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Technical Bulletin 111-1/2” Gas Line Piping Information

The information contained in this technical bulletin is for **educational purposes only**. It is **NOT** intended to be an engineering guide or replacement for any national or local codes. All Information was obtained from National Fuel Gas Code, NFPA54, ANSI Z223.1. Gas systems should be designed, installed, and inspected by a licensed professional (Plumber, gas fitter, engineer etc.). Installations must conform with local codes or, in the absence of local codes, with the *National Fuel Gas Code, ANSI Z223.1/NFPA 54*, or the *Natural Gas and Propane Installation Code, CSA B149.1*.

1/2" Gas Line Piping Information (as per ANSI Z223.1-2015)

Sizing and capacities of gas piping for use with tankless water heaters and supplementary gas appliances

General piping considerations:

The first goal of determining the pipe sizing for a fuel gas piping system is to make sure that there is adequate gas pressure at each appliance inlet. Since residential appliances will typically have equal or near equal minimum inlet gas pressure (around 5-inch water column (in. w.c. /1.25 kPa), which should be sufficient for proper operation of system regulator to deliver the requisite 3.5 in. w.c. (0.875 kPa) to the necessary appliance(s). To achieve the abovementioned, the accumulated pressure drop in the piping system should be subtracted from the source delivery pressure to ensure that the minimum required pressure will be available at the furthest appliance.

Conversely, there are other systems, where the required inlet pressure to each appliance may vary. In such instance, the maximum required inlet pressure must be satisfied, together with the requirements for the farthest appliance in the system, which is, more often than not, the critical appliance (in a typical residential and/or light commercial system).

Other requirements:

1) Capacity of the system shall be sized for 100-percent flow.
2) Requirement for minimum flow must be met.
3) Pressure at the inlet to any appliance shall not exceed the pressure rating of the appliance regulator (not super critical for small systems with source pressure of ½ psi (14-inch w.c./3.5 kPa) or less.
4) Pressure at the inlet to any appliance with source pressure greater than ½ psi shall be verified.

To determine the size of piping used in a gas piping system, the following factors must also be considered:

1) Allowable loss in pressure from point of delivery to equipment.
2) Maximum gas demand.
3) Length of piping and number of fittings.
4) Specific gravity of the gas.
5) Diversity factor.

What size gas line does a Rinnai Tankless Water Heater require?

Rinnai Tankless Water Heaters typically require a 3/4" gas line to provide a sufficient gas supply to the unit’s burner. However, if there is sufficient pressure and the gas line is short enough, there are some cases where a 1/2" gas line can be used, which is the most common size used in the United States and Canada. This can make switching from a tank-style water heater to a tankless water heater faster, easier and less expensive.

As with all tankless water heater applications, installers should check and abide by local gas-pipe size and licensing rules and codes.

Example of Piping System Design and Sizing:

Example 1: Longest Length Method (via pipe charts).

Determine the required pipe size of each section and outlet of the piping system shown in Figure 1, with designated pressure drops of both 3.0 in. w.c. (747.3 Pa) and 0.3 in. w.c. (74.73 Pa), using the Longest Length Method. The gas to be used has specific gravity of 0.60 and a heating value of 1000 Btu/ft3 (37.5 MJ/m3).

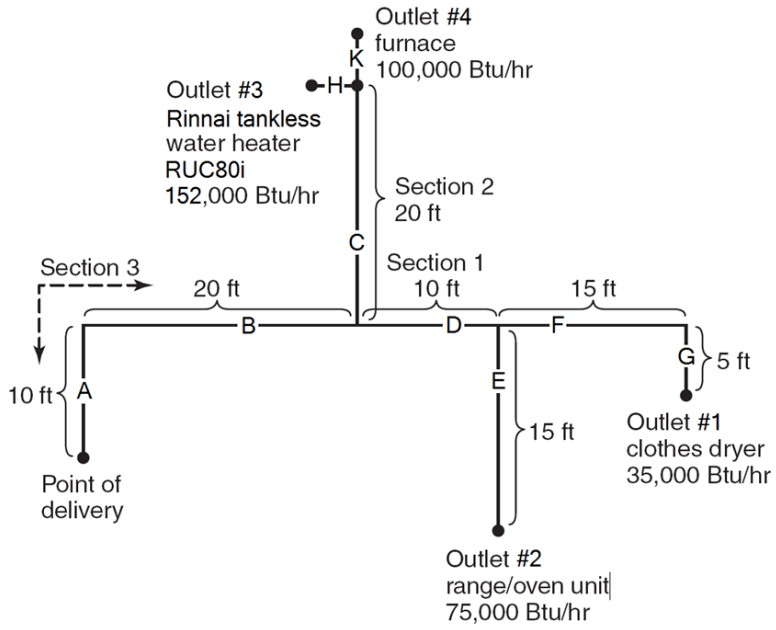

FIGURE 1: Distribution Piping

Solution:

