This appendix is a direct excerpt from the *2000 International Fuel Gas Code* and no attempt has been made to coordinate with Chapter 24 of the *International Residential Code*.

APPENDIX A (IFGS)

SIZING AND CAPACITIES OF GAS PIPING

Not adopted by the State of Oregon.

(This appendix is informative and is not part of the code.)

In order to determine the size of piping to be used in designing a gas piping system, the following factors must 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.

For any gas piping system, for special gas utilization equipment, or for conditions other than those covered by Tables 402.3(1) through 402.3(4), or Tables 402.3(15), 402.3(16), or 402.3(17) such as 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 the authority having jurisdiction.

Description of Tables

(1) The quantity of gas to be provided at each outlet should be determined, whenever possible, directly from the manufacturer's Btu input rating of the equipment which will be installed. In case the ratings of the equipment to be installed are not known, Table A–1 shows the approximate consumption of average appliances of certain types in Btu per hour.

To obtain the cubic feet per hour of gas required, divide the total Btu input of all equipment by the average Btu heating value per cubic foot of the gas. The average Btu per cubic foot of the gas in the area of the installation may be obtained from the serving gas supplier.

(2) Capacities for gas at low pressure [0.5 psig (35 kPa gauge) or less] in cubic feet per hour of 0.60 specific gravity gas for different sizes and lengths are shown in Tables 402.3(1) and 402.3(2) for iron pipe or equivalent rigid pipe, in Tables 402.3(3) and 402.3(4) for smooth wall semirigid tubing, and Tables 402.3(18), 402.3(19), and 402.3(20) for corrugated stainless steel tubing. Tables 402.3(1) and 402.3(3) are based upon a pressure drop of 0.3 inch (75 pa) water column, whereas Tables 402.3(2), 402.3(4), and 402.3(18) are based upon a pressure drop of 0.5 inch (125 pa) water column. Tables 402.3(19) and 402.3(20) are special low–pressure applications based upon pressure drops greater than 0.5 inch water column (125 pa). In using these tables, no additional allowance is necessary for an ordinary number of fittings.

(3) Capacities in thousands of Btu per hour of undiluted liquefied petroleum gases based on a pressure drop of 0.5 inch (125 pa) water column for different sizes and lengths are shown in Table 402.3(14) for iron pipe or equivalent rigid pipe and in Table 402.3(15) for smooth wall semirigid tubing, and in Table 402.3(23) for corrugated stainless steel tubing. Tables 402.3(24) and 402.3(25) for corrugated stainless steel tubing are based on pressure drops greater than 0.5 inches water column (125 pa). In using these tables, no additional allowance is necessary for an ordinary number of fittings.

(4) Gas piping systems that are to be supplied with gas of a specific gravity of 0.70 or less can be sized directly from Tables 402.3(1) through 402.3(4), unless the authority having jurisdiction specifies that a gravity factor be applied. Where the specific gravity of the gas is greater than 0.70, the gravity factor should be applied.

Application of the gravity factor converts the figures given in Tables 402.3(1) through 402.3(4) to capacities with another gas of different specific gravity. Such application is accomplished by multiplying the capacities given in Tables 402.3(1) through 402.3(4) by the multipliers shown in Table 402.3(13). In case the exact specific gravity does not appear in the table, choose the next higher value specific gravity shown.

(5) Capacities for gas at pressures greater than 0.5 psig (3.5 kPa gauge) in cubic feet per hour of 0.60 specific gravity gas for different sizes and lengths are shown in Tables 402.3(5) to 402.3(12) for iron pipe or equivalent rigid pipe and Tables 402.3(23) and 402.3(24) for corrugated stainless steel tubing.

Use of capacity tables

To determine the size of each section of gas piping in a system within the range of the capacity tables, proceed as follows: (Also see sample calculation at end of Appendix A.)

1. Determine the gas demand of each appliance to be attached to the piping system. Where Tables 402.3(1) through 402.3(23) are to be used to select the piping size, calculate the gas demand in terms of cubic feet per hour for each piping system outlet. Where Tables 402.3(25) through 402.3(34) are to be used to select the piping size, calculate the gas demand in terms of thousands of Btu per hour for each piping system outlet.
2. Where the piping system is for use with other than undiluted

liquefied petroleum gases, determine the design system pressure, the allowable loss in pressure (pressure drop), and the specific gravity of the gas to be used in the piping system.

