

The Gifford Method for Simplified Pipe and Pump sizing

By Henry Gifford

You can use this book to easily find out what size pipe or pump you need for a job.

Design decisions can be based on fear or ambition. Fear of a system not working usually leads to lousy performance because of horribly oversized pipes and pumps, with flow balancing attempted by random balancing valves. Ambition to improve performance and reduce installation cost leads to installing the smallest piping and pump that can do the job, ambition to reduce operating costs leads to installing the smallest pump possible, and ambition to avoid service calls means avoiding random balancing methods such as valves partly closed that someone fools with later.

Finding out what size pump and pipe will work best for a particular job can only be done by calculations. Previous methods were so complicated that they were not practical to use without a computer, so most people didn't bother doing any better than guessing. Rules of thumb make people sound smart but don't work. The real secret is hard work, and that just got a lot easier with the introduction of this new calculating method.

The steps involved in the Gifford method are:

1 - Draw a simple diagram of the planned or installed piping system.

2 - Write on the drawing the length and size of the pipes installed or that you plan to install. If you don't know what size pipe to use go from your experience or best guess and then calculate what the best size would be. (Later, when you get more used to this method you can skip guessing at size).

3 - Add up the length of all the pipe from the pump out around the loop and back to the pump.

4 - Use the charts on pages 10 - 19 to convert the pipe length to a flow value - called **CV** on the chart.

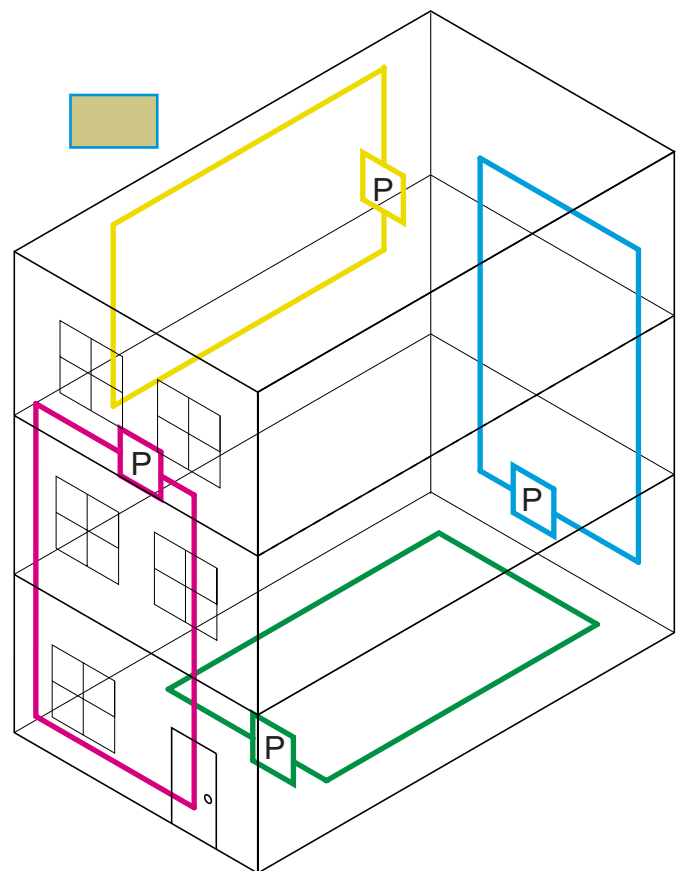
5 - Look at that **CV** number on the pump chart on page 21 to see how much water will flow with what pump.

More complicated piping arrangements will be explained later.

Here's how to use this method: First draw a simple sketch of the piping system.

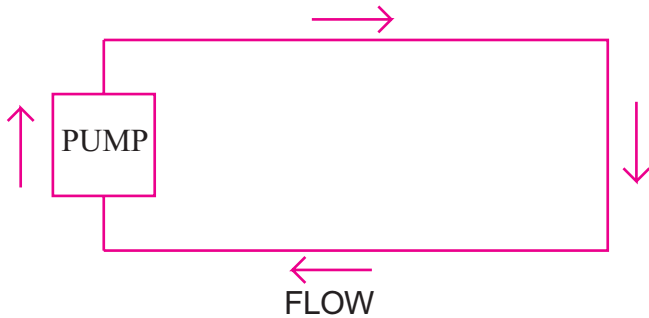


You can draw the piping system upside down or right side up - it doesn't matter because up and down don't effect how much friction there is from water moving through the piping.

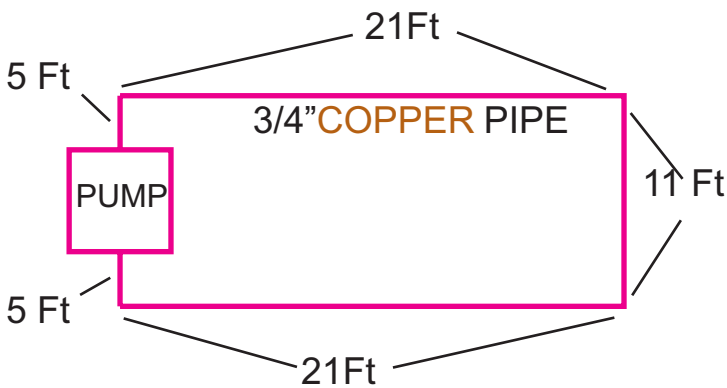


All 4 of the piping systems shown above can be drawn the same for purposes of calculating the flow. If each of the pipe loops are the same length and pipe size (1/2", etc) then the same brand and model of pump installed in each loop will move the same amount of water in each loop. Pressure gauges installed near each pump would show different readings because the height of the water is different, but the flows would be exactly the same.

It can help to draw 1 or more arrows to show the direction of water flow through the piping. This is partly because some valves and other things require flow in one direction only, and partly because showing the direction of flow helps keep things organized in your mind. It's easy to get confused about where the water is flowing and what is connected to what, so anything that can reduce mistakes is helpful.



Write down the sizes and lengths of all the pipe in the loop. It can help if you use different color pens or pencils because the drawing will get crowded. In this book the pipes are Red, the pipe lengths are Black, and the flow values are Blue.



Add up the lengths of all the

5 Ft
 21 Ft
 11 Ft
 21 Ft
 5 Ft

 63 Ft Total

This means that the water will travel 63 feet from the pump outlet through the pipe and back to the pump inlet. Longer pipe means more friction, shorter pipe means less friction. The same pump would move more water in a shorter loop and less water in a longer loop because of the difference in friction. More water is another way of saying the same water would be going around the loop faster.

The length of straight pipe is not the only thing that slows the water down. Elbows and other changes in size or shape also slow the water down. An elbow slows the water down as much as a few feet of pipe. The chart on page 20 shows how many feet of pipe would slow water down as much as an elbow, valve, tee, etc. The chart is called Equivalent Feet of Pipe because the friction in an elbow is equivalent to a certain number of feet of pipe, an open valve is equivalent to another number of feet of pipe depending on it's shape, etc.

So the length of pipe that is equivalent to the 4 elbows should get added to the 63 Feet of pipe. Since the chart on page 20 shows that a 3/4" Copper elbow is equivalent to 2 Feet of pipe that means:

8 Ft (4 Elbows x 2 Ft Equivalent each)
 5 Ft
 21 Ft
 11 Ft
 21 Ft

 71 Ft Total

So the total for the loop including elbows is 71 feet of 3/4" Copper pipe. This number of feet of pipe including equivalent pipe for elbows, etc. is sometimes called "developed length" or "total equivalent length".

More complicated examples including tees, valves that open and close, etc. will be shown later.

The next step is to look on the CV chart on pages 10- 19 to find the flow capacity for that length and size of pipe. The flow capacity is called the CV.

