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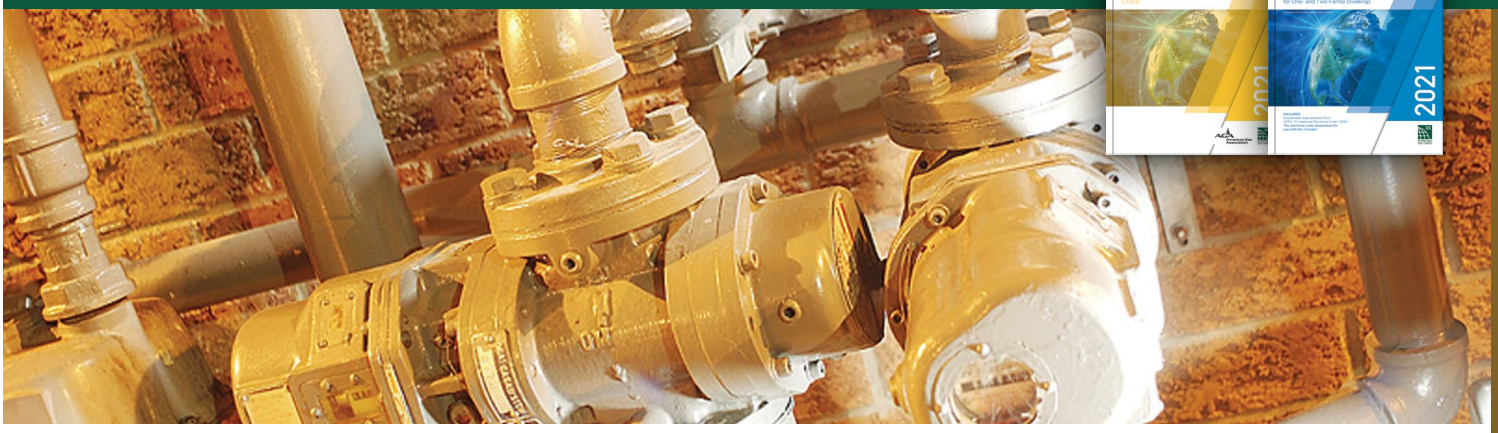
CodeNotes™

Fuel Gas Pipe Sizing Based on the 2021 IFGC® and IRC®



Introduction

This CodeNotes™ provides an overview of fuel gas pipe sizing calculations and requirements in the 2021 International Fuel Gas Code® (IFGC®) and 2021 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 (m3) of gas per hour (CFH), 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/ft3 (37.3 MJ/m3) 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.

Figure 1 Partial View of a Label

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

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

These sections of the IFGC and IRC provide a step-by-step approach to the proper application of the respective code tables using the traditional longest- length method. Utilizing this method of pipe sizing, the pipe size of each section of gas piping in the system is determined using the longest length of piping from the point of delivery to the most remote outlet and the load of the section.

STEP 1: Determine Longest Length of Pipe

Determine the longest pipe run, which is the measured length of pipe from the point of delivery to the most remote gas outlet.

STEP 2: Determine Appliance Demand Volume

Determine the maximum gas demand volume required by each appliance in CFH (this is simply the appliance maximum input rate divided by the heating value of the gas). Note: Table 1 can be used where the input rates for appliances are not known. Add the maximum demand volume of all appliances connected to the system to obtain the maximum system load in CFH.

STEP 3: Select Appropriate Sizing Table

Determine the maximum gas demand volume required by Locate the appropriate sizing table, based on the type of pipe, gas, inlet pressure and pressure drop. See Table 2: IFGC Table 402.4(2)/IRC, Table G2413.4(1).

STEP 4: Gas Piping Sizing

Select the row in the table that equals the longest pipe length determined in Step 1 (if the longest length is between table values, use the row with the next higher value). This row is used to size all gas piping in the system.

For each appliance, select the column in that row that equals the appliance demand volume (if the value is between columns, select the column with the next larger value). Once the appropriate column is located, the required pipe size for that appliance can be found at the top of the table.

To size each section of pipe, add the gas demand for all appliances supplied through that section of pipe. Using the same table row as before, select the column in that row that equals the calculated demand volume for that section of pipe.

