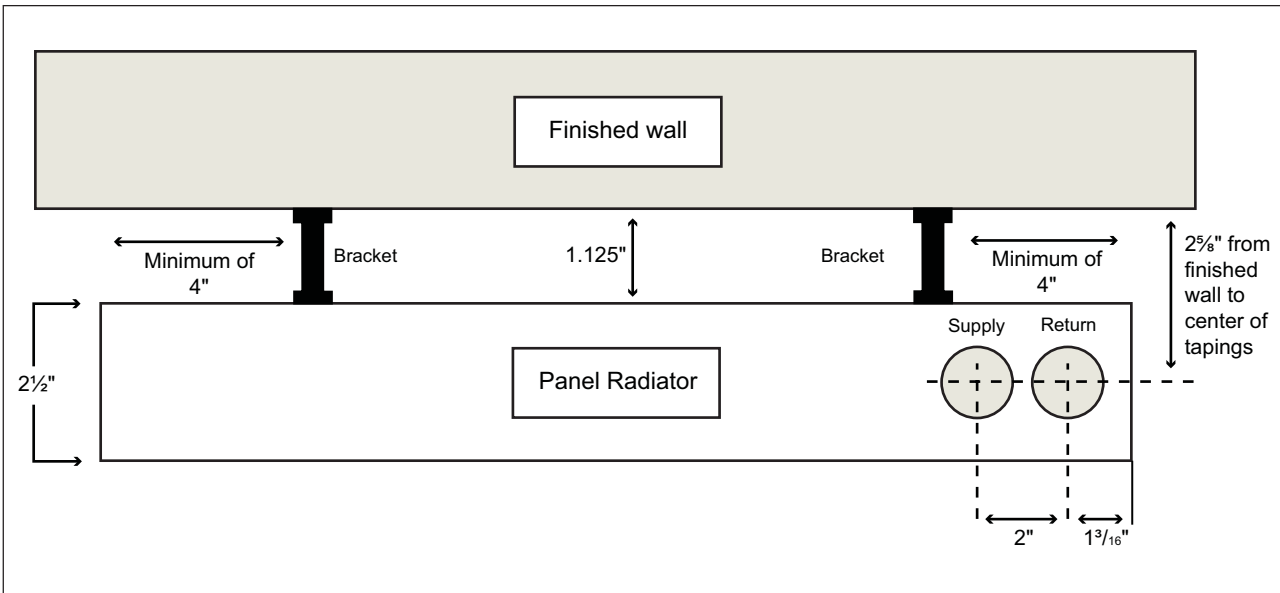


Fig. 7 Model 21 Panel Radiator Rough in Dimensions

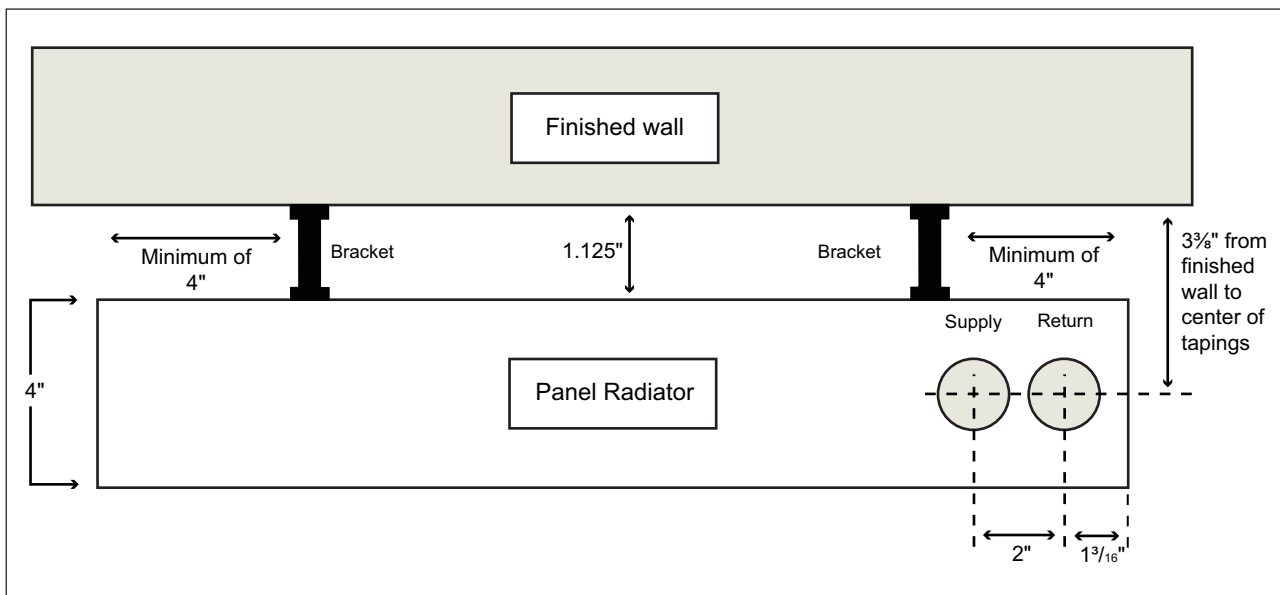


Fig. 8 Model 22 Panel Radiator Rough in Dimensions

Note: This drawing is conceptual in nature and does not address all design, installation or safety considerations. Additional safety and/or auxiliary equipment may be needed. This diagram is for reference use by officials, designers, and licensed installers. It is expected that installers have adequate knowledge of accepted industry practices for the equipment, procedures, and applications involved. All piping should be installed according to standard piping practices and applicable local codes. Drawing is not to scale.

