

CHAPTER EIGHT

Reference Material

Near Boiler Piping Sizing Chart

Gas Input BTUs	Oil Input GPH	Horse- power	EDR	Pipe Size Based on 50 FPS				
				Single Riser	Double Riser	Triple Riser	Header	Equalizer
75,000	0.5	2.0	215	1½	—	—	1½	1¼
100,000	0.7	2.5	285	1½	1¼	—	1½	1¼
125,000	0.9	3.0	355	1½	1¼	—	1½	1¼
150,000	1.1	3.6	425	2	1¼	—	2	1½
175,000	1.3	4.2	496	2	1¼	—	2	1½
200,000	1.4	4.8	567	2	1½	—	2	1½
250,000	1.8	6.1	708	2½	2	—	2½	1½
300,000	2.1	7.2	850	3	2	—	3	1½
350,000	2.5	8.5	992	3	2	—	3	2
400,000	2.9	9.7	1,133	3	2	—	3	2
450,000	3.2	10.9	1,275	3	2½	—	3	2
500,000	3.6	12.1	1,417	4	2½	—	4	2½
600,000	4.3	14.5	1,700	4	3	—	4	2½
700,000	5.0	16.9	1,983	4	3	—	4	2½
800,000	5.7	19.3	2,267	5	3	—	5	3
900,000	6.4	21.8	2,550	5	3	—	5	3
1,000,000	7.0	24.2	2,833	5	4	3	5	3
1,500,000	10.7	36.3	4,250	6	4	4	6	3
2,000,000	14.3	48.3	5,667	—	5	4	8	4
2,500,000	17.9	60.4	7,083	—	6	5	8	4
3,000,000	21.4	72.5	8,500	—	6	5	8	4

Note: Pipe sizes smaller than listed can cause high velocity. See page 58

Relationship of Pipe Size to Pressure Drop in Supply Piping Capacities Shown in Square Feet EDR

Pipe Size in Inches	Pressure Drop in PSI per 100 Feet					
	1/16 PSI	1/8 PSI	1/4 PSI	1/2 PSI	3/4 PSI	1 PSI
1	50	100	150	200	250	300
1½	200	300	500	700	850	950
2	400	650	900	1300	1600	1900
2½	650	1000	1500	2100	2700	3100
3	1250	1850	2600	3800	4700	5500
4	2500	3800	5600	7900	9800	11500
5	4800	6700	9700	14200	17500	20400
6	7600	11000	15800	22800	28800	33600
8	15600	22000	32400	45600	58000	66000

Steam and water flowing in same direction.

Can be used for pressures 1 PSI to 6 PSI.

PIPE SIZING REFERENCE

One Pipe Steam

Pipe Size	Capacity In Square Feet Per Pipe Size					
	Up to 200' Main	Run Out	Upfeed Riser	Radiator Valves	Dry Return	Wet Return
¾"	—	20	24	—	—	—
1"	—	25	45	25	320	700
1¼"	—	60	98	60	670	1,200
1½"	—	70	152	90	1,058	1,900
2"	260	100	288	160	2,300	4,000
2½"	425	260	464	—	3,800	6,700
3"	775	475	799	—	7,000	10,700
4"	1,640	—	—	—	—	—
5"	3,030	—	—	—	—	—
6"	4,975	—	—	—	—	—

Use one pipe size larger for: counter flow mains and horizontal run outs over 6 feet.

Two Pipe Steam

Pipe Size	Capacity in Square Feet Per Pipe Size								
	Up to 200' Main	Supply Run Out	Supply Riser	Radiator Valve	Radiator Trap	Return Riser	Return Run Out	Dry Return	Wet Return
½"	—	—	25	25	200	200	—	—	—
¾"	80	25	75	75	400	400	400	—	—
1"	150	75	150	150	700	700	700	460	1,400
1¼"	300	150	200	200	—	1,300	1,300	960	2,400
1½"	500	200	400	400	—	2,200	2,200	1,500	3,800
2"	950	400	650	—	—	—	—	3,300	8,000
2½"	1,500	650	900	—	—	—	—	5,500	13,400
3"	2,600	900	—	—	—	—	—	10,000	21,400
4"	5,500	—	—	—	—	—	—	21,000	44,000
5"	9,700	—	—	—	—	—	—	—	—
6"	15,500	—	—	—	—	—	—	—	—

Use one pipe size larger for: counter flow mains and horizontal supply run outs over 6 feet.