TABLE 1: ESTIMATED INPUT FOR INITIAL DESIGN PURPOSES. This table is from Annex A of the National Fuel Gas Code (ANSI 223.1).

APPLIANCE	Input BTU/H (APPROX)
Space Heating Units	
Hydronic boiler	100,000
Single family	60,000
Multiple family, per unit	
Warm-air furnace	100,000
Single Family	60,000
Multiple Family	
Space and Water Heating Unit	
Hydronic boiler	
Single Family	120,000
Multiple family, per unit	75,000
Water Heating Appliance	
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
	40,000
Built-in top unit, domestic	65,000
Range, free-standing, domestic	
Other Appliances	
Barbecue	40,000
Clothes Dryer, Type 1 (domestic)	35,000
	40,000
Gas fireplace, direct vent	2,500
Gas light	80,000
Gas log	3,000
Refrigerator	

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.

Solution: The longest run is from the meter (point of delivery) to rooftop unit (RTU) No. 5 and is 210 feet (64,008 mm). The result is that all pipe sizes will be chosen from the 250-foot (76,200 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 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 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.

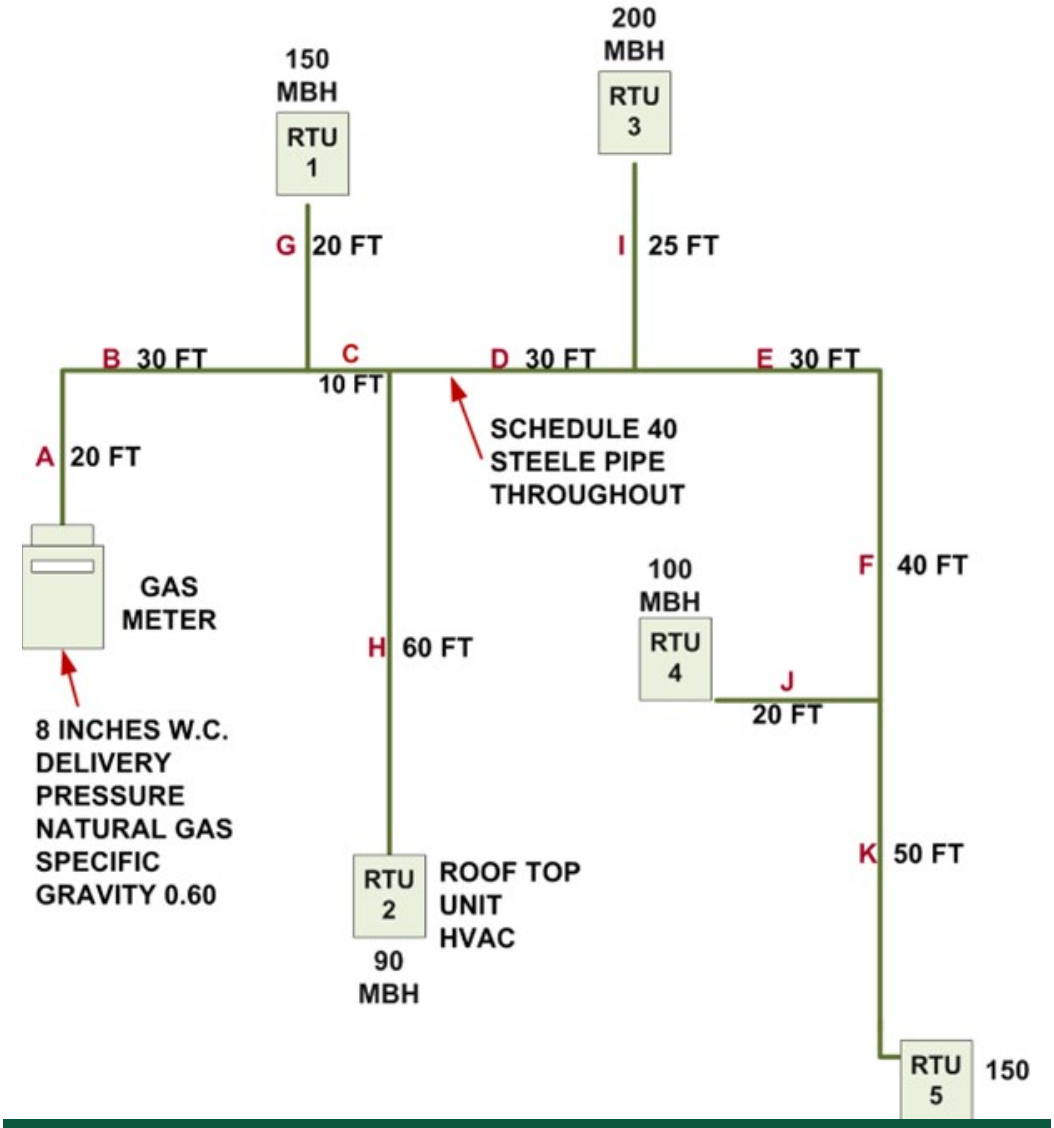


Figure 2 Pipe Sizing Systems

TABLE 2 IFGC Table 402.4(2)/IRC Table G2413.4 (1) Schedule 40 Metallic Pipes (Partial Table)

					Gas		Natural	
					Inlet Pressure		Less than 2 psi	
					Pressure Drop		0.5 in. w.c.	
					Specific Gravity		0.60	
Nominal	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	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	2
B	690	2
C	540	2
D	450	2
E	250	$1^{1/2}$
F	250	$1^{1/2}$
G	150	$1^{1/4}$
H	90	1
I	200	$1^{1/4}$
J	100	1
K	150	$1^{1/4}$

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.

IFGC Section 402.4.2/IRC Section G2413.4.2 Branch Length Method.

