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

Equation 1 can be expressed as:

$$F = \frac{H}{EC} \times \frac{(t - t_a)\,N}{(t_d - t_o)} \qquad (2)$$

where the expression $\frac{H}{EC}$ is the rate at which fuel is burned during the design hour. Values of this rate are plotted as ordinates in Figs. 1, 2 and 3 for coal, oil and gas. For a given efficiency, the rate of fuel burning is directly proportional to the load and therefore these charts can be extended by moving the decimal points the same number of digits in both vertical and horizontal scales. Use of these charts thus expedites the estimate.

TABLE 1. HEAT CARRYING CAPACITY OF GRAVITY WARM AIR FURANCE ROUND LEADER PIPES

180 F Register Temperature

LEADER PIPE	BTU PER HR AT DESIGN CONDITIONS PER SQ IN. OF LEADER PIPE
First floor	111
Second floor	167
Third floor	200

The charts are plotted so that the load is expressed in three terms: (a) hourly heat loss at design conditions, (b) square feet of steam radiator surface (240 Btu per hour), and (c) square feet of hot water radiator surface (150 Btu per hour). By entering the chart at the correct point on the abcissa corresponding to the calculated heat loss (H), following vertically to the seasonal efficiency assumed and thence horizontally to the

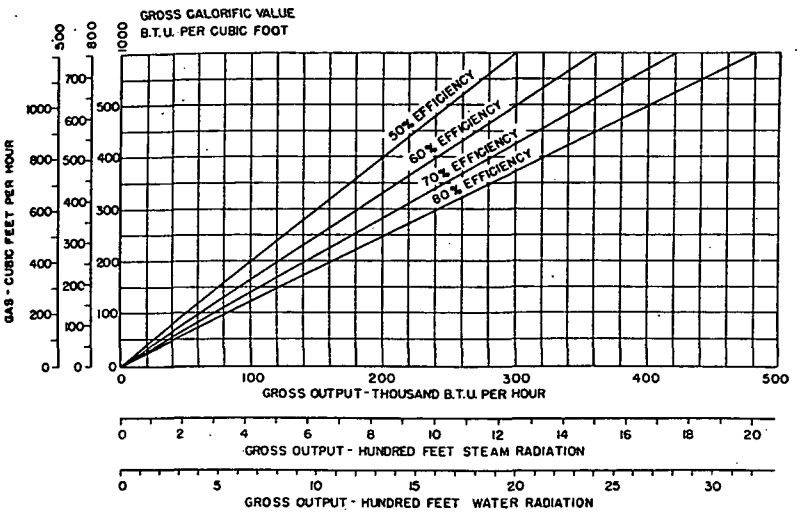

FIG. 3. GAS FUEL BURNING RATE CHART

fuel rate, the rate of fuel burning during a maximum or design hour will be found along the left hand scale for various calorific values of the fuel.

In the case of gravity warm air heating installations, the load is usually expressed in square inches of leader pipe. This can be converted into hourly heat loss by multiplying by the factors in Table 1.

Example 3. A building located in Salt Lake City with an oil-burning heating plant has a calculated hourly heat loss of 260,000 Btu per hour. The plant is designed to maintain a temperature of 70 F inside during all 24 hours of the day, the outside design temperature is −5 F, the average outside temperature 40 F, the heating season 5088 hours long, the assumed efficiency 60 per cent, and the oil has a calorific value of 143,400 Btu per gallon. What will be the seasonal fuel consumption?