TECH TIP # 52

HARDI

HEATING, AIRCONDITIONING & REFRIGERATION DISTRIBUTORS INTERNATIONAL

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Determining Water Flow Rate in Two-Pipe Circuits
(A Tech Tip on Solving Design Problem Unit 1)

One gallon of water circulated per minute will provide 500 Btu's per hour of heat for each one degree of temperature drop. (8.33 pounds per gallon x 60 minutes = 499.8)

Thus, for a design temperature drop (TD) of 20, one gallon per minute (gpm) will provide…

500 x 20 or 10,000 Btu\hr (per gpm)

30 degree drop ….

500 x 30 OR 15,000 Btu\hr (per gpm)

and so forth.

In the diagram attached, there are four baseboard branches with a heat capacity as noted. Let's compute the gpm first for each branch. We will assume a 20 degree TD.

Branch A	5,200/10,000 = 0.52 gpm (round off to .5 gpm)
Branch B	11,400/10,000 = 1.14 gpm (round off to 1.1 gpm)
Branch C	23,000/10,000 = 2.30 gpm
Branch D	8,200/10,000 = 0.82 gpm (round off to .8 gpm)

In a two-pipe circuit, the total gpm circulated must be the sum of the gpm in each branch. Thus,

.5 + 1.1 + 2.3 + .8 = 4.7 gpm is needed in this circuit.

We have noted this at point 1 in the supply piping.

By tracing the supply piping starting at point 1, we can deduct the gpm diverted to each branch from 4.7 gpm and determine the gpm flowing in various sections in the supply line. Let's start at point 2 in circuit.