CV 1/2" 3/4"

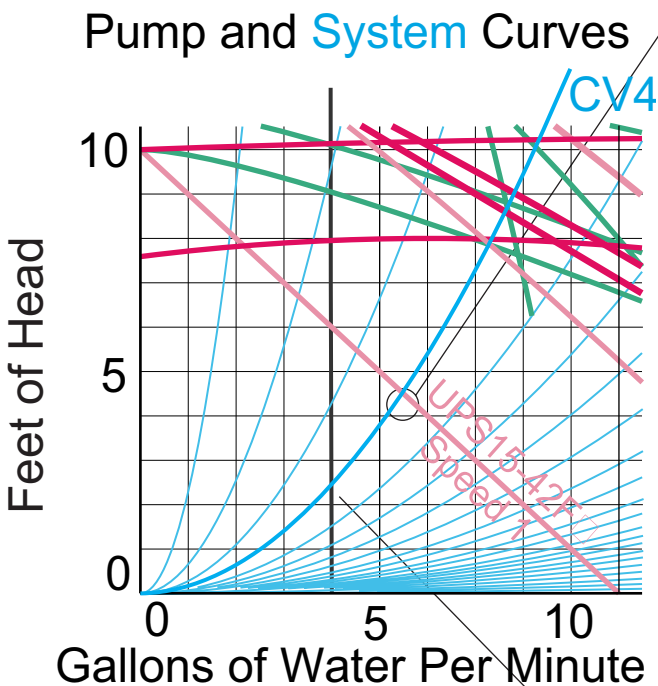
3.7		79	82
3.75	12	77	80
3.8		75	78
3.85		73	76
3.9		71	74
3.95	11	70	72
4	16	68	70

On page 11 look for 71 ft. of 3/4" Copper. The Copper colored numbers are for Copper pipe, the black numbers are for Steel pipe. Look in the CV column and find the CV value. It's 3.9 for 71 ft. of Copper.

What does it mean that the CV for 71 Feet of 3/4" Copper pipe is 3.9? Technically speaking a CV of 3.9 means that 3.9 gallons of water per minute will flow through that piping at a pressure difference of exactly 1 PSI. (Pound per Square Inch). To an engineer it means that you can calculate how much friction results from a known flow through that pipe.

But people don't buy pumps to create friction in piping, they buy pumps to move water. Practically speaking the CV means that you can look up how much water will flow through that piping with a certain pressure or pump. Here's how to look it up:

Suppose the piping is a loop of heating baseboard and you want 4 gallons of water per minute flowing through the pipe so you can get the baseboard manufacturer's heat output at the 4 GPM rating. Look on the pump chart on page 21 and find the CV line closest to 3.9 - it's the CV line for CV4.



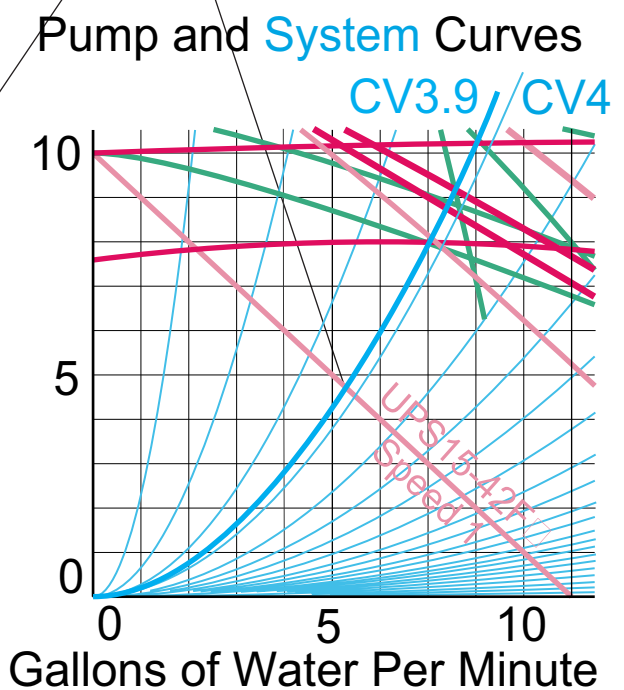
Look for where the CV4 line crosses the 4GPM line (4GPM because that's how much water flow we want). The numbers on the left show how much friction (feet of head) will be in the system when water flows at 4GPM - about 2.5 feet of head. This tells us how strong the pump needs to be to move 4 GPM.

To find out how much water a certain model of pump moves in this system look where the CV4 line crosses a pump line (curve). The closest pump curve that crosses the CV4 line is for a Grundfos UPS15-42F.

Notice that the curve for the Grundfos UPS15-42F crosses the CV4 line (curve) over to the right of the 4GPM line. This means that pump will pump more than 4GPM in that pipe loop. How much more?

Look at the GPM lines near where the CV4 curve and the pump curve meet. It's right between 5 and 6 gallons per minute - about 5.5GPM.

But don't forget that the CV was 3.9, not 4. So look a little to the left of the CV4 curve - about 10% of the way towards the CV3 curve. You'll see that if there was a curve drawn for CV3.9 it would cross the pump curve a little closer to the 5GPM line - at about 5.25 GPM.



This means that a Grundfos UPS15-42F set on speed 1 and installed in a loop of 63 feet of 3/4" Copper plus 4 elbows will move about 5.25 Gallons of water per minute.

This is it - about 5.25 gallons will flow per minute no matter what anyone else or their rules of thumb try to tell you.

If you want only 4 GPM buy a smaller pump, but none smaller are available in Iron and there's no reason to spend money on a Bronze pump for a heating system. A real baseboard heating system like this would probably have a zone valve or a flow-check valve installed which would slow the water down to about 4GPM anyway.

Here's how to figure out what happens in a system with a flow-check or other type of valve installed:

Look on the chart on page 20 and see if the valve you are interested in using is listed. Suppose you want a Honeywell brand zone valve that solders (sweats) into 3/4" Copper and operates on 24 Volt power - easier than running 110 Volt power. Assuming you also want an end switch to control something else, and you also want wires to connect to instead of screws. That leaves you a choice between the two Honeywell models described below:

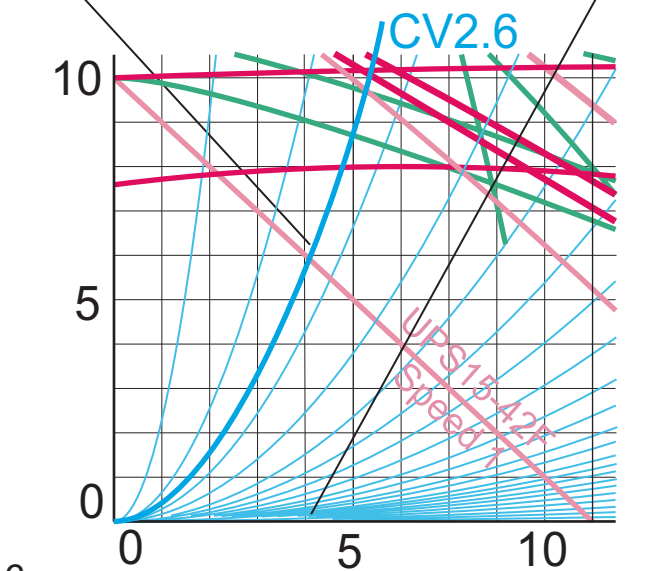
- V8043E1012 = 89 Feet of 3/4" Copper
- V8043E1061 = 17 Feet of 3/4" Copper

The equivalent lengths of 3/4" Copper pipe for the valves shown above came from the chart on page 20. Notice that choosing a different zone valve makes a big difference in equivalent pipe length.

The V8043E1012 is probably more readily available, and would therefore likely be the one you would use.