Two Pipe Vacuum

Pipe Size	Capacity in Square Feet Per Pipe Size						
	Up to 200' Main	Supply Run Out	Supply Riser	Radiator Valve	Radiator Trap	Return Riser	Return Run Out
½"	—	—	25	25	200	500	—
¾"	80	25	75	75	400	1,000	500
1"	150	75	150	150	700	2,000	1,000
1¼"	300	150	200	200	—	4,500	2,000
1½"	500	200	400	400	—	—	4,500
2"	950	400	850	—	—	—	—
2½"	1,500	650	1,500	—	—	—	—
3"	2,600	900	2,600	—	—	—	—
4"	5,500	—	—	—	—	—	—
5"	9,700	—	—	—	—	—	—
6"	15,500	—	—	—	—	—	—

How to Size Main Vent

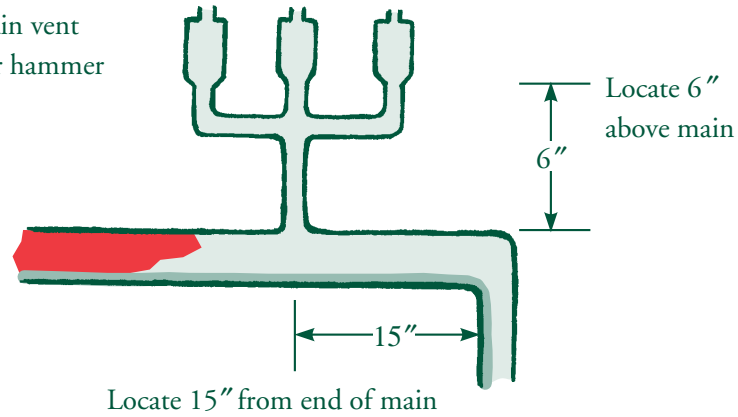
Air Capacity of Black Pipe (in cubic feet)

Pipe Size	Length							
	25	50	75	100	150	200	250	300
1½	0.36	0.71	1.07	1.42	2.13	2.84	3.55	4.26
2	0.58	1.17	1.75	2.33	3.50	4.66	5.83	6.99
2½	0.83	1.66	2.49	3.32	4.98	6.64	8.30	9.96
3	1.28	2.57	3.85	5.13	7.70	10.26	12.83	15.39
4	2.21	4.42	6.63	8.84	13.26	17.68	22.10	26.52
5	3.47	6.95	10.42	13.89	20.84	27.78	34.73	41.67
6	5.02	10.04	15.06	20.08	30.12	40.16	50.20	60.24
8	8.87	17.73	26.60	35.46	53.19	70.92	88.65	106.38

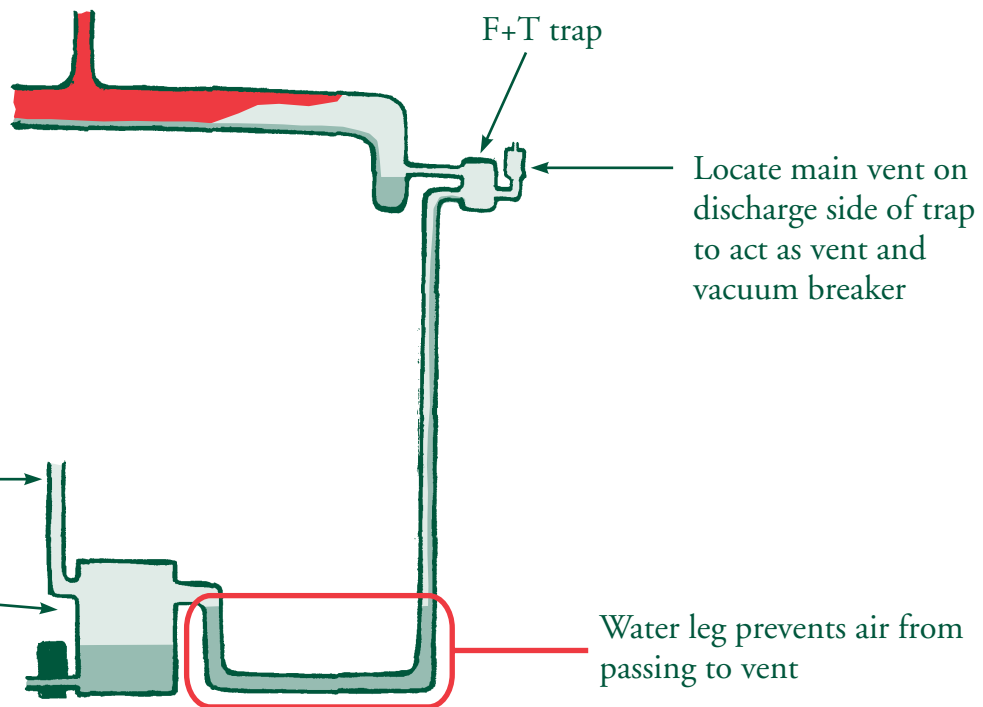
Shaded areas require more than 4 minutes to vent all air with typical main vent at rate of 1.4 cubic feet per minute.

