Table 5 .... Degree Days for Industrial Heating in Various Cities of the United States.[a]

Annual Totals for a Normal Heating Season

State	City	Degree Days 45F Base	Degree Days 55F Base	State	City	Degree Days 45F Base	Degree Days 55F Base	State	City	Degree Days 45F Base	Degree Days 55F Base
Ala....	Birmingham	6	853	Md....	Baltimore	986	2491		Dayton	1487	3147
	Mobile	....	245						Sandusky	1949	3425
	Montgomery	....	504	Mass..	Boston	1787	3603		Toledo	1990	3757
					Nantucket	1514	3419				
Aris...	Phoenix	....	229					Okla...	Oklahoma City	600	1835
	Yuma	....	37	Mich..	Alpena	3131	5499				
					Detroit	2240	4089	Ore....	Baker	2321	4307
Ark....	Fort Smith	329	1478		Escanaba	3699	5918		Portland	373	1911
	Little Rock	276	1188		Grand Haven	2405	3435		Roseburg	272	1868
					Grand Rapids	2332	4177				
Cal....	Eureka	....	1328		Houghton	4029	6112	Pa.....	Erie	2337	3837
	Fresno	3	718		Lansing	2537	4444		Harrisburg	1565	3236
	Independence	519	1930		Marquette	3713	5842		Philadelphia	1122	2695
	Los Angeles	....	17		Port Huron	2630	4275		Scranton	1938	3755
	Red Bluff	24	822		Saginaw	2312	4552		Pittsburgh	1377	3028
	Sacramento	3	803		Sault Ste. Marie	4049	6575				
	San Diego	....	26					R. I...	Block Island	871	3388
	San Francisco	....	384	Minn..	Duluth	4419	6774				
	San Luis Obispo	....	230		Minneapolis	3309	5417	S. C...	Charleston	....	336
					Moorhead	4796	6572		*Columbia*	....	759
Col....	Denver	1548	3440		St. Paul	2497	5497		Greenville	297	1502
	Grand Junction	1757	3433								
	Pueblo	1499	3261	Miss...	Vicksburg	....	468	S.D....	Huron	3743	5678
									Pierre	3162	5234
Conn..	Meriden	....	734	Mo....	Columbia	1252	2939		Rapid City	2590	4628
	New Haven	1769	3237		Hannibal	1635	3231		Yankton	2898	6045
					Kansas City	1463	2980				
D.C. ..	Washington	1041	2487		St. Louis	1186	2745	Tenn..	Chattanooga	242	1398
					Springfield	982	2423		Knoxville	431	1741
Fla....	Pensacola	....	127						Memphis	166	1284
									Nashville	419	1678
Ga.....	Atlanta	109	1165	Mont..	Havre	3736	5874				
	Augusta	....	661		Helena	2843	5071	Tex....	Abilene	....	915
	Macon	....	711		Kalispell	2874	5131		Amarillo	786	2220
	Savannah	....	231						El Paso	32	919
				Neb..	Lincoln	3023	3850		Fort Worth	....	754
Idaho..	Boise	1045	2814		North Platte	2291	4152		Galveston	....	43
	Lewiston	1034	2688		Omaha	2284	3982		Houston	....	110
	Pocatello	2161	4140		Valentine	2833	4801		Palestine	....	484
									San Antonio	....	305
Ill.....	Cairo	749	2119	Nev...	Winnemucca	1670	3468				
	Chicago	1969	3743					Utah..	Modena	1978	3981
	Springfield	1677	3289	N. H..	Concord	2646	4640		Salt Lake City	1475	3202
Ind....	Evansville	799	2335	N. J...	Atlantic City	1123	2904	Vt....	Burlington	3014	4984
	Indianapolis	1397	2829						Northfield	3652	7121
				N. M..	Santa Fe	1634	3106				
Ia.....	Charles City	3370	5293					Va....	Lynchburg	554	1928
	Davenport	2296	4142	N. Y...	Albany	2018	4302		*Norfolk*	260	1496
	Des Moines	2440	4180		Binghamton	2073	4296		Richmond	549	1895
	Dubuque	1628	4468		Buffalo	2359	4316				
	Keokuk	1926	3579		Ithaca	2412	4023	Wash..	North Head	184	2062
	Sioux City	2894	4732		New York	1098	3089		Seattle	408	2185
					Oswego	2274	4363		Spokane	1741	3672
Kan...	Concordia	1652	2690		Rochester	2341	4231		Tacoma	507	2365
	Dodge City	1385	2962						Walla Walla	993	2565
	Topeka	1518	1811	N. C...	Charlotte	172	1388				
	Wichita	1152	2587		Hatteras	....	718	W. Va.	Elkins	1506	3327
					Raleigh	229	1080		Parkersburg	1147	2784
Ky....	Lexington	....	2557		Wilmington	....	729				
	Louisville	1073	2294					Wis....	Green Bay	3318	5331
				N.D...	Bismarck	3831	6468		La Crosse	3034	3992
La.....	New Orleans	....	30		Williston	4616	6399		Madison	3067	4850
	Shreveport	....	565						Milwaukee	2657	4617
				Ohio..	Cincinnati	1376	3003				
Me....	Eastport	2956	5236		Cleveland	1525	3795	Wyo..	Cheyenne	2500	4700
	Portland	2530	4572		Columbus	1600	3255		Lander	3208	5450