63 Feet Straight Lengths of Pipe
 8 Feet Four Elbows
 89 Feet Honeywell V8043E1012
 160 Feet Total

Next look up 160 Feet of 3/4" Copper on the CV chart on page 11. You'll see CV2.6 is closest so use it. Look at where a CV2.6 line would cross the pump curve and see the gallons down below - about 4.



So this means that a Grundfos UPS15-42F pump installed in a loop of 63 Feet of 3/4" Copper pipe with 4 elbows and a Honeywell zone valve model #V8043E1012 will pump about 4 gallons per minute. That's very different than the 5.25 gallons per minute that would circulate without the zone valve.

How could you even hope to guess at a thing like this? A different model of 3/4" sweat zone valve might be equivalent to anywhere from 17 to 89 feet of 3/4" Copper and you have no way of knowing unless you look it up.

What do you do if the zone valve you are using is not on the (short) list in this book? Just look up the CV value in the manufacturer's literature.

Take for example a Bell & Gossett 3/4" sweat zone valve model #CTS-7524. The manufacturer's literature says it has a CV of 2.57. You can look it up on the CV chart to find the equivalent feet to use in your calculations.

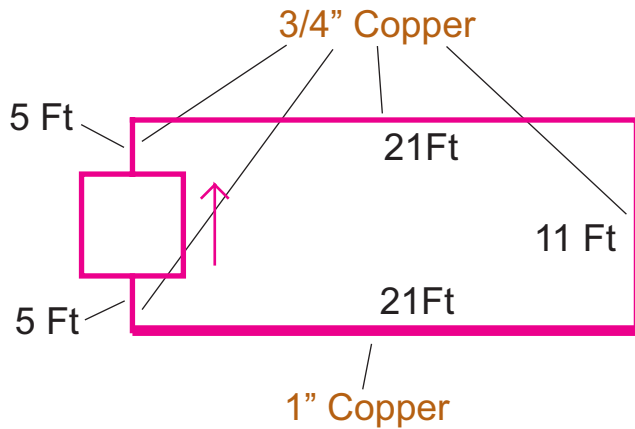
Looking on page 11 for CV2.57 we find the closest CV value is 2.55, so the zone valve is equivalent to about 167 Feet of 3/4" Copper Pipe.

CV	1/2"	3/4"
2.5	27 41	174 180
2.55	26 39	167 173
2.6	25 38	161 167
2.65	24 36	155 161
2.7	23 35	149 155
2.75	34	143 149

So to figure out how much water will flow through the system you add 167 feet of Copper pipe to all the other lengths of pipe, look up the CV for the total, and then look at that CV line on the pump chart on page 21 to see how much water will flow with what pump.

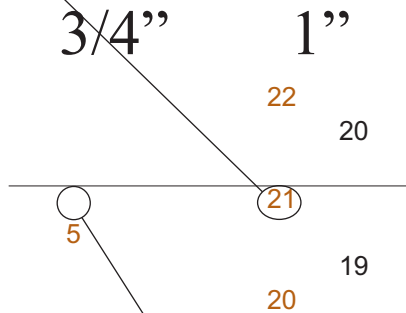
The same technique works for strainers, air separators, and any other piping part for which you know or can figure out the CV value or equivalent length of pipe.

Now here's an example of a piping system with mixed pipe sizes.



You add up all the equivalent lengths just like before, but this time you first convert everything to equivalent lengths in one size. You can convert everything to 1" if you want, but it's probably easier to use 3/4" because most of the system is already 3/4".

You convert the 21 Feet of 1" Copper to 3/4" Copper by using the CV chart again. On page 14 you find 21 feet of 1" Copper on the chart.



Look across to the equivalent length of 3/4" Copper and you see a blank spot just above 5. This means 21 Feet of 1" Copper is equivalent to just a bit more than 5 Feet of 3/4" Copper, but don't worry about being accurate to the nearest Inch. Just use 5 Feet.

So here's how you add up the pipe:

5	Feet of 3/4" Copper
21	Feet of 3/4" Copper
11	Feet of 3/4" Copper
5	Feet of 3/4" Copper (21 ft of 1")
+5	Feet of 3/4" Copper
<hr/>	
47	Feet of 3/4" Copper Total

So the loop of some 3/4" Copper mixed with some 1" Copper adds up to 47 Feet of 3/4" Copper.

This technique can be used in any situation where the pipe sizes are mixed. If a 1" zone valve is used with 3/4" pipe just look up the CV of the valve, and convert over to 3/4" Copper or whatever size pipe you are using for your calculations.

How do you deal with a system that has tees?

Easy. Here's an example. A Taco 007F was pumping water through about 70 Feet of 3/4" Copper baseboard. The loop of piping included the 70 feet of 3/4" Copper baseboard, about another 70 feet of 3/4" Copper bringing the water from the boiler room to the end of the baseboard, about twenty 90 Degree elbows, and four 45 degree elbows. There was also a 3/4" sweat flow-check valve installed to prevent convective circulation in the summer.

The system was installed for a day or two when the customer called and asked about putting some heat in the bathroom. Sure, why not. Just add another pump, and another Flow-check, etc, but what about installing a thermostat in the bathroom? An electric thermostat next to the shower? Not such a great idea.

A non-electric thermostatic radiator valve would solve the control problem. I could pipe the bathroom loop off tees in the existing loop and save installing another pump, flow-check, wiring, etc. I didn't worry about the non-electric thermostat calling for heat when the main loop was off because the main loop already had controls that kept it on almost constantly.

Calculations were needed to find out if the existing Taco 007F pump could supply both loops together, and also to find out what size pipe I needed.

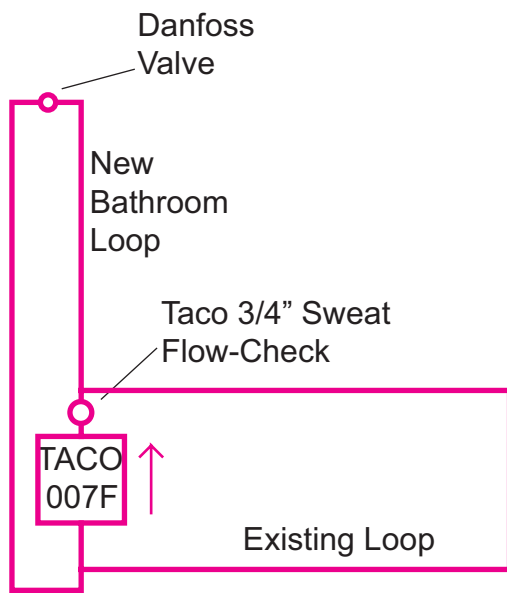
Asking around about how to do this yielded answers such as:

"The pressure drop is determined by the length of the longest loop" (Definitely not true!)

"Add a balancing valve" This is a valve partly closed by hand. How far closed? Who knows? Listen to the complaints and keep going back, then somebody fools with the setting. Not me, I don't want my beeper going off every time someone fools with a "balancing valve" that should really be called a "random balancing valve".

I had already bought a computer program that could figure this stuff out, but the program seemed too complicated for me to use. So I invented this method.

- 1 - Add up the equivalent lengths of pipe between each tee.
- 2 - Convert each equivalent length to a CV value.
- 3 - Add the CV values of each piping branch to get a total CV for all the piping between the tees.



First add up all the equivalent resistances:
Existing Loop -

140 Feet of 3/4" Copper Pipe (70 +70)
40 Feet of 3/4" Copper (20 Elbows)
+ 6 Feet of 3/4" Copper (4 45 El-
186 Feet of 3/4" Copper Total

The 40 feet figure came from multiplying the number of 90 degree elbows by the equivalent feet for each elbow as shown on the chart on page 20: 2 Feet each. The four 45 Degree elbows were each multiplied by the 1.5 factor also from the chart on page 20.