How to Locate End of Main Vent

Protect main vent from water hammer



How to Vent End of Main with Water Leg Ahead of Boiler Feed or Condensate Tank



CAST IRON RADIATOR REFERENCE

Square Feet Output per Section of Column Style Radiators

Width	4½"	7 ³ / ₈ "	9"	11½"	12½"	12½"
Height	Number of Columns at End of Radiator					
	1	2	3	4	5	6
45"	3.5	5	6	10	—	—
38"	3	4	5	8	10	—
32"	2.5	3.33	4.5	6.5	8.5	—
26"	2	2.67	3.75	5	7	7
23"	1.67	2.33	3.25	4.5	—	—
22"	1.67	2.25	3	4	6	6
20"	1.5	2	2.75	3.5	5	5
18"	1.33	1.75	2.25	3	5	4.33
16"	—	—	—	—	4	3.75
13"	—	—	—	—	3	3

Square Feet Output per Section of Tube Type Radiators

Width	5"	7"	8¾"	9¾"	12½"
Height	Number of Tubes at End of Radiator				
	3	4	5	6	7
38"	3.5	4.25	5	6	—
36"	3.5	4.25	5	6	7
32"	3	3.5	4.33	5	6
26"	2.33	2.75	3.5	4	5
23"	2	2.5	3	3.5	4.5
20"	1.75	2.25	2.67	3	3.67
16"	—	—	—	—	3
14"	—	—	—	—	2.5

Square Feet Output per Section of Thin Tube Radiators

Width	3½"	4"	4¾"	6"	7 ⁷ / ₈ "
Height	Number of Tubes at End of Radiator				
	2	3	4	5	6
38"	2.5	2.6	—	—	—
32"	2.0	2.4	—	—	3.7
26"	—	—	2.4	3.0	3.0
25"	1.6	1.6	2.0	—	3.0
23"	—	—	—	2.1	—
22"	1.3	1.4	1.8	—	—
20"	—	—	1.8	—	2.3
19"	1.1	1.2	1.6	—	2.3
17"	—	—	—	2.0	—

CHAPTER 8 CONVECTOR RADIATION REFERENCE

Convactor Ratings in Square Foot Output

Depth in Inches	Length in Inches	Front Outlet Models									
		Cabinet Style					Wall Mount Style				
		Height in Inches									
		18	20	24	26	32	14	18	20	26	32
4	24	12	13	15	15	17	13	15	15	17	17
	32	16	19	21	22	23	19	21	22	23	25
	36	18	22	24	25	27	22	24	25	27	28
	40	21	24	28	28	30	24	28	28	30	32
	44	23	27	31	31	34	29	31	31	34	36
	48	25	30	34	35	37	30	34	35	37	39
	56	30	35	40	41	44	35	40	41	44	47
64	34	41	46	47	51	41	46	47	51	54	
6	24	17	19	22	23	26	19	22	23	26	27
	32	24	27	31	33	36	27	32	33	36	37
	36	27	31	36	37	41	31	36	37	41	43
	40	30	35	41	42	47	35	41	42	47	48
	44	34	39	45	47	52	39	45	47	52	54
	48	37	43	50	52	57	43	50	52	57	59
	56	44	51	59	61	67	51	59	61	67	70
64	51	58	68	71	78	58	68	71	78	81	
8	24	22	24	27	27	29	24	27	27	29	31
	32	32	34	38	39	42	34	38	39	42	44
	36	37	39	43	44	48	39	43	44	48	50
	40	41	44	49	50	54	44	49	50	54	56
	44	46	49	54	56	60	49	54	56	60	63
	48	51	54	60	61	66	54	60	61	66	69
	56	61	64	71	73	79	54	71	73	79	82
64	70	74	82	84	91	74	82	84	91	95	
10	24	23	28	30	31	35	28	30	31	35	36
	32	33	39	43	44	50	39	43	44	50	51
	36	39	45	49	50	57	45	49	50	57	59
	40	45	51	55	57	64	51	55	57	64	66
	44	51	57	62	63	71	57	62	63	71	73
	48	57	62	68	70	79	62	68	70	79	82
	56	69	74	80	82	93	74	80	82	93	96
64	81	85	93	95	107	85	93	95	107	111	

