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CodeNotes™

Pipe Sizing Based on the 2015 IFGC® and IRC®

Introduction:

This *CodeNotes*™ provides an overview of pipe sizing calculations and requirements in the 2015 *International Fuel Gas Code*® (IFGC®) and 2015 *International Residential Code* (IRC®). It will cover both the longest length method and the branch length method. Applicable code tables, figures and example problems and solutions are provided for each method to help the reader easily understand the pipe sizing methodology.

General Criteria and Related Information

To determine the demand volume required by an appliance in cubic feet (m^3) of gas per hour, the maximum input rating of the appliance must be used. This is provided by the appliance manufacturer in British thermal units per hour [Btu/h-(W)] as specified by the appliance manufacturer. If the average heating value per unit of fuel is known [about 1,000 Btu/ft^3 (37.3 MJ/m^3) for natural gas], the volume of gas required per hour can be calculated. The heating value can be obtained from the gas supplier. The IFGC requires the input rating of all appliances be shown on the appliance label. Figure 1 shows a typical example of a partial appliance label. When the input rating of the appliances is unknown at the time of the piping system design, the gas demand must be estimated based on input from appliance manufacturers, gas utilities or other sources, see Table 1: Estimated Input for Initial Design Purposes. The load on the piping system must be based on the simultaneous operation of all appliances at full output. While estimated input ratings can be used for initial system designs, pipe sizing must be verified once the actual appliances and their input ratings are known.

RECOVERY RATING based on 100 deg. F rise	33.9	GPH
MINIMUM SUPPLY PRESSURE	6″	w.c.
MANIFOLD PRESSURE	5″	w.c.
INPUT RATING-BTU/HR	40,000	
CAPACITY	50	US GALLONS

Figure 1 Partial View of an Appliance Label

If a designer fails to verify the sizing with the actual connected load values, the resulting system could be undersized. In all cases, the fuel gas supply piping must have the capacity to supply the actual connected load of the appliances installed.

IFGC Section 402.4.1/ IRC Section G2413.4.1 Longest Length Method

This section of the IFGC/IRC provides a step-by-step approach for the longest length method.

STEP 1: Maximum Pipe Length

First, determine the maximum pipe length from the point of delivery to the farthest outlet.

STEP 2: Equivalent Length of Fittings

Second, determine the equivalent length of all fittings and add it to the pipe length to get the total determined length. This is typically done on a piping run having four or more fittings. Many designers simply add 50 percent of the actual length of piping as an all-inclusive fitting allowance (i.e., actual pipe length x 1.50).

STEP 3: Maximum Demand Volume

Third, determine the maximum piping system load by adding the maximum input rating of all appliances to be connected to the system. Divide that value by the heating value of the gas to get the maximum demand volume of the system in cubic feet of gas per hour.

STEP 4: Determine Pipe Size

Fourth, locate the appropriate sizing table, see Table 2: IFGC Table 402.4(2)/IRC, Table G2413.4(1), based on the type of pipe, gas, inlet pressure and pressure drop. Select the row in the table that equals the determined length, or the next higher row if the length is between table values. Then select the column in that row that equals the maximum demand of the system. If the value is between columns, select the next larger column. Once the appropriate box in the table is located, the pipe size can be found in that column at the top of the table.

All piping in the system should then be constructed using piping of the size derived from the table. Basing the sizing on the most demanding circuit (longest run) compensates for pressure losses throughout the entire system (see Figure 2 and Table 3).

TABLE 1: ESTIMATED INPUT FOR INITIAL DESIGN PURPOSES. This table is from Annex A of the *Natural Fuel Gas Code* (ANSI 273.1).

APPLIANCE	INPUT BTU/H (APPROX.)
Space Heating Units	
Hydronic boiler	
Single family	100,000
Multiple family, per unit	60,000
Warm-air furnace	
Single family	100,000
Multiple family, per unit	60,000
Space and Water Heating Units	
Hydronic boiler	
Single family	120,000
Multiple family, per unit	75,000
Water Heating Appliances	
Water heater, automatic instantaneous	
Capacity at 2 gal./minute	142,800
Capacity at 4 gal./minute	285,000
Capacity at 6 gal./minute	428,400
Water heater, automatic storage, 30- to 40-gal. tank	35,000
Water heater, automatic storage, 50-gal. tank	50,000
Water heater, domestic, circulating or side-arm	35,000
Cooking Appliances	
Built-in oven or broiler unit, domestic	25,000
Built-in top unit, domestic	40,000
Range, free-standing, domestic	65,000
Other Appliances	
Barbecue	40,000
Clothes dryer, Type 1 (domestic)	35,000
Gas fireplace, direct-vent	40,000
Gas light	2,500
Gas log	80,000
Refrigerator	3,000

For SI: 1 British thermal unit per hour = 0.2931 W.