The 70 feet of baseboard element is figured the same as regular 3/4" Copper pipe - because it's made of 3/4" Copper pipe.

I hoped to save some money by using 1/2" Copper to supply four feet of 3/4" Copper baseboard in the bathroom. I had heard the rule of thumb about never supplying 3/4" baseboard with 1/2" Copper, but I figured it couldn't hurt to calculate it out.

There was about a 100 feet (50 Feet over, 50 Feet back) run over to the bathroom with about 6 el-

Here's the bathroom supply piping in 1/2":

100 Feet of 1/2" Copper Pipe
6 Feet of 1/2" Copper Pipe (elbows)

But what about the different pipe sizes? It would be easier to calculate if it was all 3/4" Copper, but I was too proud to spend my money on larger pipe just to make the calculations easier. I calculated both the 1/2" and the 3/4" parts in 3/4" Copper equivalents because the rest of the system was 3/4" Copper.

The CV chart on page 10 shows that the 106 Feet of 1/2" Copper from above is equivalent to about 695 Feet of 3/4" Copper pipe.

I chose a 3/4" sweat Danfoss thermostatic valve model #013G8044 (solder type). Looking in the manufacturer's literature shows the valve has a CV of 2.7. Looking on page 11 of the CV chart shows CV2.7 is equivalent to 149 Feet of 3/4" Copper.

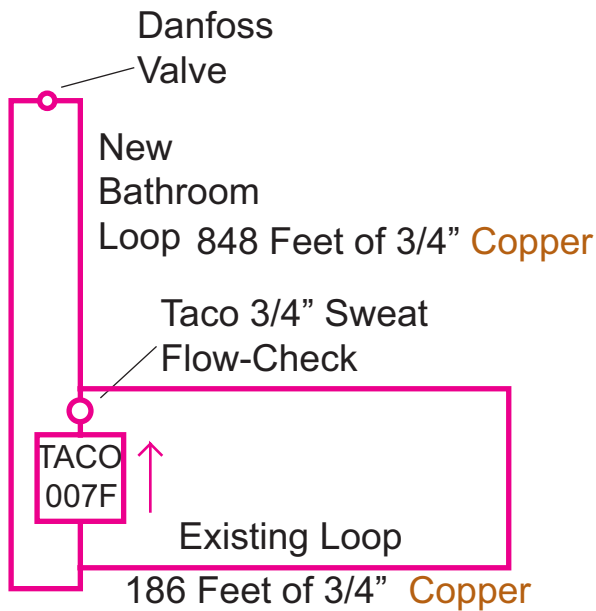
Then of course there's the 4 Feet of 3/4" Copper baseboard element. Here's the addition:

695 Feet of 3/4" Copper (1/2" & elbows)
149 Feet of 3/4" Copper (Danfoss)
848 Feet of 3/4" Copper Total

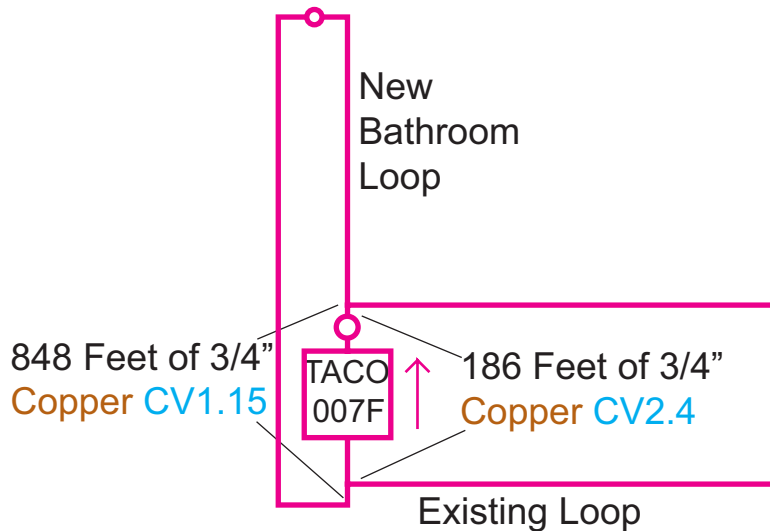
The Taco 3/4" Sweat Flow-check valve is shown on the chart on page 20 to be equivalent to 27 Feet of 3/4" Copper pipe, and the short pieces of pipe between the tees & the pump bring it up to about 30 Feet. The water didn't flow through the boiler - it was a Weil-Mclain GV boiler piped so the water goes around it. Otherwise a few feet should be added for the boiler. Most Cast Iron boilers have low friction, the newer Copper boilers have more friction.

Next the equivalent lengths should be written on the diagram to keep things straight.

Notice that the diagram doesn't actually show all the elbows. Why spend your time drawing them? Just put in their equivalent lengths.



Next write the CV values for each loop between tees on the diagram. Look up the CV values on the CV chart just like before. Now we'll skip some labels to make room on the diagram.



Now you have enough information to treat the waterflow from one tee around both loops to the other tee as one piece of pipe! Just add the two CV values to each other. $CV2.4 + CV1.15 = CV3.55$. $CV3.55$ describes the flow characteristics of both pipe branches between the tees acting as one.

From this point on you can figure out the rest of the system treating the two branches as one piece of pipe!

Figuring as if we have one piece of pipe (the two loops) with a CV value of 3.55, the chart on page 11 shows that it is equivalent to 86 feet of 3/4" Copper pipe.

To finish the calculation for the whole system we add the equivalent lengths:

$$\begin{aligned} &86 \text{ Feet of } 3/4" \text{ Copper (two loops)} \\ &+ 30 \text{ Feet of } 3/4" \text{ Copper (Flow check,)} \\ &\hline &116 \text{ Feet of } 3/4" \text{ Copper pipe Total} \end{aligned}$$

The CV for the whole system can be found by looking it up next to 116 Feet of 3/4" Copper pipe on the chart on page 11. It's about CV3.05. Looking on the pump chart we see that a Taco 007 will move about 6 gallons of water per minute in this system.

Is 6 Gallons per minute enough to heat both loops?

Here's how to figure out how much will flow in each branch: 6 Gallons per minute goes into the inlet of the tee and flows out the outlets in percents according to the CV values of each branch.

$CV2.4$ (Main loop) + $CV1.15$ (bathroom) = $CV3.55$ (total). The amount of water flowing through the bathroom is $1.15/3.55 = 32\%$ of the total. (This is the only part where you might want a calculator, but you don't need it.) The other 68% ($2.4/3.55$) of the flow will go through the main loop.

32% of 6 Gallons is $(.32 \times 6)$ 1.9 GPM which is more than the baseboard's 1 GPM minimum, and the main loop will get the other $(6-1.9)$ 4.1 GPM This is enough flow with a substantial margin for solder in elbows, worn pump, etc.

What happens when the thermostatic valve closes? Then it's as if the bathroom loop were not there and there was just the 30 Feet through the flow-check plus the 186 Feet for the existing loop = 216 Feet of 3/4" Copper which has a CV of 2.25 which means the Taco 007F would move about 4.5 Gallons per Minute in the main loop - within acceptable limits.