Depth in Inches	Length in Inches	Slope Top Models									
		Cabinet Style					Wall Mount Style				
		Height in Inches									
		18	20	24	26	32	14	18	20	26	32
4	24	15	16	17	17	18	16	17	17	18	18
	32	21	22	23	24	25	22	23	24	25	26
	36	24	25	27	27	29	25	27	27	29	30
	40	28	28	30	31	32	28	30	31	32	34
	44	31	32	34	35	36	32	34	35	36	38
	48	34	35	37	38	40	35	37	38	40	41
	56	40	41	44	45	47	41	44	45	47	49
64	46	48	51	52	55	48	51	52	55	58	
6	24	22	24	26	27	29	24	26	27	29	30
	32	32	34	37	38	41	35	37	38	41	42
	36	37	39	42	43	47	39	42	43	47	49
	40	41	44	48	49	53	44	48	49	53	55
	44	46	49	53	54	59	49	53	54	59	61
	48	51	54	58	60	65	54	58	60	65	67
	56	62	63	69	71	75	63	69	71	76	80
64	70	73	80	82	88	73	80	82	88	92	
8	24	30	31	32	33	36	31	32	33	36	37
	32	42	44	46	47	51	44	46	47	51	53
	36	49	50	53	54	59	50	53	54	59	61
	40	55	56	60	61	66	56	60	61	66	69
	44	61	63	67	68	74	63	67	68	75	77
	48	68	69	73	75	81	69	73	75	81	85
	56	80	82	87	89	97	82	87	89	97	101
64	93	95	101	103	112	95	101	103	112	116	
10	24	34	35	38	40	44	35	38	40	44	45
	32	47	49	54	56	61	49	54	56	61	64
	36	54	57	62	64	71	57	62	64	71	74
	40	61	64	70	72	80	64	70	72	80	83
	44	68	71	78	81	89	71	78	81	89	93
	48	75	78	86	87	98	78	86	89	98	102
	56	89	93	101	105	115	93	101	105	115	120
64	102	107	117	121	133	107	117	121	133	138	

OTHER FORMS OF RADIATION REFERENCE

Square Feet Output of Baseboard Radiation

Type	Height	Square Feet per Linear Foot
Cast Iron	7"	3.00
Copper/Aluminum Fin	7"	3.25
Cast Iron	9"	3.33
Copper/Aluminum Fin	9"	4.33

Square Feet Output from Direct Pipe Coils per Linear Foot

Number of Rows	Pipe Size		
	1"	1¼"	1½"
1	0.55	0.675	0.77
2	1.05	1.3	1.45
4	1.83	2.27	2.57
6	2.36	2.93	3.30
8	2.71	3.32	3.78
10	3.05	3.78	4.25
12	3.38	4.19	4.73

