factor not allowed for in the estimating method will become controlling and thus give discrepant and even ridiculous results.

Of the various estimating methods in use attention is directed in this discussion to but two as they are illustrative of all, viz: (1) calculated heat loss method, and (2) degree-day method.

CALCULATED HEAT LOSS METHOD

This method is theoretical and assumes constant temperatures for very definite hours each day throughout the entire heating season. It does not take into account factors which are difficult to evaluate such as opening of windows, abnormal heating of the building, poor heating systems, winter heat gains, such as sun effect, and many others.

In order to apply this method the hourly heat loss from the building under maximum load, or design condition, is computed following the principles discussed in Chapters 4 and 5 and the method described and illustrated in Chapter 6.

In some cases, however, depending on the presence of interior partitions, the computed heat loss is modified when used for estimating the heat or fuel consumption. If the building has no interior walls or partitions then, by the method of Chapters 5 and 6, the infiltration losses are calculated by using only half the total window crack. In such a building the calculated loss need not be modified in order to prepare heat or fuel estimates by this method. Where the building does contain interior walls or partitions instead of using as the calculated heat loss (H) which is equal to the sum of the transmission losses (H_t) and the infiltration losses (H_i), it is more desirable to let $H = H_t + \frac{H_i}{2}$.

In predicting fuel consumption for heating a building by the Calculated Heat Loss Method, the general equation is:

$$F = \frac{H\,(t - t_a)\,N}{E\,(t_d - t_o)\,C} \qquad (1)$$

where

F = quantity of fuel or energy required (in the units in which C is expressed).
H = calculated heat loss, Btu per hour, during the design hour, based on t_o and t_d $\left(\text{generally } H = H_t + H_i \text{ but may on occasion equal } H_t + \frac{H_i}{2}\right)$.
t = average inside temperature maintained during heating period, degrees Fahrenheit.
t_a = average outside temperature through estimate period, degrees Fahrenheit (for cities with an Oct. 1-May 1 heating season, see Table 3, Chapter 6).
t_d = inside design temperature, degrees Fahrenheit (usually 70 F).
t_o = outside design temperature, degrees Fahrenheit (see Fig. 1 or Table 3 in Chapter 6).
N = number of heating hours in estimate period (for an Oct. 1—May 1 heating season, 212 days × 24 hr = 5088).
E = efficiency of utilization of the fuel over the period, expressed as a decimal; not the efficiency at peak or rated load condition.
C = heating value of one unit of fuel or energy.

Although the assumption of an Oct. 1-May 1 heating season is reasonably accurate in the well-populated New York-Chicago zone it is not

valid as far north as Minneapolis nor farther south than Washington, D. C. and St. Louis. Consequently, it is suggested that allowance be made for this variation, especially in the far north or southern cities.

Example 1. A residence in Chicago is to be heated to 70 F from 6 A.M. to 10 P.M. and 55 F from 10 P.M. to 6 A.M. The calculated hourly heat loss is 120,000 Btu per hour based on 70 F inside at −10 F outside. If the building is to be heated by metered steam, how many pounds would be required during an average heating season?

Solution. The heating value of steam may be taken as 1000 Btu per pound, and since it is purchased steam, the efficiency can be assumed as 100 per cent. From Table 3, Chapter 6, t_a = 36.4 F. The average inside temperature is:

$$\frac{(16 \times 70) + (8 \times 55)}{24} = 65 \text{ F.}$$

Substituting in Equation 1:

$$F = \frac{120{,}000\,(65 - 36.4)\,5088}{1.00\,[70 - (-10)]\,1000} = 218{,}275 \text{ lb.}$$

Example 2. How much would the fuel cost to heat the building in Example 1 during an average heating season with coal at \$8 per ton and with a calorific value of 11,000 Btu per pound, assuming that the seasonal efficiency of the plant was 55 per cent?

Solution. Substituting in Equation 1: $F = \frac{120{,}000\,(65 - 36.4)\,5088}{0.55\,[70 - (-10)]\,11{,}000} = 36{,}079$ lb $\doteq$ 18 tons, which, at \$8 per ton, costs \$144.

Several time-saving procedures have been devised for quickly estimating the heat consumption of one and two-story residences in order that fuel estimates can be predicted more quickly from Equation 1. A graphical method of calculating heat losses has been developed[1] which makes possible a quick solution if the gross wall, ceiling, or floor areas and respective transmission coefficients are known.

The Federal Housing Administration has originated a short-cut formula for residential heat loss determinations which makes use of the floor area and three selected transmission coefficients. Equation 2 is for a one-story residence and Equation 3 is intended for two-story structures.

$$H_1 = A\,(0.45 + U_w + U_c + U_f)\,(t_d - t_o) \qquad (2)$$

$$H_2 = A\,(0.45 + 1.2\,U_w + 0.5\,U_c + 0.5\,U_f)\,(t_d - t_o) \qquad (3)$$

where

H_1 = heat loss from one-story residence, Btu per hour.
H_2 = heat loss from two-story residence, Btu per hour.
A = floor area, square feet.
U_w = coefficient of transmission for outside wall.
U_c = coefficient transmission for ceiling from air in rooms to air in attic space (for ventilated attics).
U_f = coefficient of transmission for floor from air in rooms to air in basement.
t_d = inside design temperature, degrees Fahrenheit.
t_o = outside design temperature, degrees Fahrenheit.

Both the graphical method and short-cut formula have been found to give accurate and consistent results for the average residence, but if precise estimates are required, the procedure outlined in Chapter 6 should be used.

[1] Graphical Method of Calculating Heat Losses, by Paul D. Close (A.S.H.V.E. JOURNAL SECTION, *Heating, Piping and Air Conditioning*, June, 1943, p. 305).