Chart Converting Pipe Length to CV

CV 1/2" 3/4"

0.5	681	1024	4341	4512						
0.53	618	929	3937	4092						
0.55	563	846	3587	3729						
0.58	515	774	3282	3412						
0.6	473	711	3014	3133						
0.63	436	655	2778	2888						
0.65	403	606	2568	2670						
0.68	374	562	2382	2476						
0.7	348	522	2215	2302						
0.72	324	487	2065	2146						
0.75	303	455	1929	2005						
0.78	284	426	1807	1878						
0.8	266	400	1696	1762						
0.83	250	376	1594	1657						
0.85	236	354	1502	1561						
0.88	222	334	1417	1473						
0.9	210	316	1340	1393						
0.93	199	299	1268	1318						
0.95	189	284	1202	1250						
0.97	179	269	1142	1187						
					1"	1 1/4"	1 1/2"			
1	170	256	1085	1128	4410	4100	11832	16888	29348	38240
1.05	154	232	984	1023	4000	3719	10732	15318	26620	34685
1.1	141	212	897	932	3645	3388	9778	13957	24255	31603
1.15	129	194	821	853	3335	3100	8947	12770	22191	28915
1.2	118	178	754	783	3063	2847	8217	11728	20381	26555
1.25	109	164	695	722	2822	2624	7572	10808	18783	24473
1.3	101	151	642	667	2610	2426	7001	9993	17366	22627
1.35	93	140	595	619	2420	2250	6492	9266	16103	20982
1.4	87	131	554	575	2250	2092	6037	8616	14974	19510
1.45	81	122	516	536	2098	1950	5628	8032	13959	18188
1.5	76	114	482	501	1960	1822	5259	7506	13044	16995
1.55	71	107	452	470	1836	1706	4925	7029	12216	15917
1.6	67	100	424	441	1723	1601	4622	6597	11464	14937
1.65	63	94	399	414	1620	1506	4346	6203	10780	14046
1.7	59	89	375	390	1526	1419	4094	5844	10155	13232
1.75	56	84	354	368	1440	1339	3863	5514	9583	12486
1.8	53	79	335	348	1361	1265	3652	5212	9058	11802
1.85	50	75	317	330	1289	1198	3457	4934	8575	11173
1.9	47	71	301	312	1222	1136	3278	4678	8130	10593
1.95	45	67	285	297	1160	1078	3112	4441	7718	10056
2	43	64	271	282	1103	1025	2958	4222	7337	9560
2.05	41	61	258	268	1049	976	2815	4019	6984	9099
2.1	39	58	246	256	1000	930	2683	3829	6655	8671
2.15	37	55	235	244	954	887	2560	3653	6349	8273
2.2	35	53	224	233	911	847	2445	3489	6064	7901
2.25	34	51	214	223	871	810	2337	3336	5797	7554
2.3	32	48	205	213	834	775	2237	3192	5548	7229
2.35	31	46	197	204	799	742	2142	3058	5314	6924
2.4	30	44	188	196	766	712	2054	2932	5095	6639
2.45	28	43	181	188	735	683	1971	2813	4889	6371
2.5	27	41	174	180	706	656	1893	2702	4696	6118

Chart Converting Pipe Length to CV

CV 1/2" 3/4" 1" 1 1/4" 1 1/2" 2"

2.5	27	41	174	180	706	656	1893	2702	4696	6118	20458	23587
2.55	26	39	167	173	678	630	1820	2597	4513	5881	19664	22671
2.6	25	38	161	167	652	606	1750	2498	4341	5657	18915	21808
2.65	24	36	155	161	628	584	1685	2405	4179	5445	18208	20992
2.7	23	35	149	155	605	562	1623	2317	4026	5246	17540	20222
2.75		34	143	149	583	542	1565	2233	3881	5057	16908	19493
2.8	22	33	138	144	563	523	1509	2154	3743	4878	16309	18803
2.85	21	32	134	139	543	505	1457	2079	3613	4708	15742	18149
2.9	20	30	129	134	524	487	1407	2008	3490	4547	15204	17529
2.95		29	125	130	507	471	1360	1941	3372	4394	14693	16940
3	19	28	121	125	490	456	1315	1876	3261	4249	14207	16380
3.05			117	121	474	441	1272	1815	3155	4111	13745	15847
3.1	18	27	113	117	459	427	1231	1757	3054	3979	13305	15340
3.15	17	26	109	114	444	413	1192	1702	2958	3854	12886	14857
3.2		25	106	110	431	400	1155	1649	2866	3734	12487	14396
3.25	16	24	103	107	418	388	1120	1599	2779	3620	12106	13957
3.3			100	104	405	376	1086	1551	2695	3511	11741	13537
3.35	15	23	97	101	393	365	1054	1505	2615	3407	11394	13136
3.4		22	94	98	381	355	1024	1461	2539	3308	11061	12753
3.45			91	95	371	344	994	1419	2466	3213	10743	12386
3.5	14	21	89	92	360	335	966	1379	2396	3122	10438	12034
3.55			86	90	350	325	939	1340	2329	3034	10146	11698
3.6	13	20	84	87	340	316	913	1303	2265	2951	9866	11375
3.65		19	81	85	331	308	888	1268	2203	2870	9598	11065
3.7			79	82	322	299	864	1234	2144	2793	9340	10768
3.75	12	18	77	80	314	292	841	1201	2087	2719	9093	10483
3.8			75	78	305	284	819	1170	2032	2648	8855	10209
3.85			73	76	298	277	798	1139	1980	2580	8626	9946
3.9		17	71	74	290	270	778	1110	1930	2514	8407	9692
3.95	11		70	72	283	263	758	1082	1881	2451	8195	9448
4		16	68	70	276	256	739	1055	1834	2390	7992	9214
4.05			66	69	269	250	721	1030	1789	2331	7795	8988
4.1			65	67	262	244	704	1005	1746	2275	7606	8770
4.15	10	15	63	65	256	238	687	981	1704	2220	7424	8560
4.2			62	64	250	232	671	957	1664	2168	7249	8357
4.25			60	62	244	227	655	935	1625	2117	7079	8162
4.3		14	59	61	239	222	640	913	1587	2068	6915	7973
4.35	9		57	60	233	217	625	892	1551	2021	6757	7791
4.4			56	58	228	212	611	872	1516	1975	6605	7615
4.45		13	55	57	223	207	597	853	1482	1931	6457	7444
4.5			54	56	218	202	584	834	1449	1888	6314	7280
4.55			52	54	213	198	572	816	1418	1847	6176	7121
4.6	8	12	51	53	208	194	559	798	1387	1807	6043	6967
4.65			50	52	204	190	547	781	1357	1769	5914	6818
4.7			49	51	200	186	536	765	1329	1731	5788	6674
4.75			48	50	195	182	524	748	1301	1695	5667	6534
4.8		11	47	49	191	178	514	733	1274	1660	5550	6398
4.85			46	48	187	174	503	718	1248	1626	5436	6267
4.9			45	47	184	171	493	703	1222	1593	5325	6140
4.95	7		44	46	180	167	483	689	1198	1561	5218	6016
5			43	45	176	164	473	676	1174	1530	5115	5897

Chart Converting Pipe Length to CV

CV 1/2" 3/4" 1" 1 1/4" 1 1/2" 2" 2 1/2"