Square Feet Output from Un-Insulated Pipe

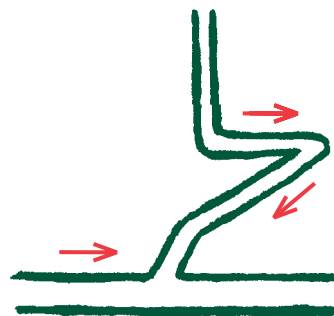
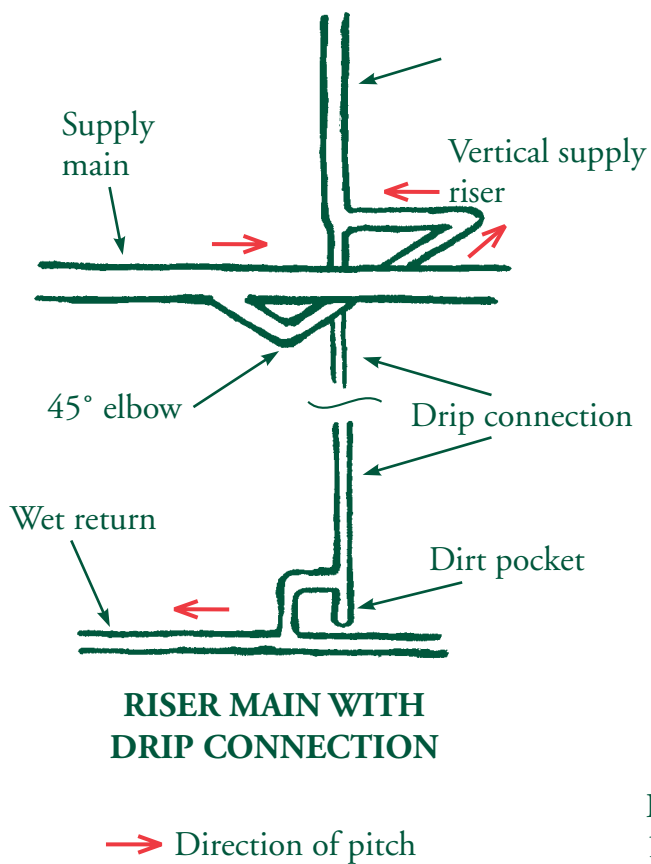
Length of Pipe (in feet)	Pipe Size								
	1"	1¼"	1½"	2"	2½"	3"	4"	5"	6"
1	0.5	0.625	0.70	0.875	1.0	1.25	1.58	1.75	2.3
10	5.0	6.250	7.00	8.75	10.0	12.5	15.8	17.5	22.0
25	12.5	15.600	17.50	21.90	25.0	31.25	39.5	43.75	57.5
50	25.0	31.250	35.00	43.75	50.0	62.50	79.0	87.50	115.0
100	50.0	62.500	70.00	87.50	100.0	125.00	158.0	175.00	230.0

Square Feet Output of Wall and Ceiling Type Radiators

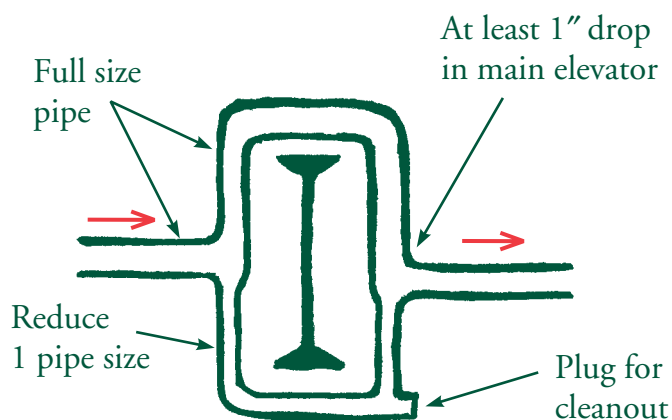
Size	Square Feet per Radiator
13½ × 17 x 3	5
13½ × 21 x 3	6
13½ × 22 x 3	7
13½ × 29 x 3	9

Square Feet Output of Sectional Wall Type Radiators

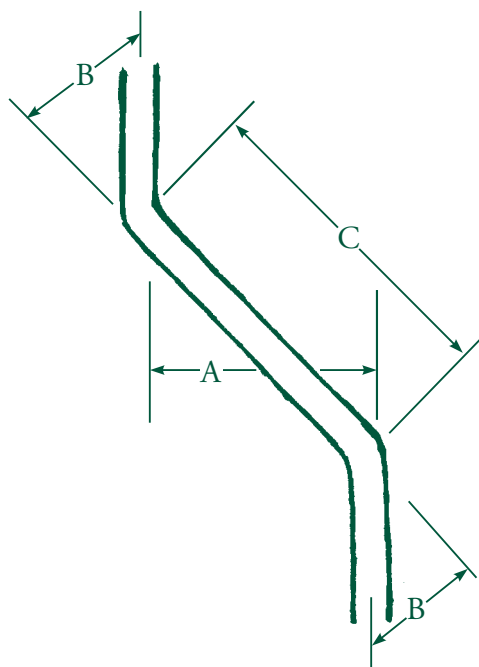
Height	Depth	Square Feet per Section
13 ⁷ / ₈	2 ³ / ₄	¾
15	2 ³ / ₄	1
21½	2 ³ / ₄	1½
26½	2 ³ / ₄	1 ⁴ / ₅
37	2 ³ / ₄	2½



