according to the type of installation encountered. The manufacturer's specific instructions contained in the installation manual required to be supplied with each burner should be followed. It is possible through the use of suitable indicators to determine whether carbon monoxide is present in flue gases. Carbon monoxide should not exceed 0.04 percent when operating at the maximum gas input to the burners.

During recent years, the use of fuel gas (natural, manufactured, and liquified petroleum) has become increasingly popular for heating tourist cabins and motels. Due largely to the intermittent use of such equipment and the fact that so many of the users are entirely unfamiliar with the fundamentals governing its operation, many special and unusual problems arise. The importance of safe-guarding the public interest has prompted some state and city officials to adopt and enforce legislation governing not only the manner in which these appliances are installed but the extent to which they must be equipped with reliable safety devices, for example, connection to an effective flue is mandatory. Furthermore, all such heating equipment must incorporate an automatic ignition pilot which will shut off gas supply to the main burner or burners in the event of pilot outage. If liquified petroleum gas is used, the automatic pilot must cut off all gas supply to the appliance, including the pilot burner, in case the pilot flame becomes extinguished.

Ratings for Gas Appliances

Input rating for a gas appliance is established by demonstrating that the appliance can meet the Approval Requirements of the *ASA*. The tests are conducted at the *A.G.A. Laboratories*. Output rating is determined from the approved input and an average efficiency stated in the Approval Requirements, and is the heat available at the outlet.

Sizing Gas-Fired Heating Plants

Although gas-burning equipment usually is completely automatic, maintaining the temperature of rooms at a predetermined figure, there are some manually controlled installations. In order to overcome effectively the starting load and losses in piping, a manually-controlled gas boiler should have an output as much as 100 per cent greater than the equivalent standard radiation which it is expected to serve.

Boilers under thermostatic control, however, are not subject to such severe pick-up loads and consequently, it is possible to use a lower selection factor. For a gas-fired boiler or furnace under thermostatic control, a factor of 20 to 25 percent is usually sufficient for pick-up allowance.

In those installations, in mild climates where 100 per cent outside air is used, furnaces should be of larger size in order to provide adequate capacity and quick pick-up under intermittent heating conditions.

The factor to be allowed for loss of heat from piping will vary somewhat, the proportionate amount of piping installed being greater for small installations than for large ones. For selection factors to be added to installed radiation under thermostatic control, see Chapter 16.

Appliances used for heating with gas should bear the approval seal of the *A.G.A. Laboratories* on the manufacturer's nameplate, together with the official input and output ratings. It is not permissible to operate a gas heating unit above its stated rating. It may be necessary to operate below this rating at elevations above 2000 ft, unless the appliance has been tested and approved for operation at altitudes up to 5200 ft, in which case such approval will be shown on the manufacturer's nameplate. Installations should be made in accordance with recommendations shown in the publications of the *American Gas Association*.

Controls

Temperature controls for gas burners are described in Chapter 38. Some central heating plants are equipped with push-button or other manual control. The main gas valve may be of either the snap action or throttling type. Automatic electric ignition is available.

Sizing of Gas Piping

Piping for gas appliances should be of adequate size, and so installed as to provide a supply of gas sufficient to meet the maximum demand without undue loss of pressure between the point of supply (the meter) and the burner. The size of gas pipe required depends upon the following:

1. Maximum gas consumption to be provided.

TABLE 3. CAPACITY OF GAS PIPING

Length of Pipe in Feet	Nominal Diameter of Pipe in Inches				
	¾	1	1¼	1½	2
	Capacity—Cu Ft Per Hr with a 0.6 Sp Gr Gas and Pressure Drop of 0.3" Water Column				
15	172	345	750		
30	120	241	535	850	
45	99	199	435	700	
60	86	173	380	610	
75	77	155	345	545	
90	70	141	310	490	
105	65	131	285	450	920
120		120	270	420	860
150		109	242	380	780
180		100	225	350	720

2. Length of pipe and number of fittings.
3. Allowable loss in pressure from the outlet of the meter to the burner.
4. Specific gravity of the gas.

To obtain the cubic feet per hour of gas required by the burner, divide the Btu input at which the burner will be adjusted, by the average Btu heating value per cubic foot of the gas.

Capacities of different sizes and lengths of pipe, in cubic feet per hour, with a pressure drop of 0.3 in. of water column for a gas of 0.60 sp gr, are shown in Table 3. In adopting a 0.3 in. pressure drop, due allowance for an ordinary number of fittings was made.

To convert the figures given in Table 3 to capacities for another gas of different specific gravity, multiply the tabular values by the multipliers shown in Table 4.

COMMERCIAL AND INDUSTRIAL GAS EQUIPMENT

No attempt can be made, due to space limitation, to describe or classify the varied types of equipment used for commercial and industrial applications. Much of the equipment utilized is custom built to suit a particular process. Certain standard parts such as venturi and burner head sets,