there were neither friction nor cooling of the gases as they traversed the chimney. After the ideal draft for a given chimney height and entering flue-gas temperature from Fig. 3 has been obtained, and the appropriate efficiency value from Table 2 has been selected, the available draft can be computed from Equation 1. Fig. 3 can be used in reverse in conjunction with efficiency values from Table 2 to determine what chimney height is required to produce the required draft at rated output for a given heating appliance.

Fig. 2 shows that the efficiency of a given chimney varies with the mass flow rate of gases and with the entering flue-gas temperature. The efficiency also varies with the height for a given construction and depends somewhat on the method used to connect the smokepipe to the chimney, and on the amount of exposure to the outdoor air. Experimental data are not sufficiently complete to tabulate efficiencies that take into account all of these variables. However, recommended values of efficiency for several sizes of domestic chimneys of masonry materials and of metal have been selected from the literature[6,8,9,10] and summarized in Table 2 for use with Fig. 3 in determining the available draft produced by short chimneys of 15 ft in height or lower. In parts A and B of Table 2, the value of efficiency chosen from the range cited should be increased as the chimney inlet temperature increases over the applicable range. In part C of Table 2, the efficiency values listed will yield the available draft for the range of mass flows, inlet flue-gas temperatures, and chimney height shown, within 10 percent.

In the application of short chimneys, observance of the following precautions will assist the designer in obtaining the highest draft practicable and may correct unsatisfactory operation of the chimney and heating plant in certain instances:

1. Use a minimum length of horizontal smokepipe between the heater and chimney.
2. Insulate the smokepipe and the chimney itself, if made of metal. Insulation of the chimney liner in masonry chimneys reduces the heat loss from the flue gases and the infiltration of cold air.
3. Do not use an oversized chimney because larger chimneys produce greater cooling of the flue gases.
4. Avoid downdrafts by proper construction above the roof or by the use of a suitable chimney cap.
5. Avoid the use of barometric dampers in the smokepipe of natural-draft heaters, since most barometric dampers permit enough cold air to leak into the chimney to reduce the draft appreciably.
6. Avoid air leaks in the smokepipe and chimney.
7. Avoid connecting more than one heating device to a single chimney.
8. Use construction materials of low heat capacity if the chimney draft must increase quickly for an intermittently-fired heating device.
9. Do not operate a kitchen exhaust fan unless an air intake of ample area is used to prevent lowering the house pressure.
10. Avoid tight utility closets so the chimney draft will not be required to do the added work of drawing combustion air into the closet from the surroundings.

GAS APPLIANCE VENTING

Gas-burning appliances approved by the American Gas Association as vented equipment must be connected to an effective gas vent or chimney. The primary function of the gas vent or chimney is to safely remove the products of combustion from the space being heated.

Factory Built Chimneys

Factory built chimneys are listed by Underwriters' Laboratories for use with all gas appliances as well as all other types of fuel-burning equipment. These should be installed according to the manufacturers' instructions and their listing.

Table 2 .... Efficiency of Short Chimneys

A. Masonry Chimneys

Height h ft	Flue Gas Flow Rate lb/hr	Internal Liner Size, in.		
		7 (dia)	7 x 7	7 x 11 and 10 (dia)
		Efficiency, Percent		
5 to 15	90	75–82	65–76	65–80
	200	83–84	67–85	82–88
	315	75–89	67–86	81–89
		(Inlet Flue Gas Temp. 200 to 1000 F)		

B. Uninsulated Metal Chimneys

Height h ft	Flue Gas Flow Rate lb/hr	Internal Diameter, in.	
		6	8
		Efficiency, Percent	
4 to 8	90	90–100	85–95
	200	"	83–88
	315	"	70–80
		(Inlet Flue Gas Temp. 200 to 600 F)	

C. Metal Chimneys[b]

Height h ft	Uninsulated	1-in. insulation with dead air space around chimney	1-in. insulation with 1-in. open air space around chimney
	Efficiency, Percent		
8 to 14	76	85	81

[a] Six-inch chimney not recommended for these flow rates.
[b] Internal dia 6-in.; flue gas flow rate 50 to 125 lb/hr; inlet flue gas temp. 200 to 1000 F.

Brick and Metal Chimneys

Masonry and metal chimneys may be used with gas appliances as well as all other types of fuel-burning equipment. Brick chimneys should be lined to aid prompt establishment of draft and to prevent damage to the chimney by the water vapor that condenses from the flue gases.

Type B Gas Vents

Type B gas vents are listed by Underwriters' Laboratories, and are recommended for venting all vented gas-burning appliances except incinerators, appliances which may be converted readily to the use of solid or liquid fuel, and combination gas-oil burning appliances.

Type B-W gas vents are listed by Underwriters' Laboratories, for use with A.G.A. approved vented recessed heaters.

Specific installation clearances may be found on listed type B and B-W vents in the current *Gas & Oil Equipment List* published by Underwriters' Laboratories.