5		43	45	176	164	473	676	1174	1530	5115	5897	15949	15136		
5.05	10		44	173	161	464	662	1151	1499	5014	5781	15635	14837		
5.1		42	43	170	158	455	649	1128	1470	4916	5668	15330	14548		
5.15		41		166	155	446	637	1107	1442	4821	5558	15034	14267		
5.2		40	42	163	152	438	625	1085	1414	4729	5452	14746	13994		
5.25		39	41	160	149	429	613	1065	1387	4639	5349	14467	13728		
5.3			40	157	146	421	601	1045	1361	4552	5248	14195	13471		
5.35	6	9		38		154	143	413	590	1025	1336	4467	5150	13931	13220
5.4			37	39	151	141	406	579	1006	1311	4385	5056	13674	12976	
5.45			38		148	138	398	569	988	1287	4305	4963	13424	12739	
5.5			36	37	146	136	391	558	970	1264	4227	4873	13181	12509	
5.55			35		143	133	384	548	953	1241	4151	4786	12945	12284	
5.6				36	141	131	377	539	936	1219	4077	4701	12715	12066	
5.65	8		34		138	128	371	529	919	1198	4005	4618	12491	11853	
5.7				35	136	126	364	520	903	1177	3936	4537	12273	11646	
5.75			33	34	133	124	358	511	888	1157	3867	4459	12060	11445	
5.8			32		131	122	352	502	872	1137	3801	4382	11853	11248	
5.85	5			33	129	120	346	493	858	1117	3736	4308	11651	11057	
5.9				31	127	118	340	485	843	1099	3673	4235	11455	10870	
5.95				32	125	116	334	477	829	1080	3612	4164	11263	10688	
6			30		123	114	329	469	815	1062	3552	4095	11076	10511	
6.05	7			31	120	112	323	461	802	1045	3493	4028	10894	10338	
6.1				29	119	110	318	454	789	1028	3436	3962	10716	10169	
6.15				30	117	108	313	447	776	1011	3381	3898	10542	10004	
6.2					115	107	308	439	763	995	3326	3835	10373	9844	
6.25			28	29	113	105	303	432	751	979	3273	3774	10208	9687	
6.3					111	103	298	425	739	963	3222	3714	10046	9534	
6.35			27	28	109	102	293	419	728	948	3171	3656	9889	9384	
6.4					108	100	289	412	717	934	3122	3599	9735	9238	
6.45			26	27	106	99	284	406	705	919	3073	3544	9584	9095	
6.5	4				104	97	280	400	695	905	3026	3489	9438	8956	
6.55		6			103	96	276	394	684	891	2980	3436	9294	8820	
6.6			25	26	101	94	272	388	674	878	2935	3384	9154	8687	
6.65					100	93	268	382	664	865	2891	3334	9017	8556	
6.7			24	25	98	91	264	376	654	852	2848	3284	8883	8429	
6.75					97	90	260	371	644	839	2806	3236	8751	8305	
6.8					95	89	256	365	635	827	2765	3188	8623	8183	
6.85			23	24	94	87	252	360	625	815	2725	3142	8498	8064	
6.9					93	86	249	355	616	803	2686	3096	8375	7948	
6.95					91	85	245	350	608	792	2647	3052	8255	7834	
7			22	23	90	84	241	345	599	780	2609	3009	8137	7722	
7.05					89	82	238	340	590	769	2573	2966	8022	7613	
7.1					87	81	235	335	582	759	2536	2924	7910	7506	
7.15	5			22	86	80	231	330	574	748	2501	2884	7800	7402	
7.2				21	85	79	228	326	566	738	2467	2844	7692	7299	
7.25					84	78	225	321	558	728	2433	2805	7586	7199	
7.3					83	77	222	317	551	718	2399	2766	7482	7101	
7.35			20	21	82	76	219	313	543	708	2367	2729	7381	7004	
7.4					81	75	216	308	536	698	2335	2692	7282	6910	
7.45					79	74	213	304	529	689	2304	2656	7184	6818	
7.5				20	78	73	210	300	522	680	2273	2621	7089	6727	

Chart Converting Pipe Length to CV

CV 1/2" 3/4" 1" 1 1/4" 1 1/2" 2" 2 1/2"

7.5		20	78	73	210	300	522	680	2273	2621	7089	6727
7.55	3	19	77	72	208	296	515	671	2243	2586	6995	6638
7.6			76	71	205	292	508	662	2214	2552	6903	6551
7.65			75	70	202	289	501	653	2185	2519	6813	6466
7.7		19	74	69	200	285	495	645	2157	2486	6725	6382
7.75		18	73	68	197	281	489	637	2129	2454	6639	6300
7.8				67	194	278	482	629	2102	2423	6554	6219
7.85			72		192	274	476	621	2075	2392	6471	6140
7.9		18	71	66	190	271	470	613	2049	2362	6389	6063
7.95			70	65	187	267	464	605	2023	2332	6309	5987
8	4	17	69	64	185	264	459	597	1998	2303	6230	5912
8.05			68	63	183	261	453	590	1973	2275	6153	5839
8.1			67		180	257	447	583	1949	2247	6077	5767
8.15		17	66	62	178	254	442	576	1925	2219	6003	5697
8.2				61	176	251	436	569	1902	2192	5930	5627
8.25		16	65	60	174	248	431	562	1879	2166	5858	5559
8.3			64		172	245	426	555	1856	2140	5788	5493
8.35			63	59	170	242	421	548	1834	2114	5719	5427
8.4		16		58	168	239	416	542	1812	2089	5651	5363
8.45			62		166	237	411	536	1791	2065	5584	5299
8.5		15	61	57	164	234	406	529	1770	2040	5519	5237
8.55			60	56	162	231	401	523	1749	2017	5454	5176
8.6					160	228	397	517	1729	1993	5391	5116
8.65		15	59	55	158	226	392	511	1709	1970	5329	5057
8.7			58	54	156	223	388	505	1689	1948	5268	4999
8.75					155	221	383	499	1670	1925	5208	4942
8.8		14	57	53	153	218	379	494	1651	1904	5149	4886
8.85			56		151	216	375	488	1633	1882	5091	4831
8.9				52	149	213	371	483	1614	1861	5034	4777
8.95			55	51	148	211	366	477	1596	1840	4978	4724
9		14			146	208	362	472	1579	1820	4923	4671
9.05			54	50	144	206	358	467	1561	1800	4868	4620
9.1			53		143	204	354	462	1544	1780	4815	4569
9.15		13		49	141	202	351	457	1527	1761	4763	4520
9.2			52		140	200	347	452	1511	1742	4711	4471
9.25	2 3			48	138	197	343	447	1494	1723	4660	4422
9.3		13	51		137	195	339	442	1478	1704	4610	4375
9.35				47	135	193	336	437	1463	1686	4561	4328
9.4			50		134	191	332	433	1447	1668	4513	4282
9.45				46	132	189	329	428	1432	1651	4465	4237
9.5		12	49		131	187	325	424	1417	1633	4418	4193
9.55				45	130	185	322	419	1402	1616	4372	4149
9.6			48		128	183	318	415	1387	1600	4327	4106
9.65				44	127	181	315	411	1373	1583	4282	4063
9.7		12	47		126	179	312	406	1359	1567	4238	4022
9.75				43	124	178	309	402	1345	1551	4194	3980
9.8			46		123	176	306	398	1331	1535	4152	3940
9.85					122	174	302	394	1318	1519	4110	3900
9.9			45	42	121	172	299	390	1305	1504	4068	3861
9.95		11			120	171	296	386	1292	1489	4028	3822
10			44	41	118	169	293	382	1279	1474	3987	3784

Chart Converting Pipe Length to CV

CV 1/2" 3/4" 1" 1 1/4" 1 1/2" 2" 2 1/2"