STEP 1: Example conversion (Maximum gas demand for outlet #3):

$$= \frac{\text{Consumption}}{BTU\ of\ gas} = \frac{152{,}000\ \text{Btu/hr}}{1000\ Btu/ft} = 152\ CFH$$

STEP 2: Furthest Outlet [F-G]/Clothes Dryer: (5 ft + 15 ft + 10 ft + 20 ft + 10 ft) = 60 ft. >> Use 60 feet column in **Table 4**, for SCH 40 Metallic Pipe w/ Natural Gas at 3.0 Pressure Drop, and tabulate results in **Table 1** below (Gas Line Sizing Chart per Figure 1).

STEP 3: Size pipe for demand per 60 feet column (Figure 1):
[F-G] 35 CFH, = 1/2" pipe
[D] 35 CFH + 75 CFH = 110 CFH, = 1/2" pipe
[A-B] 110 CFH + 252 CFH = 362 CFH, = 1" pipe

STEP 4: Point of Delivery main (Meter): Use 1" pipe

STEP 5: Size branches by length of run (Figure 1):
[F-G] Clothes Dryer: See above
[E] Range/Oven: 75 CFH; 55', round to 60' = 1/2"
[H] Rinnai Tankless Water Heater: 152 CFH; 52', round to 60'= 1/2"
[K] Furnace: 100 CFH; 52', round to 60' = 1/2"
[C] Branch main: 252 CFH; 50' = 3/4"

Repeat **STEPs 2** thru **5** using **Table 2**,for SCH 40 Metallic Pipe w/ Natural Gas at 0.3 Pressure Drop, and tabulate results in **Table 1** below (Gas Line Sizing Chart per Figure 1).

Table 1: Gas Line Sizing Chart per figure 1

Line Section		Appliance	Name Plate Ratings (BTU/H)	Gas Line Length (Ft)	Minimum Required Pipe Size	
Section	Branch				0.3 in. w.c.	3 in. w.c.
Section 3	**A**	**Gas Supply Main**	**362000**	**10**	1 1/4"	1"
	B			**20**		
Section2	**C**	**Main Branch Line**	**252000**	**20**	1 1/4"	3/4"
	H	Tankless Water Heater	152000	2	1"	1/2"
	K	Furnace	100000	2	3/4"	1/2"
Section 1	**D**	**Main Branch Line**	**110000**	**10**	1"	1/2"
	E	Range/Oven	75000	15	3/4"	1/2"
	F	Clothes Dryer	35000	15	1/2"	1/2"
	G			5		

A close examination of the tabulated gas line sizes in **Table 1** above, reveals that, for a typical gas piping distribution system, a Rinnai RUC80i tankless water heater with a capacity of 152,000 BTU would require a 1-inch gas pipe size, given that the distance from the meter is approximately 60 feet equivalent length and based on the conventional 0.3 in w.c. pressure drop (**Table 2**). Still, **most important** is the fact that said RU80i will require only a 1/2" gas pipe size if based on the 3 in w.c. pressure drop (**Table 4**), all else being equal. **From Table 4, maximum equivalent length of a 1/2" gas line for a Rinnai RUC98i tankless water heater with a capacity of 199,000 BTU is 40 feet.**

Please Note that for simplicity other appurtenances such as elbows, tees, and valves were not included in these sample calculations, their respective equivalent pipe length must be included when sizing an actual gas piping system; refer to NFPA54, ANSI Z223.1 and/or CAN/CSA B149.1 latest edition(s).

For any gas piping system, or special appliance, or for conditions other than those covered by the tables provided in this document, such as hybrid or dual pressure systems, longer runs, greater gas demands or greater pressure drops, the size of each gas piping system should be determined by standard engineering practices acceptable to authorities having jurisdiction.