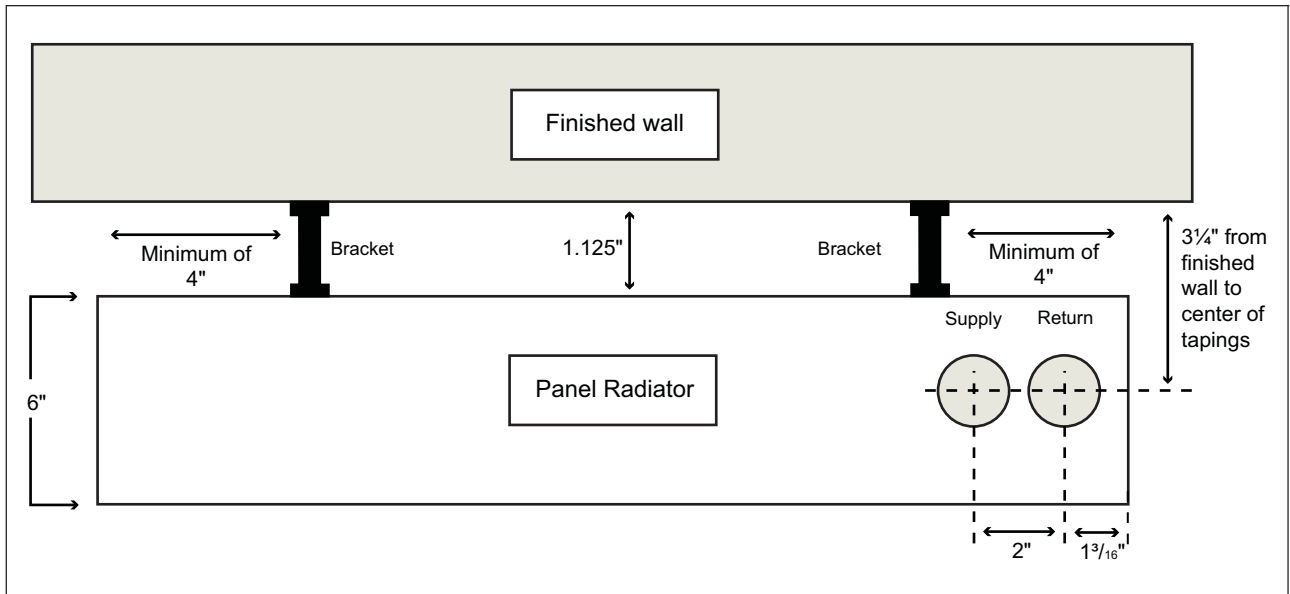


Fig. 9 Model 33 Panel Radiator Rough in Dimensions

Note: This drawing is conceptual in nature and does not address all design, installation or safety considerations. Additional safety and/or auxiliary equipment may be needed. This diagram is for reference use by officials, designers, and licensed installers. It is expected that installers have adequate knowledge of accepted industry practices for the equipment, procedures, and applications involved. All piping should be installed according to standard piping practices and applicable local codes. Drawing is not to scale.

5. Radiator Output Ratings

The Output ratings below are based on a supply temperature of 194°F (90°C), an average radiator temperature of 180°F (82°C) with a 68°F (20°C) room temperature.

Note: Output ratings printed in bold are for stocking models, other models are available with a 10 to 12 week lead-time.

Radiator output ratings:

Model 11 output ratings (BTU/hr)									Table 8
H/L	24"	36"	48"	63"	71"	79"	91"	102"	118"
12"	1,510	2,260	2,890	3,620	4,340	5,080	5,880	6,600	7,610
20"	2,140	3,200	4,100	5,130	6,140	6,830	7,590	8,880	10,230
24"	2,490	3,730	4,770	5,970	7,160	7,950	9,200	10,320	11,980
36"	2,490	3,730	6,840	8,540	10,230	11,420	13,180	14,840	17,050

Model 21 output ratings (BTU/hr)									Table 8
H/L	24"	36"	48"	59"	71"	79"	91"	102"	118"
12"	1,890	2,840	3,790	4,740	5,680	6,320	7,270	8,210	9,480
20"	2,800	4,210	5,610	7,010	8,400	9,350	10,800	12,200	14,000
24"	3,240	4,860	6,470	8,080	9,710	10,800	12,400	14,000	16,200
36"	4,520	6,780	9,050	11,310	13,600	15,100	17,300	19,600	22,500

Model 22 output ratings (BTU/hr)										Table 9
H/L	24"	36"	48"	59"	63"	71"	79"	91"	102"	118"
12"	2,740	4,100	5,470	/	7,300	8,210	9,600	11,040	12,480	14,400
20"	3,840	5,760	7,680	9,600	/	11,520	12,720	14,690	16,510	19,100
24"	4,420	6,640	8,830	11,040	/	13,250	14,780	17,090	19,200	22,180
36"	6,190	9,310	12,380	15,460	/	18,530	20,640	23,810	26,780	30,910

Model 33 output ratings (BTU/hr)									Table 10
H/L	24"	36"	48"	59"	71"	79"	91"	102"	118"
12"	4,080	6,100	8,160	10,200	12,200	13,500	15,600	17,600	20,400
20"	4,080	6,100	11,000	13,800	16,600	18,400	21,300	23,900	27,600
24"	6,380	9,600	12,800	16,000	19,200	21,300	24,700	27,700	32,000
36"	8,640	12,960	17,280	21,600	25,920	28,800	33,220	37,440	43,200

* Non-Stocking Model

Radiator dry weights:

Model 11 weights (lbs)									Table 11
H/L	24**	36**	48**	63**	71**	79**	91**	102**	118**
12**	12	18	24	29	35	39	45	50	59
20**	21	31	42	51	61	68	79	88	102
24**	25	37	49	61	73	82	94	105	122
36**	36	53	71	87	105	118	135	151	175

Model 21 weights (lbs)									Table 12
H/L	24"	36"	48"	59"	71"	79**	91**	102**	118**
12"	20	29	39	48	58	65	74	84	97
20"	33	49	66	81	98	108	125	140	162
24"	40	59	79	97	117	130	150	169	194
36**	58	86	115	142	170	189	218	244	282

Model 22 weights (lbs)											Table 13
H/L	24"	36"	48"	59"	63"	71"	79**	91**	102**	118**	
12"	23	34	46	/	56	67	75	86	97	112	
20"	39	59	78	96	/	116	128	148	166	192	
24"	47	70	94	115	/	139	154	178	200	231	
36"	68	103	137	168	/	202	225	259	291	336	

Model 33 weights (lbs)									Table 14
H/L	24**	36**	48**	59**	71**	79**	91**	102**	118**
12**	34	51	68	85	102	113	130	145	168
20**	59	88	117	144	174	193	222	249	288
24**	70	105	141	173	208	231	266	298	346
36**	105	157	208	257	309	343	395	443	513

Water Capacity and Water Weight per foot of radiator length:

Table 15						
Radiator Height	Model #11*		Model #22		Model #33*	
	Gal/ft	Lbs/ft	Gal/ft	Lbs/ft	Gal/ft	Lbs/ft
12"	0.17	1.84	0.34	3.59	0.65	5.42
20"	0.26	2.34	0.51	4.67	0.85	7.09
24"	0.1	2.67	0.59	5.42	0.97	8.10
36**	0.45	3.76	0.91	7.59	1.36	11.35

* Non-Stocking Model

Radiator output is dependent on the ambient room temperature, supply water temperature and temperature drop through the radiator. Although it is beyond the scope of this manual to accurately delineate the effects of these factors, the following guidelines provide means to calculate their effects on the radiator output.

Ambient room temperature effect: The (adjusted) output of a radiator at any room temperature (ΔT_{room}) can be computed from the output listed at a room temperature of 68°F (20°C) as:

Adjusted Output = Listed Output x $[1 + \alpha \times (68 - T_{room})]$
(T_{room} in °F) where α is a correction factor computed as:
 $\alpha = 1.385 / (\Delta T_{supply} - 75)$ with ΔT_{supply} in °F.

Note: The listed radiator output depends on the supply temperature.

Example: Select the proper radiator to heat a porch which is to be kept at 55°F (13°C) during the winter. Maximum heat loss is 8,000 Btu/hr. Assume supply temperature equal to 194°F (90°C).

Solution: The larger temperature difference between the radiator and the porch increases the radiator output. To find the proper size radiator, we must compute the listed output at 68°F (20°C).
Adjusted Output = 8,000 Btu/hr at 194°F (90°C) and 55°F (13°C). (ΔT_{room}).