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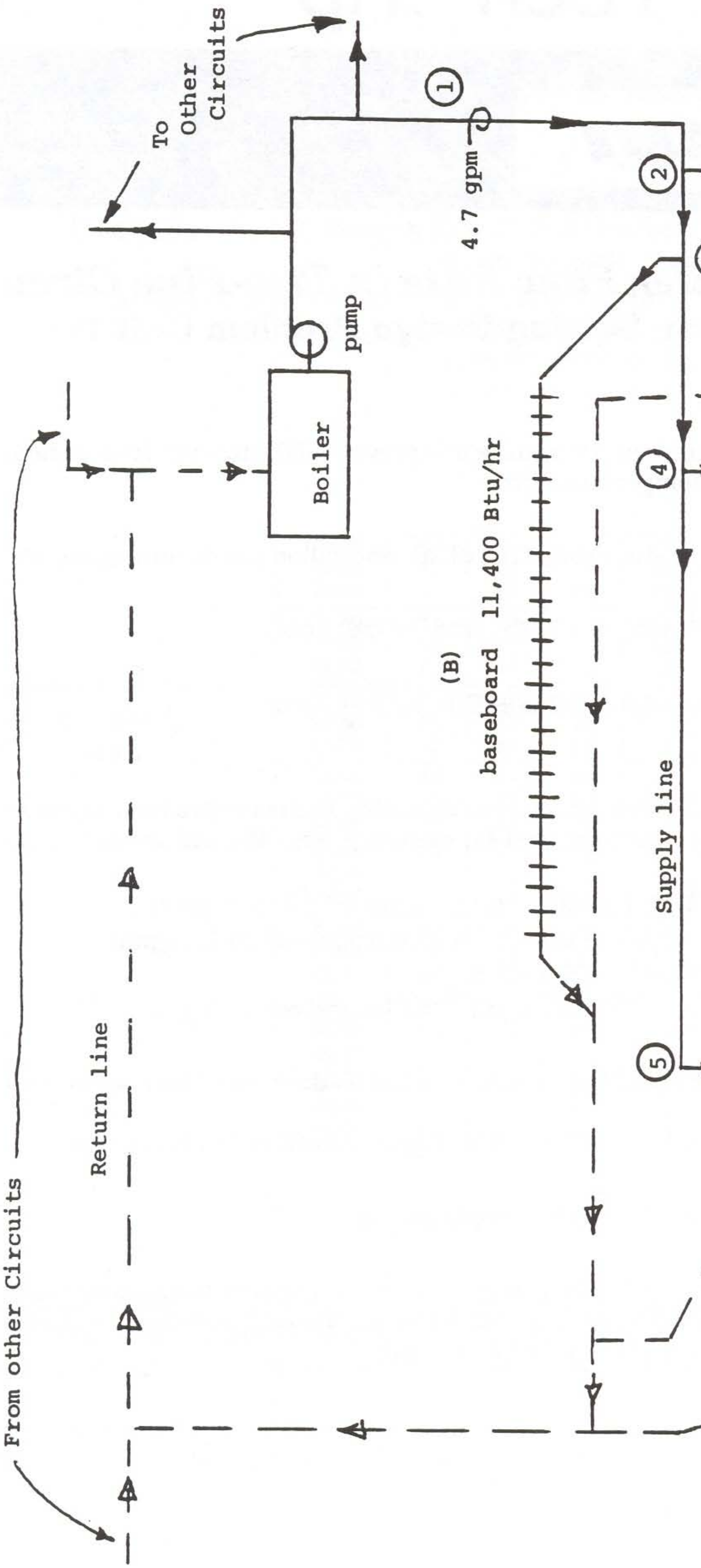
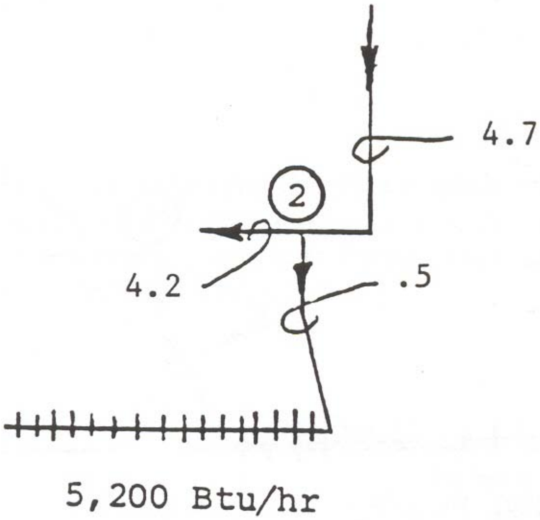
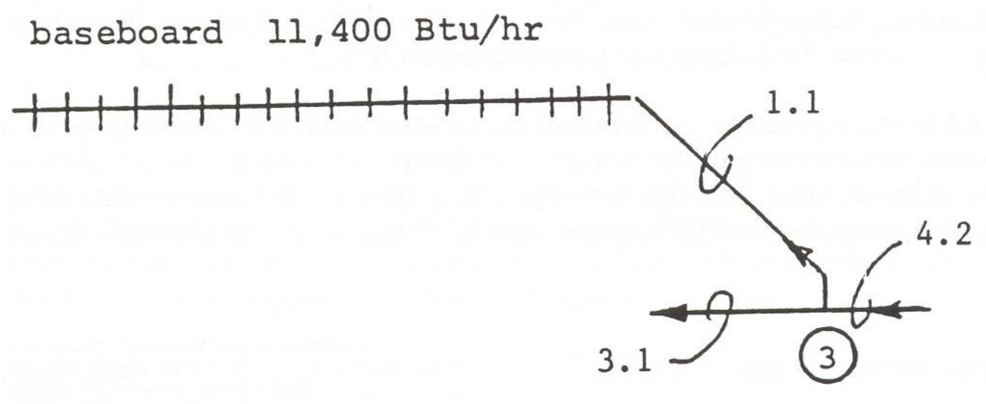
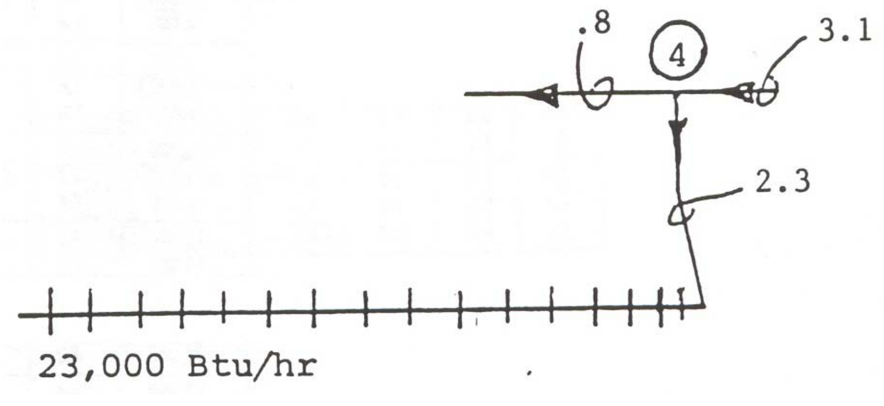