3. Measure the length of piping from the point of delivery to the most remote outlet in the building. Where a multipressure gas piping system is used, gas piping shall be sized for the maximum length of pipe measured from the gas pressure regulator to the most remote outlet of each similarly pressured section.
4. In the appropriate capacity table, select the column showing the measured length, or the next longer length if the table does not give the exact length. This is the only length used in determining the size of any section of gas piping. If the gravity factor is to be applied, the values in the selected column of the table are multiplied by the appropriate multiplier from Table 402.3(24).

   Capacities of smooth wall pipe or tubing may also be determined by using the following formulae*:

High Pressure [1.5 psig (10.3 kPa) and above]:

$$Q = 181.6\sqrt{\frac{D^5 \cdot \left(P_1^{\,2} - P_2^{\,2}\right) \cdot Y}{Cr \cdot fba \cdot L}}$$

$$= 2237\, D^{2.623} \left[\frac{(P_1^{\,2} - P_2^{\,2}) \cdot Y}{Cr.L}\right]^{0.541}$$

Low Pressure [Less than 1.5 psig (10.3 kPa)]:

$$Q = 187.3\sqrt{\frac{D^5 \cdot \Delta H}{Cr \cdot fba \cdot L}}$$

$$= 2313\, D^{2.623} \left(\frac{\Delta H}{Cr.L}\right)^{0.541}$$

where

Q = Rate, cubic feet per hour at 60°F and 30 inch mercury column

D = Inside diameter of pipe, inches (mm)

P_1 = Upstream pressure, psia

P_2 = Downstream pressure, psia

Y = Superexpansibility factor = 1/supercompressibility factor

Cr = Factor for viscosity, density, and temperature

$= 0.00354\, ST \left(\frac{Z}{S}\right)^{.152}$

S = Specific gravity of gas at 60°F and 30 inch mercury column

T = Absolute temperature, °F or = t + 460 (°C)

t = Temperature, °F

Z = Viscosity of gas, centipoise (0.012 for natural gas, 0.008 for propane), or = 1488μ

m = Viscosity, pounds per second ft

fba = Base friction factor for air at 60°F (CF = 1)

L = Length of pipe, feet (m)

ΔH = Pressure drop, in. water column (27.7 in. H_2O = 1 psi)

CF = Factor CF = $\left(\frac{fb}{fba}\right)$

fb = Base friction factor for any fluid at a given temperature, °F

*For further details on the formulae, refer to “Polyflo Flow Computer,” available from Polyflo Company, 3412 High Bluff, Dallas, Texas 75234.

†For values for natural gas, refer to Manual for Determination of Supercompressibility Factors for Natural Gas, available from American Gas Association, 1515 Wilson Boulevard, Arlington, Virginia 22209. For values for liquefied petroleum gases, refer to *Engineering Data Book*, available from Gas Processors Association, 1812 First Place, Tulsa, Oklahoma 74102.

5. Use this vertical column to locate ALL gas demand figures for this particular system of piping.
6. Starting at the most remote outlet, find in the vertical column just selected the gas demand for that outlet. If the exact figure of demand is not shown, choose the next larger figure below in the column.
7. Opposite this demand figure, in the first column at the left, will be found the correct size of gas piping.
8. Proceed in a similar manner for each outlet and each section of gas piping. For each section of piping, determine the total gas demand supplied by that section.

Table A-1
APPROXIMATE GAS INPUT FOR TYPICAL APPLIANCES

APPLIANCE	INPUT BTU PER HR. (APPROX.)
Range, free standing, domestic	65,000
Built-in oven or broiler unit, domestic	25,000
Built-in top unit, domestic	40,000
Water heater, automatic storage 30 to 40 gal. tank	45,000
Water heater, automatic storage 50 gal. tank	55,000
Water heater, automatic instantaneous	
Capacity: 2 gal. per minute	142,800
Capacity: 4 gal. per minute	285,000
Capacity: 6 gal. per minute	428,400
Water heater, domestic, circulating or side-arm	35,000
Refrigerator	3,000
Clothes dryer, type 1 (domestic)	35,000
Gas light	2,500
Incinerator, domestic	35,000

For SI: 1 Btu per hour = 0.293 W

NOTE: For specific appliances or appliances not shown above, the input should be determined from the manufacturer’s rating.

