

the counter-flowing steam and water may produce objectionable sounds, water hammer, or may retain water in some parts of the system until pressure goes off. The velocity at which such disturbance takes place depends upon the size of the pipe, its position (whether vertical or horizontal), its pitch and the quantity of water flowing counter to the steam.

TABLE 5. MAXIMUM ALLOWABLE CAPACITIES OF UP-FEED RISERS FOR ONE-PIPE LOW PRESSURE STEAM

Based on A. S. H. V. E. Research Laboratory Tests

PIPE SIZE INCHES	VELOCITY FEET PER SECOND	PRESSURE DROP OUNCES PER 100 FT.	CAPACITY		
			Sq. Ft. Radiation	B.t.u. per Hour	Lb. Steam per Hour
A	B	C	D	E	F
1	14.1	0.68	45	10,961	11.3
1¼	17.6	0.66	98	23,765	24.5
1½	20.0	0.66	152	36,860	38.0
2	23.0	0.57	288	69,840	72.0
2½	26.0	0.54	464	112,520	116.0
3	29.0	0.48	799	193,600	199.8
3½	31.0	0.44	1144	277,000	286.0
4	32.0	0.39	1520	368,000	380.0

INSTRUCTIONS FOR USING TABLE 5

- Capacities given in Table 5 should never be exceeded on one-pipe risers.
- Capacities based on ¼ lb. condensation per square foot equivalent radiation and actual diameter of standard pipe.
- All pipe should be well reamed and free from constrictions. Fittings should be up to size. (See Tables 7 and 8).

TABLE 6. COMPARATIVE CAPACITY OF STEAM LINES AT VARIOUS PITCHES^a

Pitch of Pipe in Inches per 10 Ft.

PIPE SIZE INCHES	¼ IN.		½ IN.		1 IN.		1½ IN.		2 IN.		3 IN.		4 IN.		5 IN.	
	Sq. Ft. Rad. Based on 240 B.t.u.	Max. Vel.	Sq. Ft. Rad. Based on 240 B.t.u.	Max. Vel.	Sq. Ft. Rad. Based on 240 B.t.u.	Max. Vel.	Sq. Ft. Rad. Based on 240 B.t.u.	Max. Vel.	Sq. Ft. Rad. Based on 240 B.t.u.	Max. Vel.	Sq. Ft. Rad. Based on 240 B.t.u.	Max. Vel.	Sq. Ft. Rad. Based on 240 B.t.u.	Max. Vel.	Sq. Ft. Rad. Based on 240 B.t.u.	Max. Vel.
¾	25.0	12	30.3	14	37.3	18	40.4	19	42.5	20	46.1	21	47.5	22	49.3	23
1	45.8	12	52.6	15	63.0	17	70.0	20	75.2	22	83.0	23	87.9	25	90.2	26
1¼	104.9	18	117.2	20	133.0	23	144.5	25	154.0	27	165.0	28	172.6	29	178.2	31
1½	142.6	18	159.0	21	181.0	23	196.5	25	209.3	27	224.0	28	234.8	30	242.6	31
2	236.0	19	263.5	20	299.5	23	325.5	25	346.5	27	371.5	28	388.4	29	401.1	30

^aData from A.S.H.V.E. Research Laboratory.

Buildings which are heated intermittently or which have less heating surface than is required for quick initial warming prior to occupancy, must have extra large piping in order to compensate for the unusual demand on the piping per unit of radiation.

Reaming

Tables 7 and 8 give the variation in capacity of pipe due to reaming and variation in size and smoothness of pipe as determined by experiments at the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS Research Laboratory. There are certain variations in manufacture which apparently cannot be avoided, which actually caused a 20 per cent variation in the capacity of a 1 in. pipe, as indicated by Table 8. A factor of safety has been allowed in all of the capacity tables in this chapter so that Table 8, while interesting, need not be used to discount the other tables.

Pipe Size Tables

Tables for the selection of pipe sizes for steam heating systems have been developed through the cooperative research investigations of the

TABLE 7. EFFECT OF REAMING ENTRANCE TO ONE-INCH ONE-PIPE RISERS^a

	MAXIMUM CAPACITY OF RISER	PER CENT DECREASE
Reamed entrances.....	24.7 lb. per hour	0.0
Rounded entrances.....	23.9 lb. per hour	3.2
Squared entrances.....	22.2 lb. per hour	10.1
Three wheel cutter.....	19.2 lb. per hour	22.2
Single wheel cutter.....	17.6 lb. per hour	28.7

TABLE 8. PER CENT DIFFERENCE IN CAPACITY DUE TO VARIATION OF PIPE SIZE AND SMOOTHNESS^a

Size of Pipe.....	MAXIMUM CONDENSATION, LB. PER HR.			
	¾"	1"	1¼"	1½"
Minimum.....	14.00	24.89	45.42	70.50
Maximum.....	15.20	30.08	52.08	82.00
Per Cent Variation.....	8.6	20.8	14.7	16.3

^aData from AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS Research Laboratory.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS and the *Heating and Piping Contractors National Association*. (See Tables 9 to 16). While these tables, literally followed out, will serve as an efficient guide to the designer, it is impossible entirely to eliminate the factor of good engineering judgment. For example: While a given main might be calculated to begin at 5 in. and to end at 1½ in., better practice often would make it begin at 4 in. and end at 2½ in., since the dryer steam and higher velocity at the entry would compensate for the smaller size at the end.

DESIGN OF STEAM HEATING SYSTEMS

Steam heating systems may be broadly classified as (1) air-vent one-pipe, (2) air-vent two-pipe, (3) vapor and (4) vacuum.

The choice of air-vent one-pipe, two-pipe, vapor or vacuum return line systems depends upon the requirements as to first cost, convenience,