Compute correction factor α as:
 $\alpha = 1.385 / (194 - 75) = 0.0116$
Listed Output = $8,000 / [1 + (0.0116 \times (68 - 55))] = 7,000$ Btu/hr
From Table 8: Use Model 22 20" x 59" instead of Model 22 24" x 59" (listed output = 7,010 Btu/hr).

This ambient room temperature effect is generally small and need only be considered in system design if desired room temperatures are well beyond the typical 68 - 72°F (20 - 22°C) range.

Supply water temperature effect: The effect of different supply temperatures on the output of panel radiators is computed using the conversion factors of Table 16 or read directly from the Performance Curves in Figure 10.

Table 16 contains conversion factors needed to compute the adjusted radiator output from the listed ratings. The ΔT factor is computed as the difference between the average water temperature and room temperature.

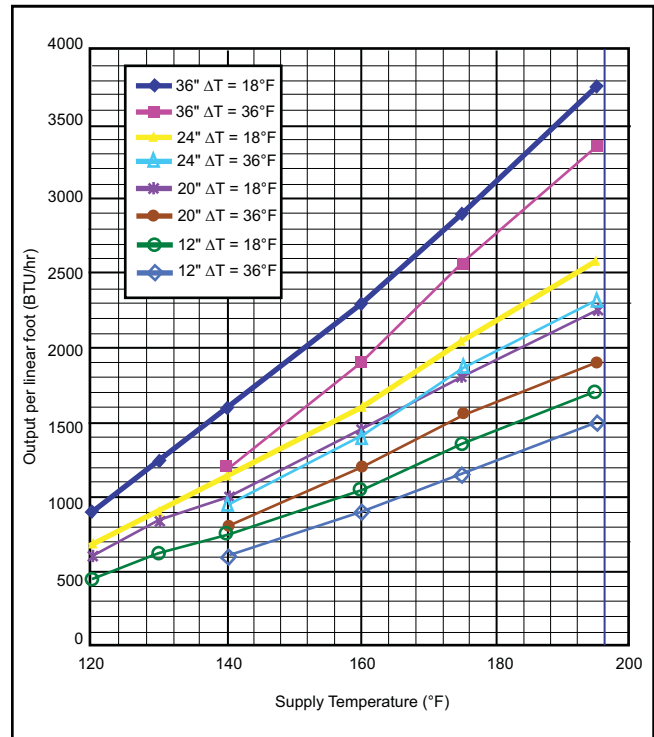


Fig. 10 Performance Curves

Conversion Factors		Table 16
ΔT in °F (°C)		Conversion Factor
10 (6)		0.045
20 (11)		0.112
30 (17)		0.198
40 (22)		0.275
50 (28)		0.367
60 (33)		0.466
70 (39)		0.569
80 (44)		0.677
90 (50)		0.789
100 (56)		0.905
108 (60)		1.000
110 (61)		1.024
120 (67)		1.147
130 (72)		1.272
140 (78)		1.401
150 (83)		1.535

Example: Compute the output of a Model 21 20" x 59" radiator with an average water temperature of 140°F (60°C) in the radiator and a room temperature of 70°F (21°C).

Solution: Listed output = 7,010 Btu/hr (See Table 8)
 $\Delta T = 140 - 70 = 70^\circ\text{F}$: Conversion Factor = 0.569 (See Table 16) Adjusted output = $0.569 \times 7,010 = 3,990$ Btu/hr.

Comment: The effect of the ambient room temperature is already accounted for in the conversion factors listed in Table 16. Figure 10 contains the performance curves for Model 22 radiators showing the output per linear foot of radiation for the different heights as a function of supply temperature.

Different curves are shown based on a 18°F (10°C) and 36°F (20°C) temperature drop through the radiator and a 68°F (20°C) room temperature.

Example: A room requires 12,000 Btu/hr with 6 ft of available space. Maximum supply temperature is 170°F (77°C). What model(s) can be used for this application?

Solution: Required heat output per foot = $12,000/6 = 2,000$ Btu/hr per linear foot. Check Figure 10 at 170°F (77°C) supply temperature and 2,000 Btu/hr Output:

Model 22: Use 24" high with about 18°F (10°C) ΔT drop.

6. Radiator Selection Procedure

Several factors must be considered in the selection of a panel radiator. These are:

- Heat loss of the room.
- Location of the radiator(s) and available floor to window height.
- Desired piping arrangement.
- Room usage.
- Type of room control used.

All factors are discussed below and must be given consideration prior to final radiator size and model selection.

1. The panel radiator(s) must have at least the required capacity to match the heat loss. Over sizing is not a problem provided thermostatic sensor heads or other temperature sensitive control is used to cycle the heat off.

2. Radiators are frequently selected based on the intended location. A 3' radiator fits nicely under a 36" window, whereas a 24" radiator may only be needed based on the heat loss. Window size and number of windows as well as overall room size affect the selection process. Once a room exceeds 12' x 12', it is advisable to install 2 smaller radiators on outside walls for more comfort.

3. The selected piping arrangement affects the radiator sizing on monoflow or one pipe diverter valve based systems, because the supply temperature reduces with distance from the boiler. Minor oversizing of the last radiators in the one pipe system may be necessary.

4. For rooms that are used occasionally where a rapid heat-up is required, it is advisable to install some extra radiation. This becomes important on heating systems operating with an outdoor reset control. There is no need for over sizing radiation in main living areas as they are generally maintained at uniform temperatures.

5. Radiators equipped with thermostatic sensor heads on a constant circulation system maintain a more uniform room temperature and respond faster to temperature disturbances such as open doors or windows, solar or internal heat gain from appliances, lights, etc. compared to a centrally located thermostat system.

7. Piping Arrangements

The design of a panel radiator based heating system involves selection of a piping system, pipe sizes, overall design temperature drop, required flow rates and desired type of system control. For trouble-free system operation, do not exceed the flow rates in Table 17.

<i>Maximum flow rates & heat carrying capacities</i>				
				<i>Table 17</i>
<i>Item</i>	<i>Max flow</i>	<i>Q (Δ T=20°F)</i>	<i>Q (Δ T=30°F)</i>	<i>Q (Δ T=40°F)</i>
½" copper or PEX	1.5	15,000	22,500	30,000
¾" PEX	2.0	20,000	30,000	40,000
¾" copper	4.0	40,000	60,000	80,000
1" copper	8.0	80,000	120,000	160,000
1¼" copper	14.0	140,000	210,000	280,000
Diverter valve	2.0	20,000	30,000	40,000
Radiator Flow	2.5	25,000	37,500	50,000

Note: Q (ΔT = 20°F (11°C)) denotes the maximum heat load carrying capacity based on a 20°F (11°C) temperature drop.

*Pipe size used for main supply/return piping in multiple one-pipe diverter valve based systems or for one-pipe systems using monoflow tees. This information is useful for sizing pipe in two-pipe distribution systems.

This chapter discusses several piping arrangements, guidelines for system design, pipe size and pump selection and fine-tuning of individual components. Heat loss (Q), water flow rate (GPM) and temperature drop (ΔT) through a hydronic heating system are related to each other as:

$$Q = 500 \times \text{GPM} \times \Delta T$$

This equation is used extensively for accurate sizing of radiators.