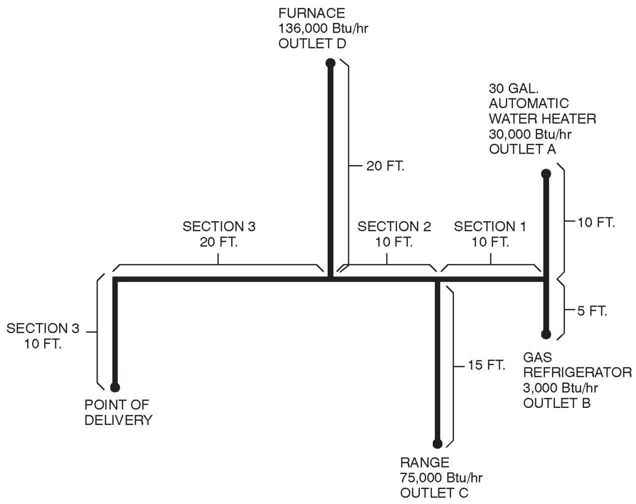

Exhibit 1

For SI: 1 foot = 304.8 mm, 1 Btu/h = 0.2931 KW, 1 gallon = 3.785 L.

Example of piping system design:

Determine the required pipe size of each section and outlet of the piping system shown in Exhibit 1, with a designated pressure drop of 0.50 inch water column (125 pa). The gas to be used has 0.65 specific gravity and a heating value of 1,000 Btu per cubic foot (37.5 Mj/m^3).

Solution:

(1) Maximum gas demand for outlet A:

$$\frac{\text{Consumption (rating plate input, or Table A-1 if necessary)}}{\text{Btu of gas}} =$$

$$\frac{\text{30,000 Btu per hour rating}}{\text{1,000 Btu per cubic foot}} = \frac{\text{30 cubic feet per hour}}{\text{(or 30 cfh)}}$$

Maximum gas demand for outlet B:

$$\frac{\text{Consumption}}{\text{Btu of gas}} = \frac{3{,}000}{1{,}000} = 3 \text{ cfh}$$

Maximum gas demand for outlet C:

$$\frac{\text{Consumption}}{\text{Btu of gas}} = \frac{75{,}000}{1{,}000} = 75 \text{ cfh}$$

Maximum gas demand for outlet D:

$$\frac{\text{Consumption}}{\text{Btu of gas}} = \frac{136{,}000}{1{,}000} = 136 \text{ cfh}$$

(2) The length of pipe from the point of delivery to the most remote outlet (A) is 60 feet (18.3 m). This is the only distance used.

(3) Using the column marked 60 feet (18.3 m) in Table 402.3(2):

Outlet A, supplying 30 cfh (0.8 m^3/hr), requires $^3/_8$ inch pipe.

Outlet B, supplying 3 cfh (0.08 m^3/hr), requires $^1/_4$ inch pipe.

Section 1, supplying outlets A and B, or 33 cfh (0.9 m^3/hr), requires $^3/_8$ inch pipe.

Outlet C, supplying 75 cfh (2.1m^3/hr), requires $^3/_4$ inch pipe.

Section 2, supplying outlets A, B, and C, or 108 cfh (3.0 m^3/hr), requires $^3/_4$ inch pipe.

Outlet D, supplying 136 cfh (3.8 m^3/hr), requires $^3/_4$ inch pipe.

Section 3, supplying outlets A, B, and C, or 244 cfh (6.8 m^3/hr), requires 1 inch pipe.

(4) If the gravity factor [*see (d) under Description of Tables*] is applied to this example, the values in the column marked 60 feet (18.3 m) of Table 402.3(2) would be multiplied by the multiplier (0.96) from Table 402.3(24) and the resulting cubic feet per hour values would be used to size the piping.