in feet. The length of run is not usually known at the outset; hence, it may be necessary to assume some pipe size at the start. Such an assumption frequently is considerably in error, and a more common and practical method is to assume the length of run and to check this assumption after the pipes are sized. For this purpose the length of run usually is taken as double the actual length of pipe.

BASIC CHART FOR STEAM PIPE SIZING

Fig. 22 is the basic chart for determining the weight-flow rate and velocity of steam in Schedule 40 pipe for various values of pressure drop per 100 ft, based on zero psig saturated steam. By use of the multiplier charts it may be used at all saturation pressures between 0 and 200 psig.

TABLES FOR PIPE SIZING FOR LOW-PRESSURE

The basic chart, Fig. 22, can be used for sizing pipe on low-pressure systems. The values in Table 5 which are taken from the basic chart provide a more rapid means of selecting pipe sizes for the various pressure drops listed and for systems operated at 3.5 and 12 psig. The weight-flow rates shown for 3.5 psig can be used for saturated pressures from 1 to 6 psig, and those shown for 12 psig can be used for saturated pressures from 8 to 16 psig with an error not exceeding 8 percent.

Both Fig. 22 and Table 5 are for use where the flow of condensate does not inhibit the flow of steam. Columns *B* and *C* of Table 6 are for cases where steam and condensate flow in opposite directions as in risers or runouts that are not dripped. Columns *D*, *E*, and *F* are for one-pipe systems and include risers, radiator valves and vertical connections, and radiator and riser runout sizes, all of which are based on the critical velocities of the steam to permit the counterflow of condensate without noise.

Return piping may be sized with the aid of Table 7, where pipe capacities for wet, dry, and vacuum return lines are shown for several values of pressure drop per 100 ft of equivalent length. *It is customary to use the same pressure drop on both the steam and return sides of a system.*

Example 2: What pressure drop should be used for the steam piping of a system if the measured length of the longest run is 500 ft, and the initial pressure is not to be over 2 psig?

Solution: It will be assumed, if the measured length of the longest run is 500 ft, that when the allowance for fittings is added, the equivalent length of run will not exceed 1000 ft. Then, with the pressure drop not over one-half of the initial pressure, the drop could be 1 psi or less. With a pressure drop of 1 psi and a length of run of 1000 ft, the drop per 100 ft would be 0.1 psi, while if the total drop were 0.5 psi, the drop per 100 ft would be 0.05 psi. In both cases the pipe could be sized for a desired capacity according to the 0.1 and 0.05 pressure drop lines in Fig. 22. On completion of the sizing, the drop could be checked by taking the longest line and actually calculating the equivalent length of run from the pipe sizes determined. If the calculated drop is less than that assumed, the pipe size is all right; if it is more, it is probable that there are an unusual number of fittings involved, and either the lines must be straightened or the column for the next lower drop must be used, and the lines resized. Ordinarily, resizing will be unnecessary.

Table 6.... Steam Pipe Capacities for Low-Pressure Systems

(For Use on One-Pipe Systems or Two-Pipe Systems in which Condensate Flows Against the Steam Flow)

This table is based on data developed through research investigations of the American Society of Heating, Refrigerating and Air-Conditioning Engineers

Nominal Pipe Size, Inches	Capacity in Pounds per Hour				
	Two-Pipe Systems		One-Pipe Systems		
	Condensate flowing against steam		Supply risers upfeed	Radiator valves and vertical connections	Radiator and riser runouts
	Vertical	Horizontal			
A	B[a]	C[a]	D[b]	E	F[a]
¾	8	—	6	—	7
1	14	9	11	7	7
1¼	31	19	20	16	16
1½	48	27	38	23	16
2	97	49	72	42	23
2½	159	99	116	—	42
3	282	175	200	—	65
3½	387	288	286	—	119
4	511	425	380	—	186
5	1,050	788	—	—	278
6	1,800	1,400	—	—	545
8	3,750	3,000	—	—	—
10	7,000	5,700	—	—	—
12	11,500	9,500	—	—	—
16	22,000	19,000	—	—	—

Note: Steam at an average pressure of 1 psig is used as a basis of calculating capacities.