One-Pipe System Options

Figure 11 presents three different one-pipe arrangements. In any one-pipe system, a single pipe system connects all radiators together. Fewer materials are needed in a one-pipe system and a perimeter loop supplies water to all radiators. Since water flows possibly through all radiators and cools off along the way, it is necessary to oversize the last radiator(s) in the loop. A sizing procedure is outlined.

Table 17 shows maximum Btu load on a one-pipe system based on pipe size and overall temperature drop. Series loop system. All water flows through all radiators.

A thermostatic head cannot be used on any radiator as it will shut off all flow. A central thermostat is required for temperature control. Do not exceed heat loads as listed in Table 17.

1. one-pipe system with monoflow tees.

Monoflow tees are used to divert some water from the main loop into each radiator. Use one monoflow tee on the return if the radiator(s) are located above the main loop; use two monoflow tees if the radiators are installed below the main loop. Place the tees in the main loop to each radiator at least 12" apart. Thermostatic heads on each radiator provide very easy means for individual temperature control. The system can be operated off a central thermostat or with constant circulation using an outdoor reset system. Size the main loop based on the selected temperature drop (20°F, 30°F, or 40°F (11°C, 17°C, 22°C)) and heat load. Make sure to oversize the last radiators properly, especially when using an overall temperature drop of 30°F (17°C) or 40°F (22°C).

2. one-pipe system with diverter valves.

This arrangement is similar to using monoflow tees except that now each radiator is equipped with a diverter valve. Secondly, the total loop flow can NOT exceed 2 GPM because of possible noise at greater flow rates. The bypass adjustment in the diverter valve can be used to throttle down the flow through the first radiators and increase flow through the last radiators in the loop to make up for the drop in loop temperature. Thermostatic heads on each radiator provide an easy means for individual temperature control. The system can operate off a central thermostat or with constant circulation using an outdoor reset system. Follow Table 17 for pipe sizing (either 1/2 "copper or 5/8 "PEX).

3. Multiple one-pipe systems.

Options 2 and 3 above can be installed in a multiple loop fashion where several one-pipe systems are connected between a common supply and return manifold. Assure adequate flow in all piping systems when using monoflow loops and/or diverter valve loops. Isolation and balancing valves are recommended on each loop for service and flow control.

A properly sized pump operating on constant circulation can supply water to all loops. A single Grundfos UP15-42 or equivalent can handle up to 3 diverter valve loops; use a Grundfos UP26-64 or equivalent for 4 to 6 loops. Size the main piping for the combined flow in all branches,

following the guidelines in Table 17. Refer to the Pressure Drop Curves (Fig. 13 & 14) on pages 27 & 28 for estimating the pressure drop through each radiator when using monoflow tees. Use the Pressure Drop Diagram on page 27 for a one-pipe system using diverter valves. Use the approximate flow rate through the radiator and flow setter valve setting to read off the pressure drop. Size the circulator based on total flow and overall system pressure drop. Thermostatic heads are required in this arrangement for individual temperature control.

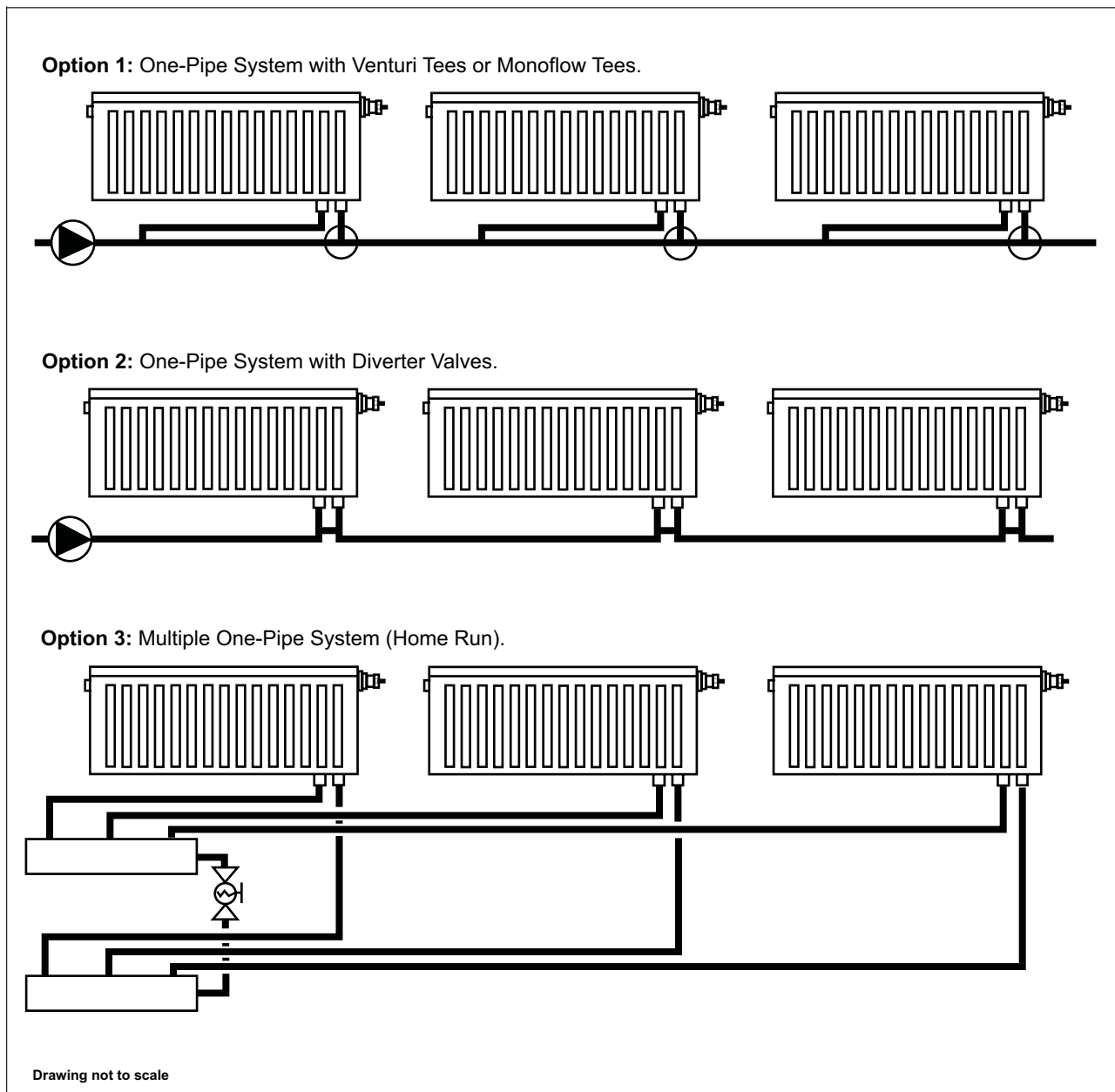


Fig. 11 One-Pipe System Options

Design procedure for One-Pipe System with monoflow tees or diverter valves

1. Select radiator hook-up sequence.
2. Determine individual heat loads.
3. Determine linear footage of wall space available for each radiator.
4. Compute the required heat load per foot for each room.
5. Select system temperature drop $\Delta T = 20, 30$ or 40°F ($11^{\circ}\text{C}, 17^{\circ}\text{C}, 22^{\circ}\text{C}$) and maximum supply temperature.
6. Compute the total heat load (Q) in the loop by adding the individual heat loads.
7. Determine loop flow rate from total heat load (Q) and selected ΔT as: $\text{GPM (loop)} = Q / (500 \times \Delta T)$
8. Compute the supply temperature for each room based on the supply temperature and heat load of the previous room and the total loop flow rate (GPM) as:

New Supply Temp = Previous Supply Temp - (Q room) / (500 x GPM)

With the supply temperature computed in Step 8 and the linear heat load in Step 4, refer to Figure 10 to find the required radiator size. Use the same ΔT value in reading from the curves in Figure 10 as the selected value in Step 5. In case more than one radiator is to be installed in a room, size all radiators based on the above procedure.