**UPFEED RISER CONNECTION
TAKEN FROM HORIZONTAL
MAIN AT 45°**



**LOOPING MAIN AROUND
STEEL BEAM**

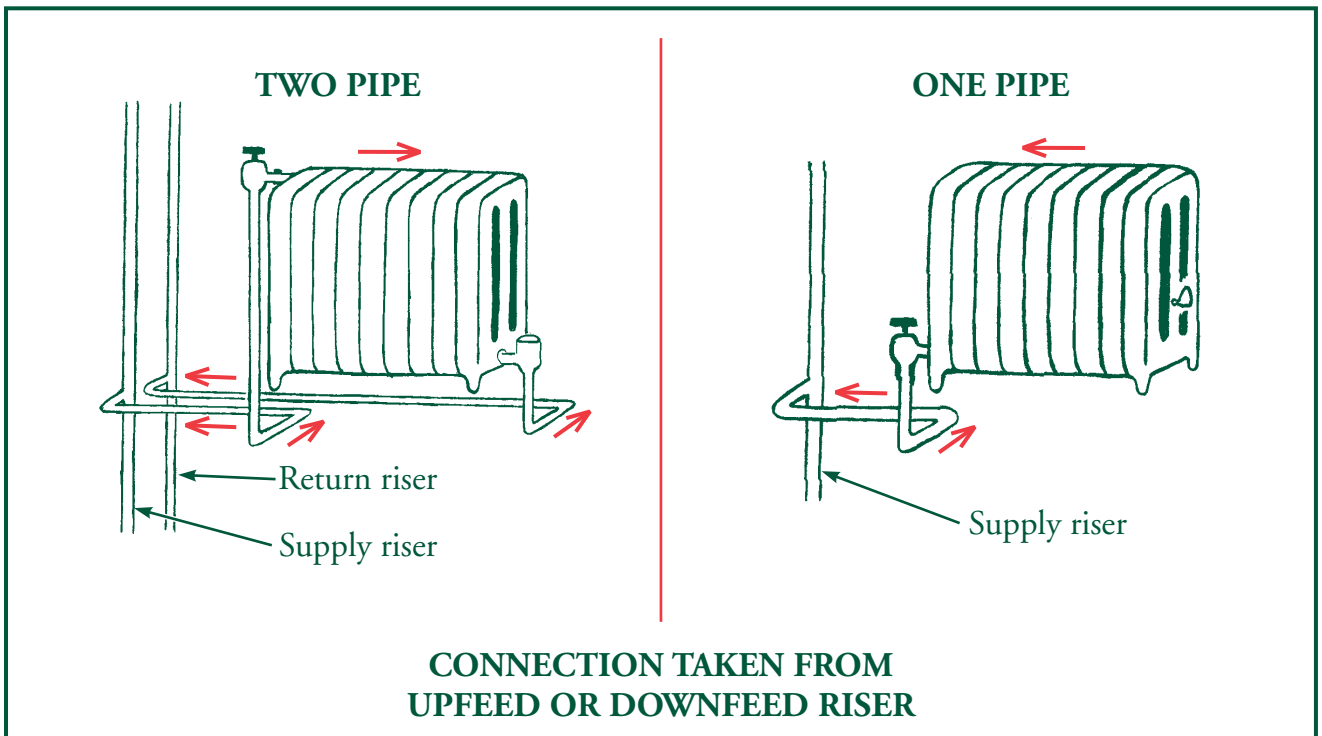
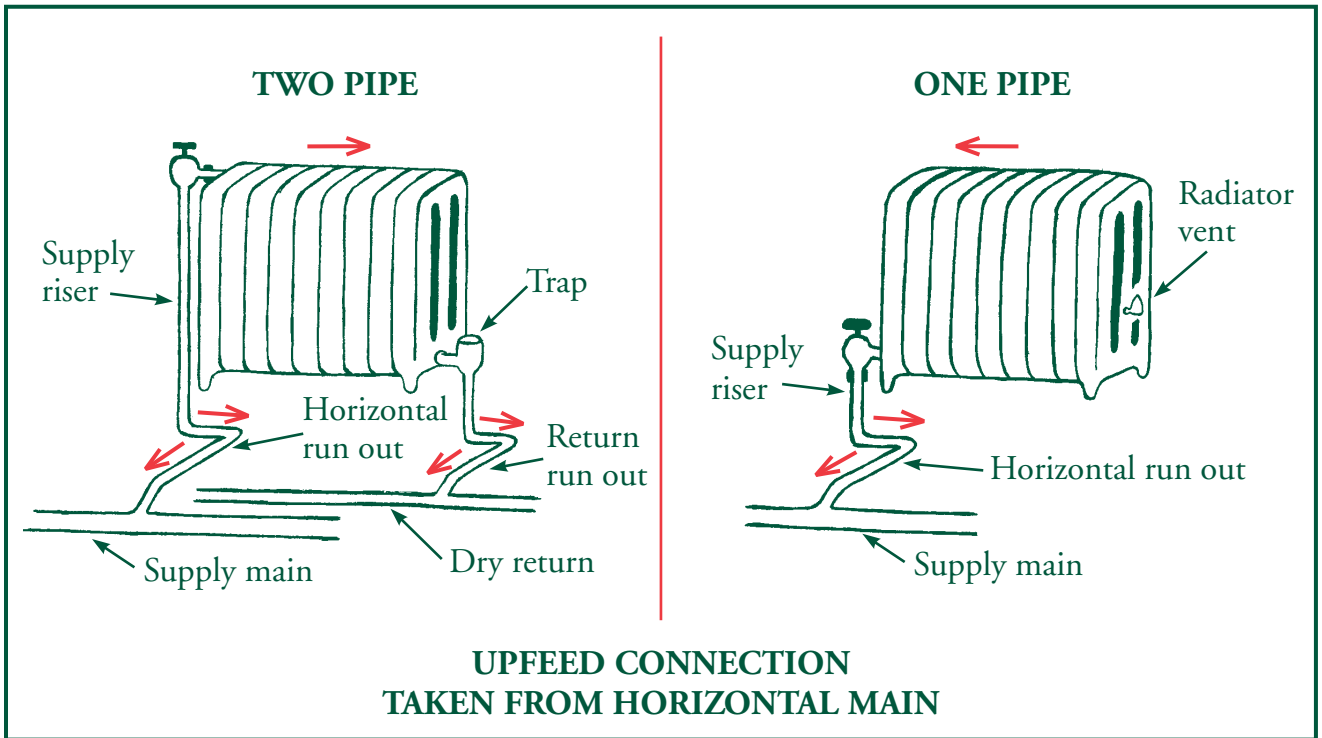