To Other Circuits
①
4.7 gpm
②
pump
Boiler
(B)
baseboard 11,400 Btu/hr
④
Supply line
⑤
Return line
From other Circuits


4.7
②
4.2
.5
5,200 Btu/hr

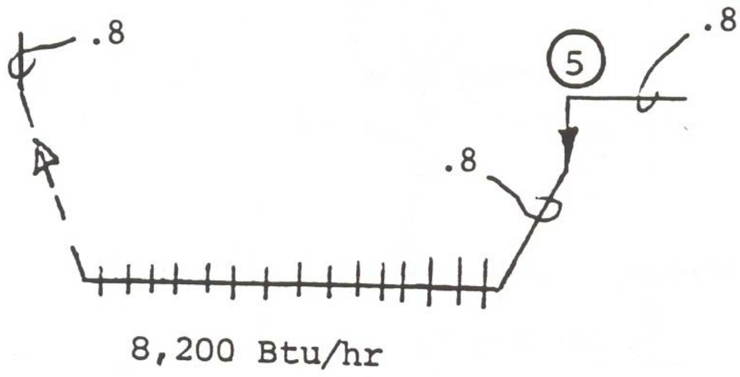
At point 2, we have 4.7 gpm approaching and .5 gpm being diverted into the branch. Thus, 4.7 - 4.2 gpm leaving the junction.



At point 3, we have 4.2 gpm approaching and 1.1 gpm being diverted into the branch. Hence, 4.2 - 1.1 = 3.1 gpm leaving the junction.

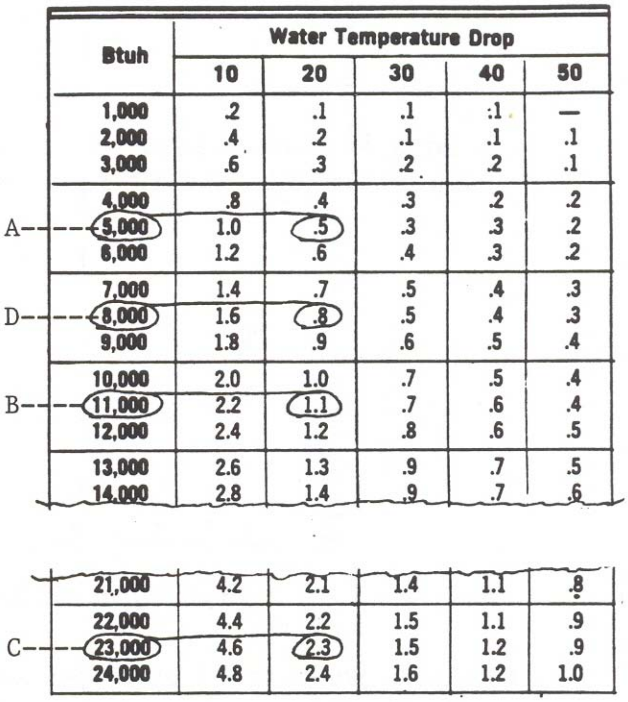


At point 4, we have 3.1 gpm approaching and 2.3 gpm being diverted into the branch. Now 3.1 - 2.3 = .8 gpm is leaving the branch -- and that is the required gpm for the last branch on the circuit (Branch D).



At point 5, 0.8 gpm is approaching and since the supply line ends at this point, all the remaining supply water flows through Branch D and enters the return main joining the other flows from the previous branches.