Table 18

1	Select room sequence	Room 1	Room 2	Room 3	Room 4
2	Heat load per room				
3	(BTU/hr)				
4	Available wall space (ft)				
5	Minimum Required Heat Load per linear ft (BTU/ft)	$\Delta T = \text{___}^{\circ}\text{F}$ Supply temp(room1) = max supply temp = $\text{___}^{\circ}\text{F}$			
6	Total heat load (BTU/ft)	$Q = \text{___}$ BTU/Hr			
7	Total loop GPM	$\text{GPM(loop)} = Q / 500 / \Delta T = \text{___}$ GPM			
8	Supply temp per room	$\text{___}^{\circ}\text{F}$	$\text{___}^{\circ}\text{F}$	$\text{___}^{\circ}\text{F}$	$\text{___}^{\circ}\text{F}$
9	List possible radiator Models and sizes				

Example: One-Pipe System Layout

Design a one-pipe system for a second floor with individual room temperature control:

Description	Heat Load	Window Size	Hook-up Sequence
Bathroom	3,000	1x 3 ft wide	first
Master Bedroom	9,000	2x 4 ft wide	second
Bedroom 2	6,000	1x 3ft wide	third
Bedroom 3	4,000	1x 3ft wide	fourth

Solution:

1. Complete the Radiator Sizing Sheet to find minimum size radiator.
2. Select control strategy and size piping and pump using Table 7.

Step 1-4: See Table above.

Step 5: Assume temperature drop (ΔT) = 30°F (17°C), maximum supply temperature = 180°F (82°C).

Step 6: Add all heat loads from row 2 and enter in Step 6.

Step 7: Compute flow rate in the one-pipe system in GPM.

Note: The flow rate can not exceed 2 GPM when using diverter valves. Using a larger ΔT lowers the GPM.

Step 8: Here we must compute the supply temperature for each room. Start with the first room and compute each supply temperature step by step as shown here.

Supply Temp (1) = 180°F (82°C)

Supply Temp (2) = $180 - 3000 / (500 \times 1.47) = 176^\circ\text{F}$ (80°C)

Supply Temp (3) = $176 - 9000 / (500 \times 1.47) = 164^\circ\text{F}$ (70°C)

Supply Temp (4) = $164 - 6000 / (500 \times 1.47) = 156^\circ\text{F}$ (60°C)

Step 9: Now with each value computed in steps 4 and 8, locate those values in Fig. 10. The output curve located directly above that point identifies the minimum size radiator required. Use the 18°F (10°C) ΔT curves if designing for a 20 to 30°F (11 to 17°C) temperature drop, use the 36°F (20°C) ΔT curves if designing for a 40°F (22°C) drop.

Results: Output/ft Radiator Models

Bedroom Supply Temp = 180°F (82°C) 1500 Btu/ft #22 20"

M. Bedroom Supply Temp = 176°F (80°C) 1125 Btu/ft #22 x 12

Bedroom #2 Supply Temp = 164°F (70°C) 2000 Btu/ft #22 24"

Bedroom #3 Supply Temp = 156°F (60°C) 1333 Btu/ft #22 24"

Use 5/8" PEX and diverter valves (or: 3/4" copper main line with 3/4" x 3/4" x 1/2" monoflow tees) with thermostatic heads on all radiators for individual room control. Place a thermostat in the bathroom or master bedroom or run constant circulation. Use a Grundfos UP15-42, a Taco 007, or equivalent pump with a balancing valve to throttle the flow. Noise may otherwise develop in the diverter valves.

		Bathroom	Master Bedroom	Bedroom 2	Bedroom 3
1	Select room sequence				
2	Heat load per room	3000	9000	6000	4000
3	Available wall space (ft)	2	8	3	3
4	Minimum required heat load per linear foot (BTU/ft)	1500	1125	2000	1333
5	Minimum Required Heat Load per linear ft (BTU/ft)	$\Delta T = 30^\circ\text{F}$ Supply temperature (room1) = max supply temperature = 180 °F			
6	Total heat load (BTU/ft)	$Q = 3000 + 9000 + 6000 + 4000 = 22000 \text{ BTU/Hr}$			
7	Total loop GPM	$\text{GPM} = Q / 500 / \Delta T = 22000 / 500 / 30 = 1.5 \text{ GPM}$			
8	Supply temp per room	$\Delta T = Q / 500 / \text{GPM}$			
		180	176	164	156
9	Possible radiator Models and sizes				

Two-Pipe System Options

Figure 12 illustrates two common two-pipe configurations.