[a] Do not use Column B for pressure drops of less than ¼ psi per 100 ft of equivalent run. Use Fig. 22 or Table 5 instead.

[b] Do not use Column D for pressure drops of less than ¼ psi per 100 ft of equivalent run except on sizes 3 in. and over. Use Fig. 22 or Table 5 instead.

[c] Pitch of horizontal runouts to risers and radiators should be not less than ½ in. per ft. Where this pitch cannot be obtained, runouts over 8 ft in length should be one pipe size larger than called for in this table.

CHARTS FOR SIZING PIPE FOR HIGH-PRESSURE

Many installations of heating systems for large industrial-type buildings have been designed for the use of high-pressure steam, that is, without the use of pressure-reducing valves. Such systems usually involve the use of unit heaters or large built-up fan units with blast heating coils. Pressures on these systems vary from 30 to 150 psi. Temperatures are controlled by a modulating- or throttling-type thermostatic valve controlled by the air temperature in the room, fan inlet, or fan outlet.

Figs. 23, 24, 25, and 26 provide charts for sizing steam piping for systems of 30, 50, 100, and 150 psig at various pressure drops. These charts are based on the Moody Friction Factor, which takes into account the Reynolds number and the roughness of the internal pipe surfaces, and contain the same information as the basic chart of Fig. 22 but in a more convenient form.

Return pipe capacities given in Tables 8 and 9 are based on the following assumed pressures in the return piping:

Pressure Drop Lb/100 Ft	Pressure in Return Line (Psig)	
	30 psi System	150 psi System
⅛	½	1¼
¼	1	2½
½	2	5
¾	3	7½
1	4	10
2	....	20

The pressure loss and line loss as given were substituted in the Babcock steam flow formula, and the resulting capacity was multiplied by 12 for 30-psig systems and by 16 for 150-psig systems to obtain the values given in Tables 8 and 9. The return-line pressures used were found by observation of operating systems. The Babcock formula was used in this case since information on condensate flow in return lines based on the Moody Friction Factor is not readily available.

SIZING PIPING FOR ONE-PIPE GRAVITY SYSTEMS

Gravity one-pipe air-vent systems, in which the equivalent length of run does not exceed 200 ft, should be sized by means of Tables 5, 6, and 7 and Fig. 22 as follows:

1. *For the steam main and dripped runouts to risers* where the steam and condensate flow in the same direction, use 1/16 psi drop (Table 5 or Fig. 22).

2. *Where the riser runouts are not dripped* and the steam and condensate flow in opposite directions, and *also for the radiator runouts* where the same condition occurs, use Table 6, Column *F*.

3. *For up-feed steam risers* carrying condensate back from the radiators, use Table 6, Column *D*.

4. *For down-feed systems, the main risers* of which do not carry any radiator condensate, use Table 6, Column *B*.

5. *For the radiator valve size and the stub connection*, use Table 6, Column *E*.

6. *For the dry-return main*, use Table 7, Column *O*.

7. *For the wet-return main*, use Table 7, Column *N*.

Table 7.... Return Main and Riser Capacities for Low-Pressure Systems—Pounds per Hour

(Reference to this table will be made by column letter G through Y)

This table is based on pipe size data developed through the research investigations of The American Society of Heating, Refrigerating and Air-Conditioning Engineers