Table 2: (Schedule 40 Metallic Pipe)

Gas:	***Natural***
Inlet Pressure:	***Less than 2 psi***
Pressure Drop:	***0.3 in. w.c.***
Specific Gravity:	***0.6***

N/A: A flow of less than 10 cfh; All table entres round to 3 significant digits; BTUH = CFH X 1000

	Pipe Size (in)							
Moninal:	*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 (CFH)***							
10	131	273	514	1060	1580	3050	4860	8580
20	90	188	353	726	1090	2090	3340	5900
30	72	151	284	583	873	1680	2680	4740
40	62	129	243	499	747	1440	2290	4050
50	55	114	215	442	662	1280	2030	3590
60	50	104	195	400	600	1160	1840	3260
70	46	95	179	368	552	1060	1690	3000
80	42	89	167	343	514	989	1580	2790
90	40	83	157	322	482	928	1480	2610
100	38	79	148	304	455	877	1400	2470

SOURCE: ANSI Z223.1-2015 Table 6.2(a)

Table 3: (Schedule 40 Metallic Pipe)					**Gas:**	**Natural**		
					Inlet Pressure:	**Less than 2 psi**		
					Pressure Drop:	**0.5 in. w.c.**		
					Specific Gravity:	**0.6**		
N/A: A flow of less than 10 cfh; All table entres round to 3 significant digits; BTUH = CFH X 1000								
	Pipe Size (in)							
Moninal:	*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 (CFH)**							
10	172	360	678	1390	2090	4020	6400	11300
20	118	247	466	957	1430	2760	4400	7780
30	95	199	374	768	1150	2220	3530	6250
40	81	170	320	657	985	1900	3020	5350
50	72	151	284	583	873	1680	2680	4740
60	65	137	257	528	791	1520	2430	4290
70	60	126	237	486	728	1400	2230	3950
80	56	117	220	452	677	1300	2080	3670
90	52	110	207	424	635	1220	1950	3450
100	50	104	195	400	600	1160	1840	3260

SOURCE: ANSI Z223.1-2015 Table 6.2(b)

Table 4: (Schedule 40 Metallic Pipe)					**Gas:**	**Natural**		
					Inlet Pressure:	**Less than 2 psi**		
					Pressure Drop:	**3.0 in. w.c.**		
					Specific Gravity:	**0.6**		
INTENDED USE: *Initial Supply Pressure of 8.0 in w.c. or greater; All table entres round to 3 significant digits; BTUH = CFH X 1000*								
	Pipe Size (in)							
Moninal:	*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 (CFH)**							
10	454	949	1790	3670	5500	10600	16900	29800
20	312	652	1230	2520	3780	7280	11600	20500
30	250	524	986	2030	3030	5840	9310	16500
40	214	448	844	1730	2600	5000	7970	14100
50	190	397	748	1540	2300	4430	7060	12500
60	172	360	678	1390	2090	4020	6400	11300
70	158	331	624	1280	1920	3690	5890	10400
80	147	308	580	1190	1790	3440	5480	9690
90	138	289	544	1120	1670	3230	5140	9090
100	131	273	514	1060	1580	3050	4860	8580

SOURCE: ANSI Z223.1-2015 Table 6.2(c)

Use of sizing equation: Gas lines sizing may also be determined precisely by employing the following formula:

Low-Pressure Gas Formula. Less than 1.5 psi (10.3 kPa):

$$D = \frac{Q^{0.381}}{19.17\left(\frac{\Delta H}{Cr\ X\ L}\right)^{0.206}}$$

D = inside diameter of pipe (in.)
Q = input rate of appliance(s) in cubic feet
ΔH = pressure drop [in. w.c.]
L = equivalent length of pipe
Cr = gas formula factor (**Table 5**)

Table 5: (Cr and Y for Natural Gas and Undiluted Propane at Standard Conditions)

	Formula Factors	
Gas	*Cr*	*Y*
Natural gas	0.6094	0.9992
Undiluted propane	1.2462	0.991

SOURCE: ANSI Z223.1-2015 Table 6.4.2

Example 2: Mathematical Calculations

Using figure 1 above, we can determine the theoretical line size diameter of the gas main with a 3.0 pressure drop.

Given:
Q = 362 CFH
L = 60 Feet
Cr = 0.6094
ΔH = 4.5

$$D = \frac{362^{0.381}}{19.17\left(\frac{4.5}{0.6094\ X\ 60}\right)^{0.206}} = 0.758\ inches$$

Since the calculated diameter is approximately 0.01 inches (rounded) greater than a 3/4" line size capacity, we will err on the side of caution and specify a 1" gas main for this hypothetical situation. It is worth noting that this is the exact line size determined by use of **Table 4**.