records to be sure that they do not include energy or fuel used for other purposes than heating the building.

Estimates based on computed heat losses alone are frequently the only ones possible to obtain especially where new equipment is put into unusual buildings and there is a scarcity of records and an absence of experience data. Such estimates also have to be made where direct information is not obtainable as, for example, if a survey is being made without the assistance or knowledge of the building operator and thus without information as to the actual consumption. Estimates of this kind are also useful in some cases where a *relative* standard of performance is desired to serve as a base of comparisons in a campaign of fuel utilization. In such situations it can be plausibly argued that an estimate based on computed heat quantities is to be preferred to one which is related to operating methods.

In interpreting and evaluating heat or fuel consumption estimates as well as in their preparation, it is well to realize that any estimating method used will produce a more reliable result over a long period operation than over a short period. Nearly all of the methods in common use will give *trustworthy results* over a full annual heating season, and in some cases such estimates will prove consistent within themselves for monthly periods. As the period of the estimate is shortened there is more chance that some 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, sun effect, poor heating systems, 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 5 and 6 and the method described and illustrated in Chapter 7.

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 6 and 7, 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 building heating by the Calculated Heat Loss Method, the general formula 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 (generally $H = H_t + H_i$ but may on occasion equal $H_t + \frac{H_i}{2}$).

t = average inside temperature maintained over estimate period, degrees Fahrenheit.

t_a = average outside temperature through estimate period, degrees Fahrenheit (Table 2, Chapter 7).

t_d = inside design temperature, degrees Fahrenheit (usually 70 F).

t_o = outside design temperature, degrees Fahrenheit (see Outside Temperatures, Chapter 7).

N = number of heating hours in estimate period (for an Oct. 1—May 1 heating season, 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.*

Example 1. A residence in Philadelphia 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 −5 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 at 1000 Btu per pound, and since it is purchased steam, the efficiency can be assumed as 100 per cent. From Table 2, Chapter 7, t_a = 42.7 F. The average inside temperature is:

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

Substituting in Equation 1:

$$F = \frac{120{,}000\,(65 - 42.7)\,5088}{1.00\,[70 - (-5)]\,1000} = 181{,}239 \text{ lb.}$$

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: $F = \frac{120{,}000\,(65 - 42.7)\,5088}{0.55\,[70 - (-5)]\,11{,}000} = 30{,}013$ lb = 15 ton, which, at $8 per ton, costs $120.

Example 3. What will be the estimated fuel cost per year of heating a building with gas, assuming that the calculated hourly heat loss is 92,000 Btu based on 0 F, which includes 26,000 Btu for infiltration? The design temperatures are 0 F and 72 F. The normal heating season is 210 days, and the average outside temperature during the heating season is 36.4 F. The seasonal efficiency will be 75 per cent. The heating plant will be thermostatically controlled, and a temperature of 55 F will be maintained from 11 P.M. to 7 A.M. Assume that the price of gas is 7 cents per 100,000 Btu of fuel consumption, and disregard the loss of heat through open windows and doors.

Solution. The average hourly temperature is:

$$t_a = \frac{(72 \times 16) + (55 \times 8)}{24} = 66.3 \text{ F.}$$