	Pipe Size Inches	1/32 Psi or ½ Oz Drop per 100 Ft			1/24 Psi or ⅜ Oz Drop per 100 Ft			1/16 Psi or 1 Oz Drop per 100 Ft			⅛ Psi or 2 Oz Drop per 100 Ft			¼ Psi or 4 Oz Drop per 100 Ft			½ Psi or 8 Oz Drop per 100 Ft		
		Wet	Dry	Vac.	Wet	Dry	Vac.	Wet	Dry	Vac.	Wet	Dry	Vac.	Wet	Dry	Vac.	Wet	Dry	Vac.
	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
Mains	¾	....	....	....	....	....	42	....	....	100	....	....	142	....	....	200	....	....	283
	1	125	62	....	145	71	143	175	80	175	250	103	249	350	115	350	....	....	494
	1¼	213	130	....	248	149	244	300	168	300	425	217	426	600	241	600	....	....	848
	1½	338	206	....	393	236	388	475	265	475	675	340	674	950	378	950	....	....	1,340
	2	700	470	....	810	535	815	1,000	575	1,000	1,400	740	1,420	2,000	825	2,000	....	....	2,830
	2½	1,180	760	....	1,580	868	1,360	1,680	950	1,680	2,350	1,230	2,380	3,350	1,360	3,350	....	....	4,730
	3	1,880	1,460	....	2,130	1,560	2,180	2,680	1,750	2,680	3,750	2,250	3,800	5,350	2,500	5,350	....	....	7,560
	3½	2,750	1,970	....	3,300	2,200	3,250	4,000	2,500	4,000	5,500	3,230	5,680	8,000	3,580	8,000	....	....	11,300
	4	3,880	2,930	....	4,580	3,350	4,500	5,500	3,750	5,500	7,750	4,830	7,810	11,000	5,380	11,000	....	....	15,500
	5	....	....	....	....	....	7,880	....	....	9,680	....	....	13,700	....	....	19,400	....	....	27,300
	6	....	....	....	....	....	12,600	....	....	15,500	....	....	22,000	....	....	31,000	....	....	43,800
Risers	¾	....	48	....	....	48	143	....	48	175	....	48	249	....	48	350	....	....	494
	1	....	113	....	....	113	244	....	113	300	....	113	426	....	113	600	....	....	848
	1¼	....	248	....	....	248	388	....	248	475	....	248	674	....	248	950	....	....	1,340
	1½	....	375	....	....	375	815	....	375	1,000	....	375	1,420	....	375	2,000	....	....	2,830
	2	....	750	....	....	750	1,360	....	750	1,680	....	750	2,380	....	750	3,350	....	....	4,730
	2½	....	....	....	....	....	2,180	....	....	2,680	....	....	3,800	....	....	5,350	....	....	7,560
	3	....	....	....	....	....	3,250	....	....	4,000	....	....	5,680	....	....	8,000	....	....	11,300
	3½	....	....	....	....	....	4,480	....	....	5,500	....	....	7,810	....	....	11,000	....	....	15,500
	4	....	....	....	....	....	7,880	....	....	9,680	....	....	13,700	....	....	19,400	....	....	27,300
	5	....	....	....	....	....	12,600	....	....	15,500	....	....	22,000	....	....	31,000	....	....	43,800

Table 8.... Return Pipe Capacities for 30 Psig Steam Systems[a]

Capacity Expressed in Pounds per Hour

Pipe Size Inches	Drop in Pressure—Pounds per 100 Ft in Length				
	⅛	¼	½	¾	1
¾	115	170	245	308	365
1	230	340	490	615	730
1¼	485	710	1,025	1,290	1,530
1½	790	1,160	1,670	2,100	2,500
2	1,580	2,360	3,400	4,300	5,050
2½	2,650	3,900	5,600	7,100	8,400
3	4,850	7,100	10,300	12,900	15,300
3½	7,200	10,600	15,300	19,200	22,800
4	10,200	15,000	21,600	27,000	32,300
5	19,000	27,800	40,300	55,500	60,000
6	31,000	45,500	65,500	83,000	98,000

[a] *Note:* The above table is based on steam at pressures of 0 to 4 psig.

Table 9.... Return Pipe Capacities for 150 Psig Steam Systems[a]

Capacity Expressed in Pounds per Hour

Pipe Size Inches	Drop in Pressure—Psi per 100 Ft in Length					
	⅛	¼	½	¾	1	2
¾	156	232	360	465	560	890
1	313	462	690	910	1,120	1,780
1¼	650	960	1,500	1,950	2,330	3,700
1½	1,070	1,580	2,460	3,160	3,800	6,100
2	2,160	3,300	4,950	6,400	7,700	12,300
2½	3,600	5,350	8,200	10,700	12,800	20,400
3	6,500	9,600	15,000	19,500	23,300	37,200
3½	9,600	14,400	22,300	28,700	34,500	55,000
4	13,700	20,500	31,600	40,500	49,200	78,500
5	25,600	38,100	58,500	76,000	91,500	146,000
6	42,000	62,500	96,000	125,000	150,000	238,000

[a] *Note:* The above table is based on steam at pressures of 1 to 20 psig.