Table 12 in the appendix can be used as an **alternative** to dividing by 10,000 for other amount according to the design TD). Simply look up the terminal capacity in the first column, and then find the corresponding gpm for the appropriate design TD. Examples are circled for the branches A, B, C and D in our example circuit.

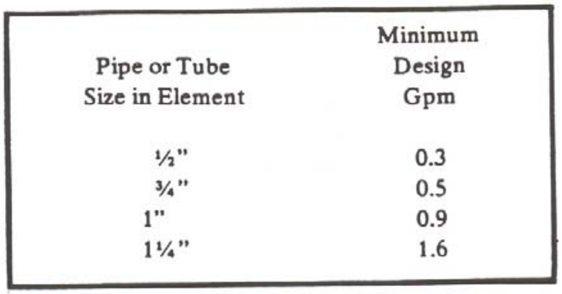


	Btuh	Water Temperature Drop				
		10	20	30	40	50
	1,000	.2	.1	.1	.1	—
	2,000	.4	.2	.1	.1	.1
	3,000	.6	.3	.2	.2	.1
	4,000	.8	.4	.3	.2	.2
A---	5,000	1.0	.5	.3	.3	.2
	6,000	1.2	.6	.4	.3	.2
	7,000	1.4	.7	.5	.4	.3
D---	8,000	1.6	.8	.5	.4	.3
	9,000	1.8	.9	.6	.5	.4
	10,000	2.0	1.0	.7	.5	.4
B---	11,000	2.2	1.1	.7	.6	.4
	12,000	2.4	1.2	.8	.6	.5
	13,000	2.6	1.3	.9	.7	.5
	14,000	2.8	1.4	.9	.7	.6
	21,000	4.2	2.1	1.4	1.1	.8
	22,000	4.4	2.2	1.5	1.1	.9
C---	23,000	4.6	2.3	1.5	1.2	.9
	24,000	4.8	2.4	1.6	1.2	1.0

Table 12 --- Gallons per Minute for Btu\h at Various Water Temperature Drops

Table 12 can also be used to determine the gpm in each section of the supply main provided the following is true. The gpm in any branch circuit has not been adjusted upward to provide for a minimum flow rate through the baseboard … as per the Table 8-1 from the text below.

Table 8-1

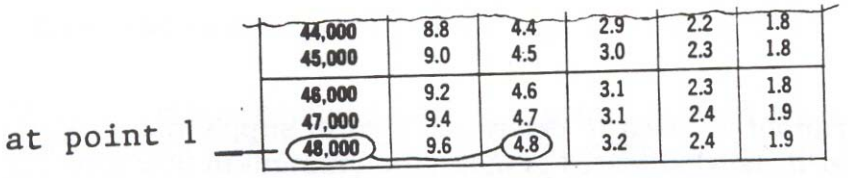


Pipe or Tube Size in Element	Minimum Design Gpm
½"	0.3
¾"	0.5
1"	0.9
1¼"	1.6

For instance, if Branch A in our example was only 4,000 Btu\hr and ¾" baseboard was being used, the calculated flow would be 4,000/10,000 or .4 gpm. However, the table states a minimum flow of .5 gpm is required.

In our example, this does not occur so we can use Table 12 to find the various flows in the circuit.

To find the total gpm, simply add up all the Btu\hr (the closest value listed), the gpm for 20 degree TD is 4.8 gpm which agrees very closely with our computed value of 4.7.



