Btu per lb coal, and for other heating values of coal they must be multiplied by the ratio of 12,000 divided by the heating value of fuel used.

Example 6: A building in Scranton, Pa. has a calculated heat loss of 240,000 Btu per hr based on an inside design temperature of 70 F and an outside design temperature of −10F. What will be the estimated normal seasonal anthracite or coke consumption for heating if 13,000 Btu per lb fuel is burned in a hand-fired boiler, with automatic control, at a seasonal efficiency of 80 percent, and what part of the total will be used during November, December, and January?

Solution: From Table 6, U is 0.0444 of coal or coke per 1000 Btu per hr heat loss per degree-day. Correcting for the outside design temperature of −10 F from Table 3, the value of U is $0.875 \times 0.0444 = 0.0389$. From Table 2, D is 6218 and from the problem, N is 240.

Substituting in Equation 4,

$$F = 0.0389 \times 240 \times 6047 = 56{,}500 \text{ lb.}$$

Fuel used over any period is, according to the theory of the degree-day, proportional to the number of degree-days during the period. From Table 2, the average numbers of degree-days for November, December, and January in Scranton are 693, 1057 and 1141 respectively, a total of 2953. The yearly total is 27,000, so that during these three months the estimated consumption is

$$\frac{2891}{6047} \times 56{,}500 = 27{,}000 \text{ lb.}$$

Estimating Steam Consumption

In estimating steam consumption the efficiency is generally assumed at 100 percent. If for low-pressure steam an average heating value of 1000 Btu per pound of steam is used, no correction is necessary. In comparing values from different cities, correction should be made for design temperature (see Table 3) when the unit figures are in terms of heat loss but not when the values are in terms of building volume or floor space.

Where the heat loss is calculated in Btu per (hour) (*degree difference in temperature*) the simple Equation 5 may be used:

$$F = \frac{H \times 24 \times D}{1000} \qquad (5)$$

where

F = pounds of steam required for estimate period.
H = calculated heat loss, Btu per (hour) (degree difference).
24 = hours in one day.
D = number of degree-days for the period of estimation.
1000 = Btu delivered per pound of steam condensed.

In this method the number of degree-days automatically takes care of average inside and outside temperature difference. When degree-days are taken from Table 2, an average inside temperature of approximately 70 F is assumed throughout the period. If an average inside temperature other than approximately 70 F is to be used, the number of degree-days should be obtained for the new base.

Example 7: An eight-story building in Pittsburgh is operated with a daytime temperature of 70 F. The calculated heat loss is 10,500 Btu per (hr) (*degree temperature difference*). What is the estimated average yearly steam consumption for building heating?

Solution: Since the average inside temperature is approximately 70 F, the degree-days from Table 2, based on 70 F may be used. Therefore, from Table 2, Pittsburgh has 5048 degree-days per normal season. Inserting in Equation 5:

$$F = \frac{10{,}500 \times 24 \times 5048}{1000} = 1{,}272{,}000 \text{ lb of steam.}$$

Consideration has been given to the difference in steam utilization of different types of buildings, and Table 7 shows actual average units for these various types. These figures were obtained from operating results in 896 buildings located in all sections of the United States. Being averages, and for small groups in each type, the figures may need considerable modification to allow for local variations. It should be especially noted that the steam used for heating water for service is not included in the values given in Table 7.

TABLE 7. STEAM CONSUMPTION OF BUILDINGS WITH VARIOUS TYPES OF OCCUPANCY[a]

TYPE OF BUILDING	NO. BLDGS	AVERAGE VOLUME HEATED SPACE 1000 CU FT	STEAM FOR HEATING: LB PER DD PER 1000 CU FT	AVERAGE HOURS OF OCCUPANCY
Office	334	2160	0.685	12.1
Office and Bank	49	3000	0.577	13.1
Office and Printing	8	1895	1.230	17.7
Office and Theater	7	4950	0.412	12.9
Office and Stores or Shops	26	1615	0.617	13.2
Bank	16	806	0.786	11.7
Department Store	63	3400	0.385	11.1
Stores	73	310	0.624	10.4
Loft	63	865	0.588	10.0
Warehouse	24	2230	0.459	9.4
Hotel and Club	73	1795	0.990	22.3
Apartment or Residence	51	1425	0.962	21.8
Theater	22	1240	0.482	12.9
Garage	13	1540	0.202	21.4
Manufacturing	19	1350	0.808	9.5
Church	9	656	0.532	7.9
Hospital	4	3308	1.194	22.0
School	8	1115	0.592	11.5
Municipal or Federal	15	3215	0.587	15.6
Lodge, Gym, Hall or Auditorium	12	880	0.390	12.4
Miscellaneous	7	1387	0.479	21.4

[a] Principles of Economical Heating, *National Association of Building Owners and Managers*

Example 8: A store in Philadelphia with a heating system designed to maintain 70 F inside in 0 F weather has 250,000 cu ft of heated space. What would be the estimated average yearly steam consumption of purchased steam for heating?

Solution: According to Table 7, a store would use 0.624 lb of steam per degree-day per 1000 cu ft heated space. From Table 2, Philadelphia has 4523 degree-days per normal year. Inserting in Equation 4:

$$F = 0.624 \times 250 \times 4523 = 706{,}000 \text{ lb of steam.}$$

Degree-Day as an Operating Unit

The degree-day is also widely used as a means of comparing the efficiency of the fuel consumption of one period with another *for the same building.* Since the fuel consumption is proportional to the weather (degree-days), and since the periods to be compared may not have the same weather conditions, the comparison can be made only after the fuel consumptions have been computed on a comparable weather basis, that is, upon the actual number of degree-days occurring for a given month and year in the city under consideration Since fuel consumption is proportional to the number