ANGLE B	CONSTANT
30°	2.000
45°	1.414
60°	1.155

MULTIPLY A BY CONSTANT
FOR ANGLE B TO FIND C

**TO CALCULATE FOR
OFFSET IN PIPE**

RADIATOR CONNECTIONS



→ Direction of pitch

Conversions

Sq. ft. Output x 240 = BTU/HR
 Sq. ft. Output x 0.000496 = Gallons of water per minute
 BTU/HR / 1000 = Pounds per hour
 Pounds of steam per hour x 4 = Sq. ft. Output
 Pounds of steam per hour x 0.002 = Gallons of water per minute
 Pounds of steam per hour x 1000 = BTU/HR
 One gallon of water x 8.345 = Pounds of water
 Boiler horsepower x 34.5 = Pounds per hour
 Boiler horsepower x 139 = Sq. ft. Output
 Boiler horsepower x 33,479 = BTU/HR

Diameter x 3.14 = Circumference
 Circumference x 0.3183 = Diameter
 Diameter² x 0.7854 = Area of a circle
 Square inches x 0.00695 = Square feet
 Cubic inches x 0.00058 = Cubic feet
 Cubic inches x 0.004329 = U.S. gallons
 Cubic feet x 7.4805 = U.S. gallons
 U.S. gallons x 231.0 = Cubic inches
 U.S. gallons x 0.13368 = Cubic feet