IThis sizing method is a less conservative variation of the longest-length method. Whereas the longest length method involves sizing all system piping based solely on the longest piping run length, this method involves sizing based on multiple piping lengths within the system.

As with the longest run method, the pipe size of each section of the longest pipe run from the point of delivery to the most remote outlet is determined using the table row for the longest run of piping and the load of the section of pipe.

The pipe size of all other branch piping, not sized as a section of the longest run, is determined using the table row for the length of piping from the point of delivery to the most remote outlet in each branch and the load of the section.

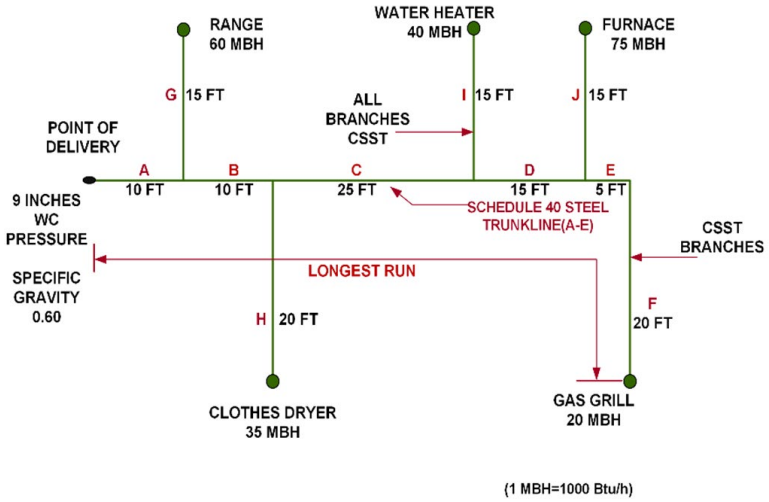


Figure 3 Branch Piping System with Schedule 40 Steel Pipe Trunkline & CSST

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	4	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 m3/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.

IFGC Section 402.4.2 / IRC Section G2413.4.2

Item 1

In accordance with Section 402.4.2 item 2/Section G2413.4.2, determine the size of Branch Sections A, B, C, D, and E (constructed of Schedule 40 steel pipe) based on the load of each section and the longest run length of 85 feet (25,908 mm). Because the system pressure is less than 0.5 psi (14 in. w.c.) (3.5 kPa), Table 4 is chosen. Because the longest run length is between rows in the table, the 90-foot (27,mm) row must be chosen.

Item 2

In accordance with Section 402.4.2 item 2/Section G2413.4.2, 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 section of pipe in Figure 3.

TABLE 5: SOLUTION A

Pipe Section		Load (CFH)	Size (In.)
A		230	1-1/4
B		170	1
C		135	1
D		95	3/4
E		20	3/8

TABLE 6: SOLUTION B

Pipe Section	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.