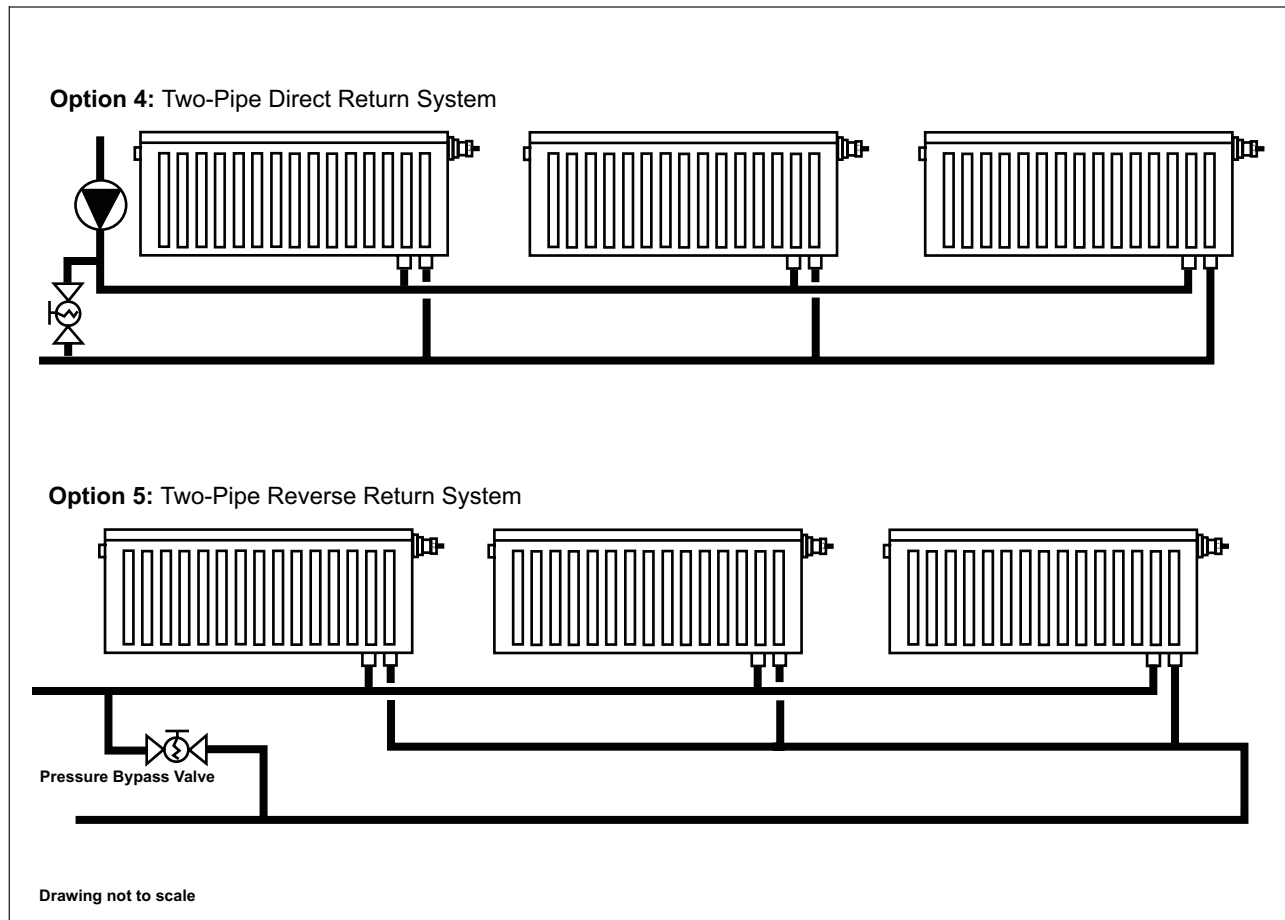


Fig. 12 Two-pipe System Options

Benefits of Two-Pipe Systems:

1. Each radiator is supplied with the same temperature water maximizing radiator output.
2. No limit to the number of radiators on a two pipe system loop; the supply and return mains must be sized for maximum flow. Follow the guidelines in Table 17 for sizing the supply and return runs. Use 1/2" copper or PEX tubing to connect radiators to main runs.
3. Individual radiator control is easily done using thermostatic sensor heads. Use constant circulation with outdoor reset control for optimum system performance. A central thermostat can be used for on/off control; however, thermostat location governs overall system control and may override individual room control.

Requirements of Two-Pipe System:

- Two main distribution pipes are needed; one for the supply to the radiators and a second pipe for the return to the boiler.
- A pressure actuated bypass valve (Part No. 3L602502 for a 3/4" Danfoss valve) connected between supply and return mains is necessary on constant circulation systems with thermostatically controlled radiators to prevent dead-heading the pump. This bypass valve is not needed on thermostat controlled systems if the radiators are not equipped with thermostatic sensor heads.

Design Procedure for Two-Pipe System

1. Determine individual heat loads.
2. Select desired overall temperature drop of systems (ΔT); i.e. 20°F (11°C), 30°F (17°C) or 40°F (22°C).
3. Compute loop flow rate GPM from:

$$\text{GPM} = Q / 500 / \Delta T$$
4. Use Figure 10 or the Conversion Factors in Table 16 to determine output of radiator models in case of lower supply temperatures.
5. Use the Pressure Drop Chart on pages 27-28 as a guide to set the flow setter valve for each radiator to ensure proper flow through each radiator. Adjust flow setter valves as needed based on system performance. Close down the flow setter on “hot” radiators by dialing in a lower setting on the adjustment ring, or adjust the flow setter to a higher setting for “cool” radiators.
6. Size piping based on system flow rate; size circulator based on flow rate and overall system pressure drop.

Table 21					
1	Select room sequence	Room 1	Room 2	Room 3	Room 4
2	Heat load per room				
3	(BTU/hr)				
4	Available wall space (ft)				
5	Minimum Required Heat Load per linear ft (BTU/ft)	$\Delta T = ___^\circ\text{F}$ Supply temp(room1) =max supply temp= $______^\circ\text{F}$			
6	Total heat load (BTU/ft)	$Q = ______ \text{BTU/Hr}$			
7	Total loop GPM	$\text{GPM}(\text{loop}) = Q / (500 \times \Delta T) = ______ \text{GPM}$			
8	Supply temp per room	$______^\circ\text{F}$	$______^\circ\text{F}$	$______^\circ\text{F}$	$______^\circ\text{F}$
9	List possible radiator Models and sizes				

Example 2: Two-pipe System Lay-out

Design and select a two pipe panel radiator system with the following requirements:

Description	Heat Load	Window Size	Required BTU/ft
Walk-in closet	2,000	none	
Bathroom	5,000	1x 2 ft wide	2,500
Bedroom 1	8,000	2x 3ft wide	1,333
Bedroom 2	10,000	2x 4ft wide	1,250
Master Bedroom	12,000	2x 4ft wide	1,500

Total Load: 37,000 Btu/hr

System Parameters:

Maximum Supply Temperature: 194°F (90°C)

Thermostat in master bedroom for ON/OFF control.

Solution: Two-Pipe System Lay-out

1. If sufficient space is available for radiators, select radiators based on required heat output and desired style. Select radiators from Tables 7-10 since the system temperature is similar to those listed. If the radiators must be sized for the available window space, determine the minimum needed model radiator based on the required Btu/ft for each room from Figure 10 with a 194°F (90°C) supply temperature. Use the same supply temperature for each radiator in a two-pipe system.

2. Select an overall temperature drop of 20°F (11°C).

3. Compute system flow rate as: $GPM = Q / 500 / \Delta T = 37000 / 500 / 20 = 3.7$ GPM

4. Combine all information in tabular form as shown in Table 2.

Table 23: Radiator Option Determination Chart: Two-Pipe System

Description	Heat Load	BTU/ft	Selected Models	No. and length of radiators	Flow-setter valve
Walk-in closet	2000			1	3-4
Bathroom	5000	2,500	1x #22 20"x36"	1x 3ft	6-7
Bedroom 1	8000	1,333	2x #22 12"x36"	2x 3ft	5-6
Bedroom 2	10000	1,250	2x #22 12"x48"	2x 4ft	6-7
Master Bedroom	12000	1,500	2x #22 20"x48"	2x 4ft	7-N

Balancing the system

Initial settings of flow setter valves will help to ensure proper flow through all radiators.

Keep in mind that this is only a starting point and that the system may require further adjustment based on the heating characteristics of the structure.

Procedure for setting the flow-setter valves.