Longest Length Method Example. Using Schedule 40 Metallic Pipe (see Table 2), size the piping system shown in Figure 2.

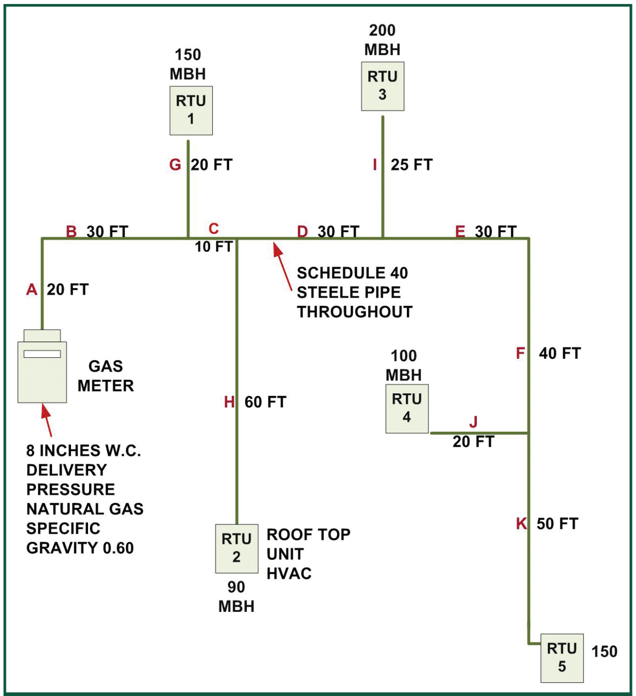

Figure 2 Pipe Sizing System

Solution: The longest run is from the meter (point of delivery) to rooftop unit (RTU) No. 5 and is 210 feet (64,008 mm). To account for pressure loss through the fittings, next add 50 percent of the actual length of piping as an all-inclusive fitting allowance (210 feet x 1.50 = 315 feet). The final result is that all pipe sizes will be chosen from the 350-foot (106,680 mm) row of the table. Determined sizes are shown in Table 3.

A cubic feet per hour (CFH) is the quantity of gas flow in cubic feet, delivered during a time period of one hour. It is calculated by dividing the appliance input with the fuel gas heating value. In our example, 1,000 Btu is the heating value used. The term MBH also is commonly used in lieu of CFH to measure the quantity of gas flow in one hour. One MBH is equal to 1,000 Btu per hour.

Secrets of the Code*Notes*™: How to Check Input Rating of an appliance

1. Turn off all other appliances using gas.
2. Read meter to determine the number of seconds required to burn one cubic foot of gas.
3. Divide number of seconds in one hour (3,600) by the number of seconds required to burn one cubic foot, as determined by No. 2.
4. Multiply result of No. 3 by the BTU content of one cubic foot of gas.

Example:

90 Secs. = Time required to burn one cubic foot of gas.

3,600 = Seconds in one hour.

1,000 = BTU content of one cubic foot of gas.

$\frac{3{,}600}{90} \times 1{,}000 = 40{,}000$ BTU per hour.

TABLE 2: IFGC TABLE 402.4(2)/IRC TABLE G2413.4(1) SCHEDULE 40 METALLIC PIPE (PARTIAL TABLE)

					Gas		Natural	
					Inlet Pressure		Less than 2 psi	
					Pressure Drop		0.5 in. w.c.	
					Specific Gravity		0.60	
Nominal	½	¾	1	1¼	1½	2	2½	3
Actual ID	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068
Length(ft)	Capacity in Cubic Feet of Gas Per Hour							
10	172	360	678	1,390	2,090	4,020	6,400	11,300
20	118	247	466	957	1,430	2,760	4,400	7,780
30	95	199	374	768	1,150	2,220	3,530	6,250
40	81	170	320	657	985	1,900	3,020	5,350
50	72	151	284	583	873	1,680	2,680	4,740
60	65	137	257	528	791	1,520	2,430	4,290
70	60	126	237	486	728	1,400	2,230	3,950
80	56	117	220	452	677	1,300	2,080	3,670
90	52	110	207	424	635	1,220	1,950	3,450
100	50	104	195	400	600	1,160	1,840	3,260
125	44	92	173	355	532	1,020	1,630	2,890
150	40	83	157	322	482	928	1,480	2,610
175	37	77	144	296	443	854	1,360	2,410
200	34	71	134	275	412	794	1,270	2,240
250	30	63	119	244	366	704	1,120	1,980
300	27	57	108	221	331	638	1,020	1,800
350	25	53	99	203	305	587	935	1,650

See Table 3 below for the final pipe sizes and load for each section of pipe in Figure 2.

