pound 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 7. A building in Marquette, Mich., has an hourly heat loss at design conditions of 240,000 Btu per hour. Based on an inside design temperature of 70 F and an outside design temperature of −20 F, what will be the estimated normal seasonal coal consumption for heating if 12,000 Btu per pound fuel is burned at a 50 per cent seasonal efficiency, and what part of the total will be used during November, December, and January?

Solution. From Table 4, U is 0.0666 lb of coal per 1000 Btu per hour heat loss. Correcting for the outside design temperature of −20 F from Table 5, the value of U is $0.778 \times 0.0666 = 0.0518$. From Table 1, D is 8745 and from the problem, N is 240.

Substituting in Equation 4:

$$F = 0.0518 \times 240 \times 8745 = 108{,}718 \text{ lb.}$$

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 1, the average numbers of degree-days for November, December, and January in Marquette are 926, 1306, and 1465, a total of 3697. The yearly total is 8745, so that during these three months the estimated consumption is:

$$\frac{3697}{8745} \times 108{,}718 = 45{,}961 \text{ lb.}$$

Estimating Steam Consumption

In estimating steam consumption the efficiency is generally assumed at 100 per cent. 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 5) when the unit figures are in terms of square feet of radiation 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:

$$F = \frac{H \times 24 \times D}{1000} \tag{5}$$

where

F = pounds of steam required for estimate period.
H = calculated heat loss, Btu per (hour) (degree difference).
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 1, an average inside temperature of approximately 65 F is assumed throughout the period. If an average inside temperature other than approximately 65 F is to be used, the number of degree-days should be obtained for the new base.

Example 8. An eight story building in Pittsburgh maintains daytime temperatures of 70 F but allows night temperature to drop to not lower than 60 F. Its calculated heat loss is 10,500 Btu per (hour) (*degree temperature difference*). What is the estimated average yearly steam consumption for building heating?

Solution. Since the average inside temperature is approximately 65 F, the degree-days from Table 1, based on 65 F may be used. Therefore, from Table 1, Pittsburgh has 5430 degree-days per normal season. Inserting in Equation 5

$$F = \frac{10{,}500 \times 24 \times 5430}{1{,}000} = 136{,}836 \text{ lb of steam.}$$

Consideration has been given to the difference in steam utilization of different types of buildings and Table 6 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 hot water is not included in the values given in Table 6.

Example 9. 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?

TABLE 6. 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	AVERAGE HOURS OF OCCUPANCY
			Lb per DD per 1000 Cu Ft	
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	3306	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.*

Solution. According to Table 6, a store would use 0.624 lb of steam per degree-day per 1000 cu ft heated space. From Table 1, Philadelphia has 4739 degree-days per normal year. Inserting in Equation 4:

$$F = 0.624 \times 250 \times 4739 = 739{,}284 \text{ lb of steam.}$$

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 of degree-days, plant operators frequently compute each month the fuel burned per degree-day by the heating