1. Identify the largest radiator. In this case it would be the master bedroom radiator. The setting for this radiator should be "N". This radiator will have the highest pressure drop and requires that the flow-setter valve be fully open.
2. Using the Pressure Drop Chart on page 27-28, find the output for this radiator (at selected ΔT) at the bottom of the chart. Based on 6,000 btu/hr at a 20°F ΔT the flow rate for this radiator is 0.6 GPM. Follow the 0.6 GPM line vertically until you intersect the N setting. Reading across to the left you will see that the pressure drop for this radiator is approximately 12 in. W.C. or 1ft/hd.
3. Draw a horizontal line across the diagram at 12 in. W.C.
4. Select the next radiator. Identify its btu/hr output, locate this figure at the bottom of the chart as you did for the first radiator. At the corresponding flow-rate, move vertically on chart until you intersect the horizontal line that you drew indicating 12" W.C. Find the appropriate flow setting. If the value is between two settings, say 3 and 4, then simply set the valve between 3 and 4.
5. Repeat step 4 for remaining radiators.
6. Use guidelines in Table 17 to size main piping. In this case, use 3/4" copper mains with 1/2" copper (or PEX) to/from each radiator. Install a thermostat in master bedroom. Size circulator based on total flow rate and install balancing valve for flow control.

Piping Lay-out Suggestions:

1. For small systems, use one-pipe system with monoflow tees or diverter valves.
Btu's per loop: 15,000 - 20,000 Btu/hr with 1/2 " copper
20,000 - 30,000 Btu/hr with 5/8 " PEX.
Increasing the overall temperature drop in the system from 20°F (11°C) to 30°F (17°C) or 40°F (22°C) permits more radiation per loop. (See Table 17).
Oversize radiators by 20 - 30% at the end of a one-pipe loop. Always install a balancing valve in each loop to regulate the flow rate to eliminate possible flow noise.
Maximum flow rate for diverter valves: 2 GPM
Maximum flow rate per radiator: 2.5 GPM.
2. For larger systems, use two-pipe reverse return or multiple one-pipe systems with common supply and return manifolds. Refer to Table 17 for pipe sizing.
Pump Selection:
1-3 loops: Grundfos UP15-42, Taco 007 or equivalent
3-6 loops: Grundfos 26-64 or equivalent
Use pressure bypass valve on two-pipe systems to prevent deadheading the pump.

Radiator Selection & System Start-up Suggestions:

1. Size radiators based on heat load, location, available space, desired style and system operating temperatures.
2. Use of thermostatic sensor heads increases comfort, eliminates problems with over sizing the radiation and provides individual room control.
3. Balance the system to ensure proper heat output from each radiator using the flow setter valve on each radiator. Shut off thermostatic heads one at a time and monitor system response. Make necessary adjustments.
4. Retighten compression fittings slightly after initial start-up.

Pressure drop curves:

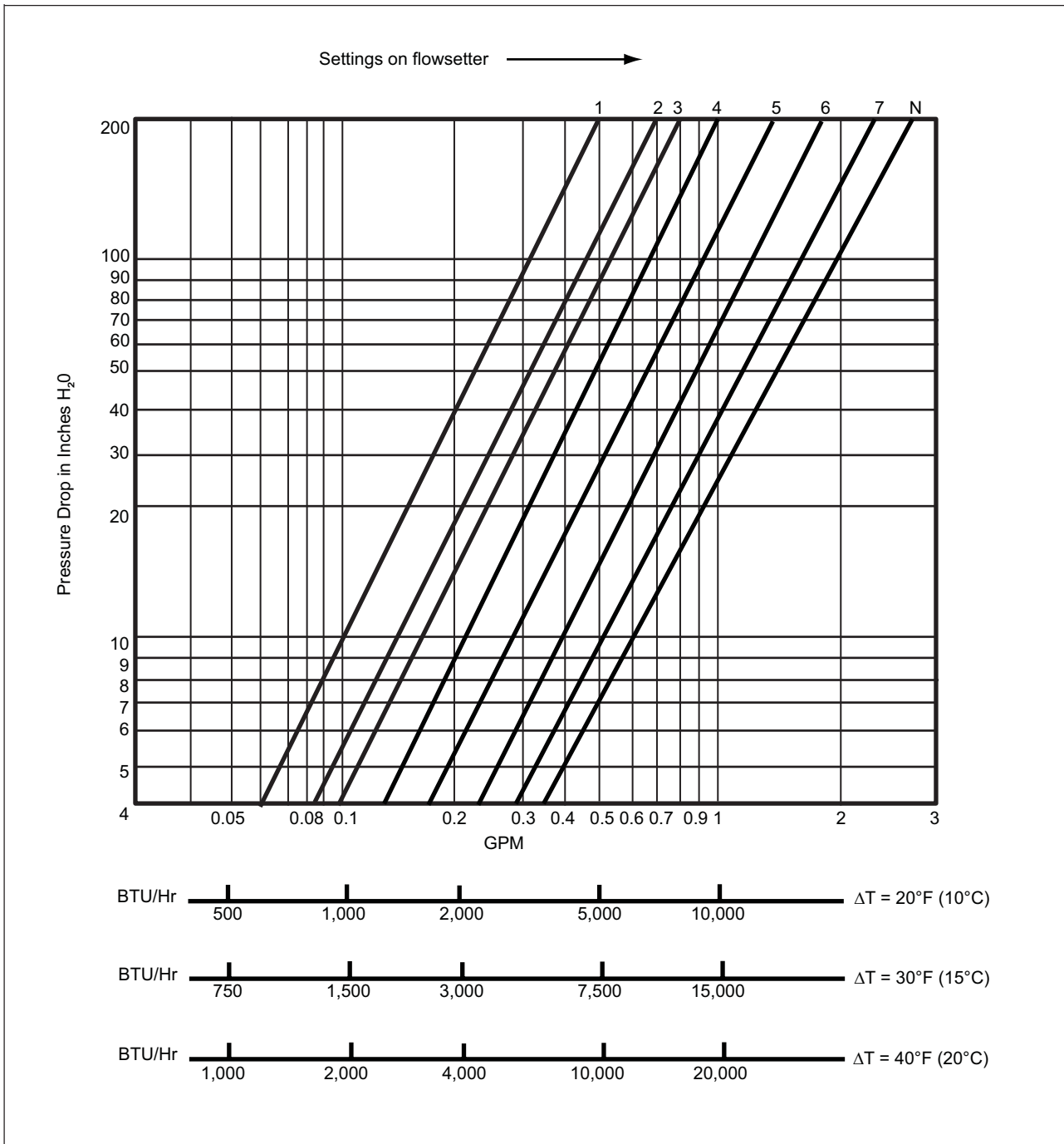


Fig. 13

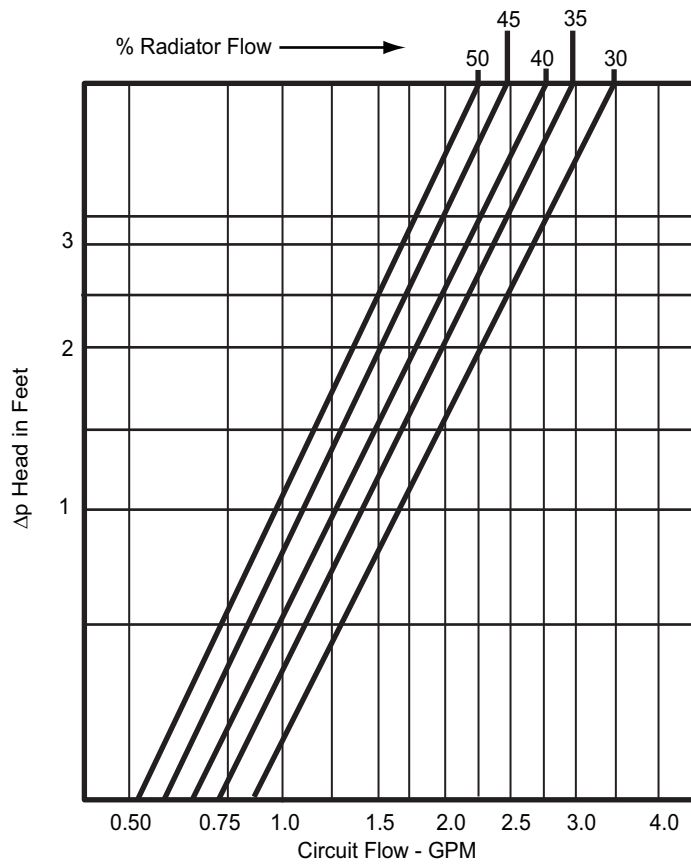


Fig. 14

8. Buderus NB Style Towel Racks

The Noblesse style towel racks are attractively designed with a vertical frame of two 2-3/4" round pipes connected horizontally with 1" curved round steel tubing precision welded in the interior. Two 1/2" NPT female tapings are available on the bottom of the towel rack for the supply and return. An air vent is already installed on the top left of the NB towel rack. The NB has an adjustable offset of 3" and 4" from the wall.

All "towel racks" have a powder baked on enamel white coating. Supply and return pipes are reversible. Openings in the towel rack are provided to hang towels. Complete wall mounting hardware and a manual air vent is supplied with each towel rack.

Piping accessories are available through Buderus for a clean, finish installation include:

<i>Piping accessories</i>		<i>Table 21</i>
Chrome plated straight thermostatic valve		Part No. 013G8015
Chrome plated angle thermostatic valve		Part No. 013G8013
Chrome plated 90° return elbow		Part No. 3L0143

<i>NB Style towel rack stock sizes</i>					<i>Table 22</i>
<i>Model #</i>	<i>Dimensions (height x width)</i>	<i>BTU @ 180° F</i>	<i>Approx. Ship Wt.</i>	<i>Part NO.</i>	
NB towel rack	24" x 32"	2,000	17 lbs. *	NB2432	
NB towel rack	24" x 48"	3,000	25 lbs. *	NB2448	
NB towel rack	24" x 71"	4,500	35 lbs.	NB2471	

* Item can be shipped via UPS

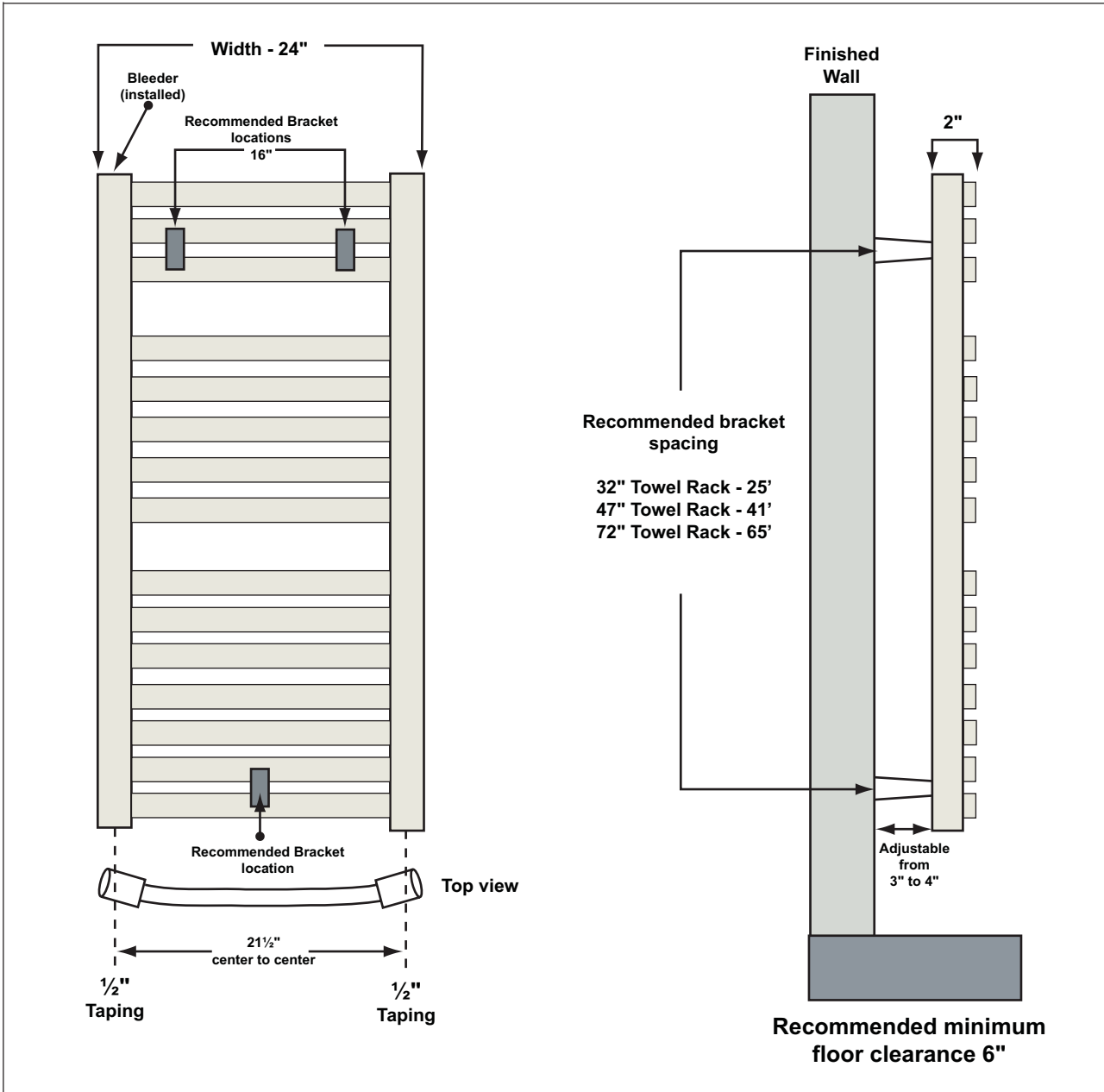


Fig. 15 Buderus NB Style Towel Warmers

- Supply and Return tapings are interchangeable.
- Factory supplied "Dip Tube" must be installed in supply taping.

Buderus

Bosch Thermotechnology Corp.
50 Wentworth Avenue
Londonderry, NH 03053

Tel: 1-800-BUDERUS
Fax: 1-603-584-1681
www.buderus.net