10			44 41	118 169	293 382	1279 1474	3987 3784
10.1		11	43 40	116 166	288 375	1253 1445	3909 3709
10.2			42	114 162	282 368	1229 1417	3833 3637
10.3			39	112 159	277 360	1205 1390	3758 3567
10.4		10	41 38	109 156	271 354	1182 1363	3687 3498
10.5			40 37	107 153	266 347	1160 1337	3617 3432
10.6		10	39	105 150	261 340	1138 1312	3549 3368
10.7			36	103 148	256 334	1117 1288	3483 3305
10.8			38 35	101 145	252 328	1096 1264	3419 3244
10.9			37	100 142	247 322	1076 1241	3356 3185
11		9	34	98 140	243 316	1057 1218	3295 3127
11.1			36 33	96 137	238 310	1038 1196	3236 3071
11.2		9	35	94 135	234 305	1019 1175	3179 3016
11.3	2		32	93 132	230 299	1001 1155	3123 2963
11.4			34	91 130	226 294	984 1134	3068 2912
11.5			31	89 128	222 289	967 1115	3015 2861
11.6		8	33	88 126	218 284	950 1096	2963 2812
11.7			32 30	86 123	214 279	934 1077	2913 2764
11.8				85 121	211 275	918 1059	2864 2718
11.9		8	31 29	84 119	207 270	903 1041	2816 2672
12				82 117	204 266	888 1024	2769 2628
12.1			30 28	81 115	200 261	873 1007	2723 2584
12.2				79 113	197 257	859 990	2679 2542
12.3			29 27	78 112	194 253	845 974	2636 2501
12.4				77 110	191 249	832 959	2593 2461
12.5		7		76 108	188 245	818 943	2552 2422
12.6			28 26	75 106	185 241	805 929	2512 2383
12.7		7		73 105	182 237	793 914	2472 2346
12.8			27 25	72 103	179 233	780 900	2434 2310
12.9				71 101	176 230	768 886	2396 2274
13	1		26	70 100	174 226	757 872	2359 2239
13.1			24	69 98	171 223	745 859	2324 2205
13.2				68 97	168 219	734 846	2288 2172
13.3			25	67 95	166 216	723 833	2254 2139
13.4		6	23	66 94	163 213	712 821	2221 2107
13.5				65 93	161 210	702 809	2188 2076
13.6			24	64 91	159 207	691 797	2156 2046
13.7		6	22	63 90	156 204	681 785	2124 2016
13.8			23	62 89	154 201	671 774	2094 1987
13.9				61 87	152 198	662 763	2064 1958
14			21	60 86	150 195	652 752	2034 1931
14.1				85	148 192	643 742	2006 1903
14.2			22	59 84	146 190	634 731	1977 1877
14.3			20	58 83	144 187	625 721	1950 1850
14.4				57 81	142 184	617 711	1923 1825
14.5			21	56 80	140 182	608 701	1896 1800
14.6				79	138 179	600 692	1871 1775
14.7		5	19	55 78	136 177	592 682	1845 1751
14.8			20	54 77	134 175	584 673	1820 1727
14.9				53 76	132 172	576 664	1796 1704
15		5		75	130 170	568 655	1772 1682

Chart Converting Pipe Length to CV

CV 1/2" 3/4" 1" 1 1/4" 1 1/2" 2" 2 1/2"

15		5			75	130	170	568	655	1772	1682	
15.1			18		52	74	129	168	561	647	1749	1660
15.2			19		51	73	127	166	553	638	1726	1638
15.3						72	125	163	546	630	1703	1616
15.4					50	71	124	161	539	622	1681	1596
15.5			17		49	70	122	159	532	614	1660	1575
15.6						69	121	157	525	606	1638	1555
15.7			18		48		119	155	519	598	1618	1535
15.8						68	118	153	512	591	1597	1516
15.9					47	67	116	151	506	583	1577	1497
16	1		16		46	66	115	149	499	576	1558	1478
16.1			17			65	113	148	493	569	1538	1460
16.2					45	64	112	146	487	562	1519	1442
16.3							110	144	481	555	1501	1424
16.4					44	63	109	142	475	548	1483	1407
16.5		4	15			62	108	140	470	541	1465	1390
16.6			16		43	61	107	139	464	535	1447	1373
16.7							105	137	458	529	1430	1357
16.8		4			42	60	104	135	453	522	1413	1341
16.9						59	103	134	448	516	1396	1325
17					41		102	132	442	510	1380	1309
17.1			15	14		58	100	131	437	504	1364	1294
17.2					40	57	99	129	432	498	1348	1279
17.3							98	128	427	493	1332	1264
17.4					39	56	97	126	422	487	1317	1250
17.5						55	96	125	418	481	1302	1236
17.6					38		95	123	413	476	1287	1222
17.7			14			54	94	122	408	471	1273	1208
17.8						13	93	121	404	465	1258	1194
17.9					37	53	92	119	399	460	1244	1181
18						52	91	118	395	455	1231	1168
18.1					36		90	117	390	450	1217	1155
18.2						51	89	115	386	445	1204	1142
18.3							88	114	382	440	1191	1130
18.4			13		35	50	87	113	378	435	1178	1118
18.5						12	86	112	374	431	1165	1106
18.6						49	85	111	370	426	1153	1094
18.7					34		84	109	366	422	1140	1082
18.8						48	83	108	362	417	1128	1071
18.9					33		82	107	358	413	1116	1059
19		3				47	81	106	354	408	1105	1048
19.1								105	350	404	1093	1037
19.2			12		32	46	80	104	347	400	1082	1026
19.3						11	79	103	343	396	1070	1016
19.4		3				45	78	102	340	392	1059	1005
19.5					31		77	101	336	388	1049	995
19.6						44		100	333	384	1038	985
19.7							76	99	329	380	1027	975
19.8						43	75	98	326	376	1017	965
19.9					30		74	97	323	372	1007	956
20			11					96	320	369	997	946

Chart Converting Pipe Length to CV

CV 3/4" 1" 1 1/4" 1 1/2" 2" 2 1/2" 3"

20		11			96	320	369	997	946	2427	2803
20.1			42	73	95	316	365	987	937	2403	2775
20.2		10	29	72	94	313	361	977	927	2379	2747
20.3			41	71	93	310	358	968	918	2356	2720
20.4					92	307	354	958	909	2333	2694
20.5			40	70	91	304	351	949	900	2310	2667
20.6			28	69	90	301	347	940	892	2288	2642
20.7					89	298	344	931	883	2266	2616
20.8			39	68	88	296	341	922	875	2244	2591
20.9			27	67	88	293	337	913	866	2223	2566
21		10			87	290	334	904	858	2201	2542
21.1			38	66	86	287	331	896	850	2181	2518
21.2				65	85	284	328	887	842	2160	2494
21.3		9	26		84	282	325	879	834	2140	2471
21.4			37	64	84	279	322	871	826	2120	2448
21.5					83	277	319	863	819	2100	2425
21.6				63	82	274	316	855	811	2081	2403
21.7			36		81	272	313	847	804	2062	2381
21.8			25	62	80	269	310	839	796	2043	2359
22.3		9	24	34	59	257	296	802	761	1952	2254
22.5		8	23	33	58	253	291	788	747	1918	2214
23			22	32	55	242	279	754	715	1835	2119
23.5	2	8	21	31	53	232	267	722	685	1758	2030
24	2	7		29	51	222	256	692	657	1685	1946
24.5			20	28	49	213	246	664	630	1617	1868
25		7	19	27	47	205	236	638	605	1553	1794
25.5			18	26	45	197	227	613	582	1493	1724
26		6	25	43	57	189	218	590	560	1436	1658
26.5			17	24	42	182	210	568	539	1382	1596
27		6	16	23	40	175	202	547	519	1332	1538
27.5				22	39	169	195	527	500	1284	1482
28			15		37	163	188	509	483	1238	1430
28.5		5	21	36	47	157	181	491	466	1195	1380
29			14	20	35	152	175	474	450	1154	1333
29.5		5			34	147	169	458	435	1116	1288
30			13	19	33	142	164	443	420	1079	1246
30.5				18	32	137	158	429	407	1044	1205
31					31	133	153	415	394	1010	1167
31.5			12	17	30	129	149	402	381	978	1130
32		4			29	125	144	389	370	948	1095
32.5				16	28	121	140	378	358	919	1061
33	1	4	11		27	117	135	366	347	891	1029
33.5	1			15	26	114	131	355	337	865	999
34					25	111	128	345	327	840	970
34.5			10	14		107	124	335	318	816	942
35					24	104	120	325	309	793	915
35.5					23	101	117	316	300	770	890
36				13		99	114	308	292	749	865
36.5			9		22	96	111	299	284	729	841
37		3				93	108	291	276	709	819
37.5			12	21	27	91	105	284	269	690	797

