an outdoor temperature of 0 F since this is likely to be the more critical condition with respect to chimney draft. The available draft for outdoor temperatures between 0 F and 60 F can be obtained by interpolation from Figs. 4 and 5 with only slight error.

Fig. 6 is a graphical representation of the available draft for a 13-ft brick chimney with a nominal 8 × 8-in. flue liner[7] over a wide range of mass flow rates and for inlet flue-gas temperatures ranging from 200 to 1000 F. This family of curves is a typical group of performance curves showing that there is a certain mass flow rate that produces a maximum available draft for any flue-gas temperature.

The following approximate method may alternately be used to determine the available draft for small residential chimneys, from 10 to 25 ft in height

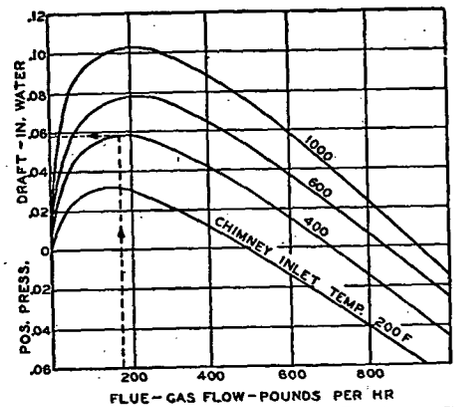

FIG. 6. AVAILABLE CHIMNEY DRAFT FOR 13 FT BRICK CHIMNEY[a, b]

[a] Square Flue Liner 6¾ x 6¾ in. inside.
[b] Barometric Pressure 29.92 in. Hg. Air Temperature 60F.

and with internal cross-section areas from 35 to 55 sq in., with a maximum probable error of ± 15 percent at the same flow and temperature conditions. This method is based on the chimney efficiencies[7] shown in Fig. 7 and the ideal draft computed from the chimney inlet temperature. The available draft may be expressed as:

$$D_a = n_c D_i \tag{13}$$

where

n_c = chimney efficiency taken from Fig. 7 at the desired conditions of temperature and flow.

D_i = ideal draft, calculated from Equation 14, assuming that the barometric pressure is 29.92 in Hg, and the ambient temperature is 60 F.

$$D_i = 0.2554 B_o H \left(\frac{1}{T_o} - \frac{1}{T_i}\right) \tag{14}$$

where

B_o = barometric pressure, inches of mercury.

H = chimney height, feet.

T_i = chimney inlet temperature, Fahrenheit degrees, absolute.

T_o = ambient air temperature, Fahrenheit degrees, absolute.

The clay-lined brick chimney is the most commonly used chimney, but recently other building materials have been used for reasons of economy or convenience. Investigations have established that the results shown in Figs. 4 and 5 for brick chimneys can be used, with slight error, for chimneys made of shale tile, concrete block, or cinder block.[8]

SHORT CHIMNEYS

The application of heating systems to one-story houses without basements requires special consideration because the chimneys in such houses

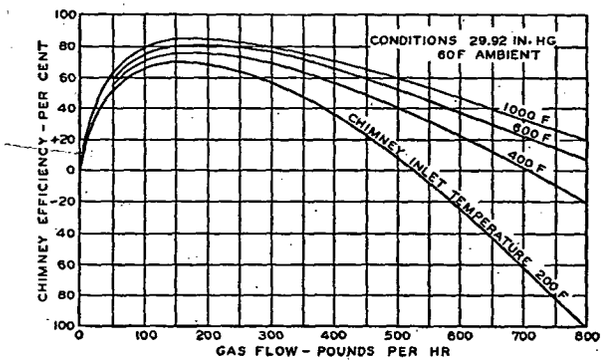

FIG. 7. EFFECT OF GAS FLOW ON CHIMNEY EFFICIENCY[a]

[a] Derived from temperature plots. Liner 8 x 8 in. outside, 6¾ x 6¾ inside. Height 13 ft.

are often made so low in height for architectural reasons that they produce insufficient draft for some kinds of heating systems. Gas-burning devices do not necessarily require a chimney for proper combustion of the gas, but the chimney must be of adequate size and height to carry the flue gases out of the building since it is undesirable and contrary to *American Standards* to have the products of combustion discharged in the living space. If a natural-draft oil-burning device is operated with insufficient draft because of a short chimney, smoky combustion usually occurs, pulsations are possible in the combustion chamber, the chimney or smoke-pipe may become blocked with soot, and the capacity of the heating equipment may be reduced to the point of inadequacy. Insufficient draft is not ordinarily the cause of smoky combustion in coal-burning heaters, but too short a chimney can cause slow pickup of the fire and insufficient heating capacity of the device.

Based on the amount of draft usually required for present-day heating systems at rated output, any chimney with an effective height of less than 15 ft above the center line of the thimble should be regarded as a short chimney. In short chimneys every precaution should be taken to attain the highest possible average temperature in the chimney and the lowest practicable friction loss. Short chimneys of conventional construction are likely to produce from 60 to 90 percent of the ideal draft and, therefore,