Complete installation instructions for gas vents will be found in *NFPA* No. 54 or *ASA* Z21.30—1959 *Standard for the Installation of Gas Appliances and Gas Piping*, (National Fire Protection Association or American Standards Association). The most recent report[11] of the American Gas Association should also be consulted.

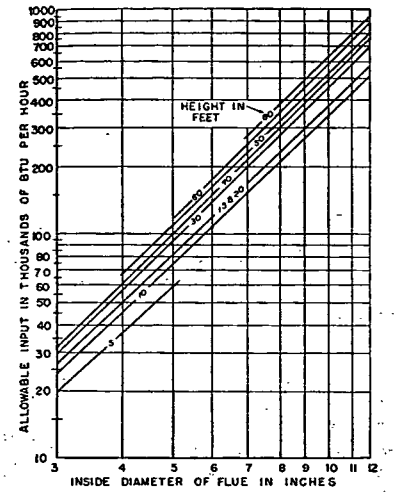

Fig. 4 .... Capacity in Btu per Hour for Gas Vents or Chimneys Serving More Than One Appliance

The minimum flue or vent sizes adopted by the American Standards Association and the National Board of Fire Underwriters in 1950 for gas appliances[12] are shown in Fig. 4.

Additional provisions of *ASA Standard* Z21.30—1959 relating to chimney size are:

1. The gas vent or chimney when connected to a single appliance shall be not less than the size of the draft hood outlet.
2. When more than one appliance is connected to a gas vent or chimney, the area of the passageway shall be not less than the area of the largest vent connector plus 50 percent of the areas of additional vent connectors.
3. Any shape of gas vent may be used, provided its venting capacity is equal to the capacity of round pipe for which it is substituted, and the minimum internal dimension of the gas vent is not less than 2 in.

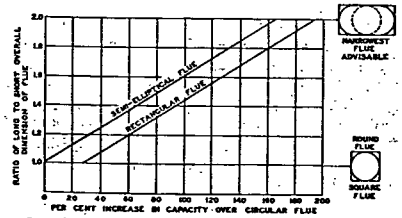

Fig. 5 .... Capacity of a Rectangular Flue or a Semi-Elliptical Flue, with Semi-Circular Ends Having Its Minimum Width Equal to the Diameter of a Circular Flue, Compared with the Capacity of the Circular Flue

Since Fig. 4 has been prepared for circular flues, relative capacities for rectangular and semi-elliptical flues[13] are shown in Fig. 5.

Heating appliances designed to burn gas, as well as appliances converted to gas burning, except those equipped with power-type burners and excepting conversion burner installations in excess of 400,000 Btu per hr input, are usually equipped with a draft hood attached to the flue outlet of the appliance. This draft hood is required if the appliance is to meet the approval requirements of the American Gas Association and the American Standards Association, and is essential for safe operation. It is designed to prevent excessive chimney draft which would lower appliance efficiency, to prevent a blocked flue or a downdraft in the chimney from impairing combustion, to provide a relief opening for the products of combustion during downdraft or blocked-flue conditions, and to prevent spillage of the products of combustion to the space surrounding the appliance, if there is a chimney draft equivalent to that provided by a 3-ft chimney. Because the draft hood is designed without moving parts, the relief opening is always open, and consequently some air is drawn into the chimney. This air lowers the gas temperature in the chimney, but it also lowers the dew point of the gases and tends to prevent condensation.

The installation of conversion burner equipment in large boilers is usually made in accordance with regulations of the local gas company. In such installations a definite chimney draft may be required for proper combustion, and the foregoing reference to the use of draft hoods would not apply.

Sealed combustion chamber appliances are so constructed and installed that all air for combustion is drawn from outdoors and all combustion products are discharged to the outside atmosphere. With the air intake and combustion product discharge located adjacent to each other in the same pressure zone, location of the terminal on a side wall does not usually present a problem.

The products of complete combustion of gas are water vapor and carbon dioxide. In the case of manufactured gas, the presence of organic sulfur compounds, generally between 3 and 15 grains per hundred cubic feet, gives rise to minute percentages of sulfur dioxide and sulfur trioxide. The volume of water vapor in the flue products from natural or coke oven gas is about twice the volume of carbon dioxide. It is extremely important that the chimney be tight and resistant to corrosion, not only from moisture, but also from dilute sulfur trioxide.

Clay linings with joints which prevent retention of moisture, and linings made of noncorrosive materials, are advantageous. The interior protection of unlined chimneys by applying an asphalt-chromate emulsion has been investigated by some gas companies, but the material is not of current interest because insurance companies do not favor potentially combustible coatings.[14]

An investigation of damage occurring in 78,129 chimneys used for venting gas appliances in a severe climate has been made by the Minneapolis Gas Company, with the results shown in Table 3 taken from Reference 14.

Advice regarding recommended practice and materials for flue connections and chimney linings can usually be obtained from the local gas company and should be given careful consideration.