Substituting in Equation 1

$$F = \frac{120{,}000\ (68.3 - 36.4)\ 5088}{1.00[70 - (-10)]1000} = 243{,}000 \text{ lb.}$$

Example 2: What would be the fuel cost to heat the building in *Example 1* during an average heating season, using stoker-fired bituminous coal at \$14.00 per ton having a calorific value of 13,000 Btu per lb, assuming that the seasonal efficiency of the system is 65 percent?

Solution: Substituting in Equation 1

$$F = \frac{120{,}000\ (68.3 - 36.4)\ 5088}{0.65[70 - (-10)]13{,}000} = 28{,}800 \text{ lb.}$$

The fuel cost is then (28,800 ÷ 2000) (14) = \$201.00

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 80 percent. The heating plant will be thermostatically controlled, and a temperature of 65 F will be maintained from 11 p.m. to 7 a.m. Assume that the price of gas is 7.5 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

$$t_a = \frac{(72 \times 16) + (65 \times 8)}{24} = 69.7 \text{ F.}$$

The maximum hourly heat loss will be

$$H = 92{,}000 \text{ Btu.}$$

The seasonal heat loss is

$$M = \frac{92{,}000\ (69.7 - 36.4) \times 24 \times 210}{100{,}000 \times 0.80 \times (72 - 0)} = 2697 \text{ hundred thousand Btu.}$$

The estimated seasonal fuel cost will be

$$2697 \times \$0.075 = \$202.00$$

It should be noted that savings from night setback may not result as calculated. Room temperature may not decrease and combustion efficiency may be poor during morning pickup. See Reference 8.

Several time-saving procedures have been devised for quickly estimating the hourly Btu loss 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[9] 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. The formula was developed to apply to detached houses approximately rectangular in shape with total exterior door and window areas equal to about 25 percent of the floor area, and with a floor area not greater than about 1500 sq ft. Equation 2 is for a one-story residence, and Equation 3 is intended for two-story structures.

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

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

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, measured to the inside faces of enclosing walls and is the sum of the following areas: (1) all the area on each principal floor level; (2) the area of all finished habitable attic rooms, including bathrooms, toilet compartments, closets, and halls; (3) all other areas intended to be heated and not located in the basement.
G = glass and infiltration factor for ordinary construction: (0.45 for no weatherstripping or storm windows), (0.40 for weatherstripping), (0.30 for storm windows with or without weatherstripping).
U_w = coefficient of transmission for outside wall.
U_c = coefficient of transmission for ceiling.
U_f = coefficient of transmission for floor.
t_d = inside design temperature, Fahrenheit degrees.
t_o = outside design temperature, Fahrenheit degrees.

Notes for application of Equations 2 and 3.

1. The calculation of heat loss from heated spaces into adjacent spaces such as attics, basementless areas, and heated or unheated garages shall be based on the assumption that the temperature of such adjacent spaces is the same as the outside design temperature.
2. For all floors over basements or other warmed spaces assume $U_f = 0$.
3. For structures having concrete slab floors laid on the ground a modified application of the formula may be made. Assume $U_f = 0$ and calculate the heat loss in accordance with the check formula. Then add the slab loss determined in accordance with the procedure developed by the *National Bureau of Standards* and described in BMS Report 103.
4. No basement area is to be included in the formula calculation. If finished habitable rooms in the basement are to be heated, the additional heat loss should be calculated separately and added to the amount obtained by the formula.

Both the graphical method and short-cut formulas, when used within the limitations established, have been found to give reasonably accurate results for the average residence, but if precise estimates are required, the procedure outlined in Chapter 12 should be used.

In the case of gravity warm air heating installations, the load was formerly expressed in square inches of leader pipe which can be converted into Btu per hour by multiplying the square inches of leader area by 111, 167, and 200 for first, second, and third floors, respectively.

DEGREE-DAY METHOD

This method is based on consumption data which have been taken from buildings in operation, and the results have been computed on a degree-day basis. While this method may not be as theoretically correct as the Calculated Heat Loss Method, it is considered by many to be of more value for practical use.

The amount of heat required in a building depends upon the outdoor temperature, if other variables are eliminated. Theoretically it is proportional to the difference between the outdoor and indoor temperatures. The *American Gas Association*[10] determined from records in the heating of residences that the gas consumption varied directly as the degree-days, or as the difference between 65 F and the mean outside temperature. In other words, on a day when the mean temperature was 20 deg below 65 F, twice as much gas was consumed as on a day when the temperature was 10