Pipe Data

Normal Size	Actual Outside Diameter	Inside Area in Square Inches	Gallons of Water per 100 Feet	Length of Pipe Containing 1 Cubic Foot	Number of Threads per Inch of Screw
1/8	0.410	0.06	0.3	2513.0	27
1/4	0.540	0.10	0.5	1383.3	18
3/8	0.675	0.19	1.0	751.2	18
1/2	0.840	0.30	1.6	472.4	14
3/4	1.050	0.53	2.7	270.0	14
1	1.315	0.86	4.5	166.9	11.5
1 1/4	1.660	1.50	7.7	96.3	11.5
1 1/2	1.900	2.04	10.6	70.7	11.5
2	2.375	3.36	17.4	42.9	11.5
2 1/2	2.875	4.78	24.8	30.1	8
3	3.500	7.39	38.4	19.5	8
4	4.500	12.73	66.1	11.3	8
5	5.563	19.99	103.8	7.2	8
6	6.625	28.89	150.0	5.0	8
8	8.625	51.15	260.0	2.8	8
10	10.750	81.55	410.0	1.8	8
12	12.750	114.80	600.0	1.3	8

Expansion of Pipes in Inches per 100 Feet

Temperature in Degrees Fahrenheit	Type of Pipe	
	Steel	Copper
0	0.00	0.00
50	0.38	0.57
100	0.76	1.14
125	0.92	1.40
150	1.15	1.75
175	1.34	2.04
200	1.57	2.38
225	1.78	2.70
250	1.99	3.02

About How Many Small Pipes Equal One Larger Pipe

Pipe Size	No. of small pipes equivalent to one large pipe										
	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	4"	5"	6"
1/2"	1	2	4	10	15	31	52	96	205	377	620
3/4"	—	1	2	4	6	14	23	42	90	166	273
1"	—	—	1	2	3	6	11	20	44	81	133
1 1/4"	—	—	—	1	1.5	2	5	9	19	32	68
1 1/2"	—	—	—	—	1	1	3	6	13	23	39
2"	—	—	—	—	—	1	1.5	3	6	11	19
2 1/2"	—	—	—	—	—	—	1	1.5	3	7	11
3"	—	—	—	—	—	—	—	1	2	3	6
4"	—	—	—	—	—	—	—	—	1	1.5	3
5"	—	—	—	—	—	—	—	—	—	1	1.5
6"	—	—	—	—	—	—	—	—	—	—	1

If you have four 1 1/4" pipes to combine into one large pipe, from the left 1 1/4" pipe size read to the right until it exceeds four, then read up for pipe size required. Answer: 2 1/2"

Approximate Properties of Saturated Steam

Vacuum Gauge Reading at Sea Level; Inches of Mercury	Absolute Pressure; Inches of Mercury	Temperature in Degrees Fahrenheit	Latent Heat of Evaporation in BTUs	Volume of 1 Pound of Steam in Cubic Feet
10	20	192	983	39
8	22	197	980	36
6	24	201	977	33
4	26	205	975	31
2	28	209	972	29
1	29	210	971	28
0	30	212	970	27

Pressure Gauge Reading at Sea Level; Pounds per Square Inch	Absolute Pressure; Pounds per Square Inch	Temperature in Degrees Fahrenheit	Latent Heat of Evaporation in BTUs	Volume of 1 Pound of Steam in Cubic Feet
0	14.7	212	970	27
1	15.7	216	968	25
2	16.7	219	966	24
3	17.7	222	964	22
4	18.7	225	962	21
5	19.7	227	960	20
6	20.7	230	958	19
7	21.7	232	957	19
8	22.7	235	955	18
9	23.7	237	954	17
10	25.7	240	952	16

Relation of Altitude and Pressure to the Boiling Point

Altitude in Feet	Atmospheric Pressure in PSI	Boiling Point of Water in Degrees Fahrenheit	
		At 0#	At 5#
Sea Level	14.69	212.0	227.0
500	14.42	211.0	226.3
1000	14.16	210.1	225.5
1500	13.90	209.4	225.0
2000	13.65	208.2	224.1
2500	13.40	207.3	223.4
3000	13.15	206.4	222.7
4000	12.68	204.7	221.4
5000	12.22	202.7	220.1
10,000	10.17	194.0	213.5