Chart Converting Pipe Length to CV

CV 1" 1 1/4" 1 1/2" 2" 2 1/2" 3" 4"

37.5			12	21	27	91	105	284	269	690	797	1538	3284
38						89	102	276	262	672	776	1497	3199
38.5	3		8	20	26	86	99	269	255	655	756	1459	3116
39			11		25	84	97	262	249	638	737	1422	3037
39.5				19		82	94	256	243	622	718	1386	2960
40					24	80	92	249	236	607	701	1351	2887
40.5				18		78	90	243	231	592	683	1318	2816
41		7	10		23	76	88	237	225	578	667	1286	2748
41.5				17	22	74	86	232	220	564	651	1255	2682
42						72	84	226	215	550	635	1226	2618
42.5					21	71	82	221	209	537	621	1197	2557
43				16		69	80	216	205	525	606	1169	2498
43.5			9		20	68	78	211	200	513	592	1143	2441
44				15		66	76	206	195	501	579	1117	2386
44.5		6				65	74	201	191	490	566	1092	2332
45					19	63	73	197	187	479	554	1068	2281
45.5	2					62	71	193	183	469	541	1044	2231
46			8	14	18	60	70	188	179	459	530	1022	2183
46.5						59	68	184	175	449	518	1000	2136
47	2				17	58	67	181	171	439	507	979	2091
48				13		55	64	173	164	421	487	938	2005
49		5	7	12	16	53	61	166	158	404	467	901	1924
50					15	51	59	159	151	388	448	865	1848
51						49	57	153	145	373	431	831	1776
52				11	14	47	55	147	140	359	415	800	1708
53			6			46	52	142	135	346	399	770	1644
54		4		10	13	44	51	137	130	333	384	742	1584
55						42	49	132	125	321	371	715	1527
56					12	41	47	127	121	310	357	689	1473
57				9		39	45	123	116	299	345	666	1422
58			5			38	44	119	112	289	333	643	1373
59					11	37	42	115	109	279	322	621	1327
60						36	41	111	105	270	311	601	1283
61				8		34	40	107	102	261	301	581	1241
62					10	33	38	104	98	253	292	563	1202
63		3				32	37	100	95	245	282	545	1164
64	1					31	36	97	92	237	274	528	1128
65			4	7	9	30	35	94	90	230	265	512	1093
66	1					29	34	92	87	223	257	496	1060
67							33	89	84	216	250	482	1029
68						28	32	86	82	210	242	468	999
69					8	27	31	84	79	204	235	454	970
70				6		26	30	81	77	198	229	441	943
71							29	79	75	193	222	429	916
72						25		77	73	187	216	417	891
73						24	28	75	71	182	210	406	867
74					7		27	73	69	177	205	395	843
75			3			23	26	71	67	173	199	384	821
76						22		69	66	168	194	374	800
77		2		5			25	67	64	164	189	365	779
78						21	24	66	62	160	184	355	759

Chart Converting Pipe Length to CV

CV 1 1/4" 1 1/2" 2" 2 1/2" 3" 4"

78			21	24	66	62	160	184	355	759
79					64	61	156	180	346	740
80		6	20	23	62	59	152	175	338	722
81					61	58	148	171	330	704
82			19	22	59	56	144	167	322	687
83					58	55	141	163	314	670
84			18	21	57	54	138	159	306	655
85					55	52	134	155	299	639
86		4		20	54	51	131	152	292	624
87			5		53	50	128	148	286	610
88				19	51	49	125	145	279	596
89			16		50	48	123	142	273	583
90					49	47	120	138	267	570
91				18	48	46	117	135	261	558
92	2		15		47	45	115	132	255	546
93				17	46	44	112	130	250	534
94					45	43	110	127	245	523
95					44	42	108	124	240	512
96			14	16	43	41	105	122	235	501
97					42	40	103	119	230	491
98		4					101	117	225	481
99			3		13	15	99	114	221	471
100					40	38	97	112	216	462
105			12	13	36	34	88	102	196	419
110	1		11	12	33	31	80	93	179	382
115		3	10	11	30	29	73	85	163	349
120			9	10	28	26	67	78	150	321
125		2	8		26	24	62	72	138	296
130	1			9	24	22	57	66	128	273
135			7	8	22	21	53	62	119	253
140		2			20	19	50	57	110	236
145			6	7	19	18	46	53	103	220
150					18	17	43	50	96	205
155				6	17	16	40	47	90	192
160			5		16	15	38	44	84	180
165					15	14	36	41	79	170
170		1		5	14	13	34	39	75	160
175					13	12	32	37	71	151
180			4		12		30	35	67	143
185						11	28	33	63	135
190				4	11		27	31	60	128
195		1				10	26	29	57	121
200					10		24	28	54	115
205			3			9	23	27	51	110
210					9		22	25	49	105
215							21	24	47	100
220				3		8	20	23	45	95
225					8		19	22	43	91
230							18	21	41	87
235						7		20	39	84
240					7		17		38	80

Chart Converting Pipe Length to CV

CV 2" 2 1/2" 3" 4"

240		7	17	80	38	
245			16	19	77	36
250		6	18	74	35	
255	2		15	17	71	33
260		6		68	32	
265			14	16	66	31
270	2			63	30	
275		5	13	15	61	29
280		5		59	28	
285			12	14	57	27
290				55	26	
295			11	13	53	25
300				51	24	
305			12	50	23	
310		4	10	48		
315		4		47	22	
320			11	45	21	
325				44		
330			9	42	20	
335			10	41	19	
340				40		
350			8	9	38	18
360	1	3	3	36	17	
370			7	8	34	16
380	1			32	15	
390				30	14	
400			6	7	29	
410				27	13	
420				26	12	
430			6	25		
440		2	5	24	11	
450		2		23		
475			5	20	10	
500			4	18	9	
525			4	17	8	
550				15	7	
575			3	14		
600			3	13	6	
625		1	1	12		
650				11	5	
700			2	9		
750			2	8	4	
800				7		
850					3	
900				6		
1000			1	5	2	
1100			1	4		
1200				3		
1300						
1400						
1500				2	1	

Number of feet of pipe equivalent to one elbow, valve, etc.

	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"
90 Degree Elbow	1	2	4	5	8	11
45 Degree Elbow	.5	1	.75	1.5	2	4
Swing Check Valve	2	4	3	6	9	13
Reduced port ball valve	1.9	3	2.2	3.3	4.3	6.5
Bell & Gossett Flow Check			83	83	54	74
Taco Flow Check			27	27	42	42
Taco Vortech Air separator					17	38

Honeywell Zone Valves - two connection type (not 3-way diverting)

All 1/2" sweat valves = **14 feet of 1/2" Copper** except V4043A1184 = 170 feet of 1/2" Copper

3/4" sweat: V4043A1259, V8043E1061, V8043F1093 = **17 feet of 3/4" Copper**

V4044A1191, V4044B1314, V8044A1044, V8044E1011 = **22 feet of 3/4" Copper**

V8043A1029, V8043B1027, V8043E1012, V8043E1111, V8043F1036 = **89 feet of 3/4" Copper**

1" sweat: V4043A1317, V8043E1079, V8043F1101 = **69 feet of 1" Copper**

V8043A1037, V8043E1020, V8043F1051 = **360 feet of 1" Copper**

Equivalent feet of pipe (size of run!) for run return
 Pipe sizes below are size of run - size of branch doesn't make any difference
 One venturi tee on return: One venturi tee on supply venturi tees on both supply & return

Bell & Gossett, Nibco	62	21	21	19	20	58	49	47	42	
Taco	45	26	30	(not made)	68	33	39	106	44	53