TABLE 3: FIGURE 2 SOLUTION

PIPE SECTION	LOAD (CFH)	SIZE (in.)
A	690	2½
B	690	2½
C	540	2
D	450	2
E	250	1½
F	250	1½
G	150	1¼
H	90	1
I	200	1¼
J	100	1¼
K	150	1¼

Example: Input, Btu/h ÷ Heating Value (1,000) = CFH)

Other than a very limited exception for minor components, all installation, enlargement, alteration, repair, removal, conversion or replacement of fuel gas piping will require a permit.

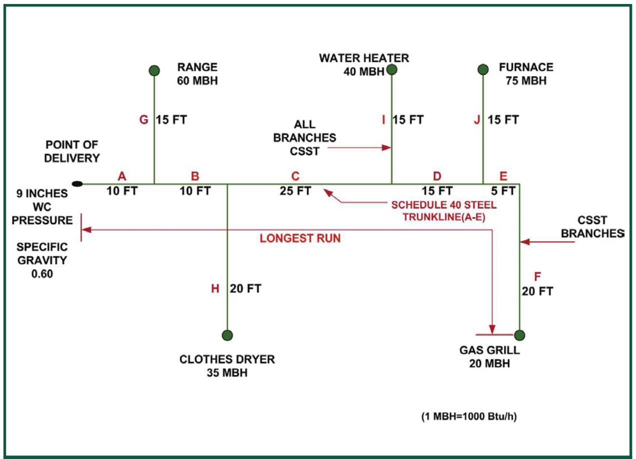

Figure 3 Branch Length Method

IFGC Section 402.4.2/IRC Section G2413.4.2 Branch Length Method. This sizing method is a variation of the longest-length method. Because this method is less conservative, it is especially important to account for the equivalent length of fittings installed in the system (see Figure 3). This method involves multiple piping lengths within a system for application of the tables or equations, whereas the longest length method involves only one piping length per system.

TABLE 4: [IFGC TABLE 402.4(15)/IRC TABLE G2413.4(5) CORRUGATED STAINLESS STEEL TUBING (CSST) (PARTIAL TABLE)

TUBE SIZE (EHD)							
Flow Designation	13	15	18	19	23	25	30
Length (ft)	Capacity in Cubic Feet of Gas Per Hour						
5	46	63	115	134	225	270	471
10	32	44	82	95	161	192	330
15	25	35	66	77	132	157	267
20	22	31	58	67	116	137	231
25	19	27	52	60	104	122	206
30	18	25	47	55	96	112	188
40	15	21	41	47	83	97	162
50	13	19	37	42	75	87	144
60	12	17	34	38	68	80	131
70	11	16	31	36	63	74	121
80	10	15	29	33	60	69	113
90	10	14	28	32	57	65	107
100	9	13	26	30	54	62	101

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 inch water column = 0.2488 kPa, 1 British thermal unit per hour = 0.2931 W, 1 cubic foot per hour = .0283 m^3/h, 1 degree = 0.0 1745 rad.

Notes:
1. Table includes losses for four 90-degree bends and two end fittings. Tubing runs with larger numbers of bends and/or fittings shall be increased by an equivalent length of tubing to the following equation: $L = 1.3n$, where L is additional length (feet) of tubing and n is the number of additional fittings and/or bends.
2. EHD—Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.
3. All table entries have been rounded to three significant digits.

In accordance with Section 402.4.2 Item 2, determine the size of Branch Sections F, G, H, I and J (constructed of CSST) based on the load of each section and the length of piping and tubing from the point of delivery to the outlet on that section. Table 4 is chosen because the branch sections are constructed of CSST and the pressure is less than 0.5 psi [(14 in. w.c) (3.5 kPa)]. Where a length falls between entries in the table, use the next longer length row. See Table 5 and Table 6 for the final pipe sizes and load for each section of pipe in Figure 3.

TABLE 5: SOLUTION A

PIPE SECTION	LOAD (CFH)	SIZE (IN.)
A	230	1¼
B	170	1
C	135	1
D	95	¾
E	20	3/8

TABLE 6: SOLUTION B

CSST BRANCH	LOAD (CFH)	LENGTH PIPING AND TUBING (FT)	SIZE EHD
F	20	85	18
G	60	25	19
H	35	40	18
I	40	60	23
J	75	75	30

CSST is Corrugated Stainless Steel Tubing. It consists of continuous, semi-rigid stainless steel tube with an outer yellow or black plastic jacket covering. Yellow-jacketed CSST was developed first and is the most common. It has a non-conductive plastic yellow jacket. Black-jacketed CSST is relatively new. Its black jacket is electrically conductive. Manufacturer information indicates this conductive jacket dissipates the energy of indirect lightning strikes that might otherwise pierce or damage the yellow-jacketed CSST.