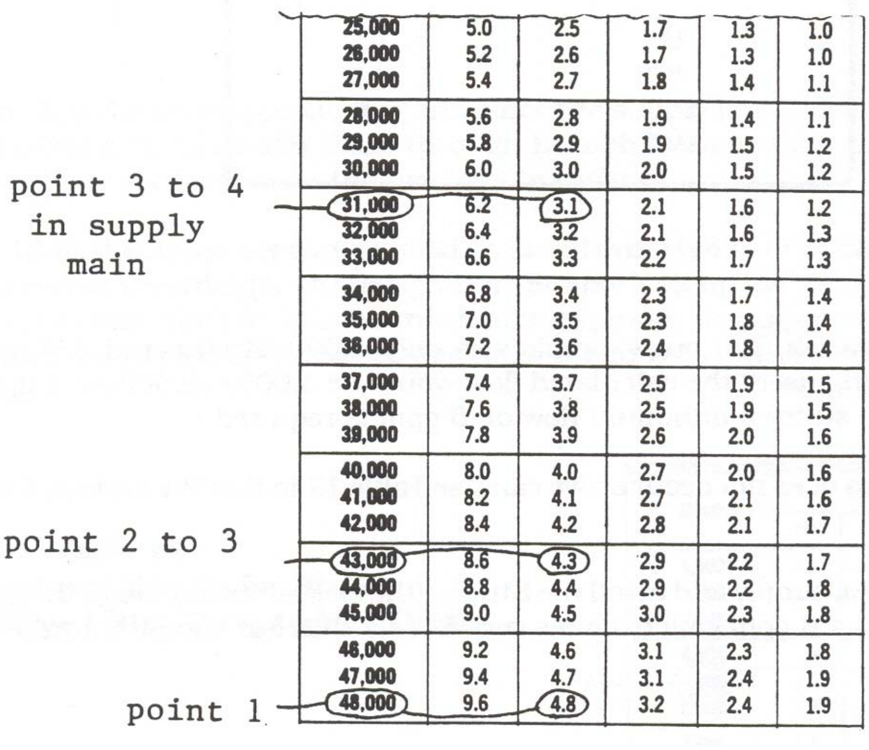
44,000	8.8	4.4	2.9	2.2	1.8
45,000	9.0	4.5	3.0	2.3	1.8
46,000	9.2	4.6	3.1	2.3	1.8
47,000	9.4	4.7	3.1	2.4	1.9
48,000	9.6	4.8	3.2	2.4	1.9

To find the gpm for each section in the supply main, simply detect the heat output of each terminal and read the appropriate gpm for the remaining load.

47,800 (total load) - 5,200 (Branch A) = 42,600 Btu\hr
From the table: gpm is 4.3 (point 2 to 3)

42,600 - 11,400 (Branch B) = 31,200 Btu\hr
From the table: gpm is 3.1 (point 3 to 4)

31,200 - 23,000 (Branch C) = 8,200 Btu\hr
From the table: gpm is .8 (point 4 to 5) See top of Table 12, page 4)



25,000	5.0	2.5	1.7	1.3	1.0
26,000	5.2	2.6	1.7	1.3	1.0
27,000	5.4	2.7	1.8	1.4	1.1
28,000	5.6	2.8	1.9	1.4	1.1
29,000	5.8	2.9	1.9	1.5	1.2
30,000	6.0	3.0	2.0	1.5	1.2
31,000	6.2	3.1	2.1	1.6	1.2
32,000	6.4	3.2	2.1	1.6	1.3
33,000	6.6	3.3	2.2	1.7	1.3
34,000	6.8	3.4	2.3	1.7	1.4
35,000	7.0	3.5	2.3	1.8	1.4
36,000	7.2	3.6	2.4	1.8	1.4
37,000	7.4	3.7	2.5	1.9	1.5
38,000	7.6	3.8	2.5	1.9	1.5
39,000	7.8	3.9	2.6	2.0	1.6
40,000	8.0	4.0	2.7	2.0	1.6
41,000	8.2	4.1	2.7	2.1	1.6
42,000	8.4	4.2	2.8	2.1	1.7
43,000	8.6	4.3	2.9	2.2	1.7
44,000	8.8	4.4	2.9	2.2	1.8
45,000	9.0	4.5	3.0	2.3	1.8
46,000	9.2	4.6	3.1	2.3	1.8
47,000	9.4	4.7	3.1	2.4	1.9
48,000	9.6	4.8	3.2	2.4	1.9

Remember: Table 12 cannot be used to determine gpm in supply mains when branch flow rates are (artificially) adjusted to maintain a minimum flow which is higher than the flow computed based on Btu requirements.

Return mains can be computed the same way, only flow rates from branches are added together since the flow is merging rather than diverging at each junction.