[a] From *Degree-Day Handbook*, by C. Strock and C. H. B. Hotchkiss (The Industrial Press, 1937, pp. 123-134). Values are not coordinated with Table 2 which is from a later source.

ture of 0 F is found to be 0.00490 therms per (degree day) (1000 Btuh design heat loss). From Table 3, the correction factor is 0.875 for −10 F outdoor design temperature. Hence, 0.875 × 0.0049 = 0.00429.

By Equation 4,

$$F = 0.00429 \times 60 \times 6310 = 1624 \text{ therms}$$
$$= 1624 \times 100{,}000/800 = 203{,}000 \text{ cu ft.}$$

Estimating Oil Consumption

Table 4 gives unit fuel consumption factors for oil, similar to those given for gas.

The factors in Table 4 apply only to an indoor design temperature of 70 F and an outdoor design temperature of 0 F. For other outdoor design temperatures, the constants in Table 4 must be multiplied by the values in Table 3 as explained under Estimating Gas Consumption.

Values given in Table 4 are based on use of oil with a heating value of 141,000 Btu per gallon. For other heating values, multiply the values in Table 5 by the ratio of 141,000 divided by the heating value per gallon of fuel being used.

Example 5: Estimate the seasonal oil consumption of a boiler, designed for oil firing, in a building located in Toledo, Ohio. The building has a calculated heat loss of 240,000 Btu per hr. The oil heat value is 144,000 Btu per gal, and the assumed seasonal efficiency is 70 percent. The outdoor design temperature for Toledo is −10 F, and the indoor design temperature is 70 F.

Solution: From Table 4, under 70 percent efficiency and in the bottom line, the value of U is found to be 0.00347 gal per 1000 Btu hourly heat loss for 0 F outdoor temperature. The correction factor for −10 F outdoor design temperature from Table 3 is 0.875 which makes the correction 0.875 × 0.00347 = 0.00304. Making a further correction for the heating value, 0.00304 × (141,000/144,000) = 0.00298 gal per 1000 Btu per hr calculated heat loss per degree day.

From Table 2, the total normal degree days for Toledo are 6394. Since U is expressed in 1000 Btu, N is equal to 240. Substituting in Equation 4

$$F = 0.00298 \times 6394 \times 240 = 4570 \text{ gal.}$$

Estimating Coal or Coke Consumption

Coal or coke consumption estimates are made by following exactly the same procedure as for oil. Values of U are given in Table 4 which only apply to an indoor design temperature of 70 F and an outdoor design temperature of 0 F. A correction must be made for other conditions by use of the multiplying factors in Table 3. Data in Table 4 are based on 12,000 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 indoor design temperature of 70 F and an outdoor design temperature of −10 F. 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 4, U is 0.0408 of coal or coke per 1000 Btu per hr heat loss per degree day. Correcting for the outdoor design temperature of −10 F from Table 3, the value of U is 0.875 × 0.0408 = 0.0357. From Table 2, D is 6047 and from the problem, N is 240.

Substituting in Equation 4

$$F = 0.0357 \times 240 \times 6047 = 51{,}800 \text{ lb.}$$

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 2891. The yearly total is 6047, so that during these three months the estimated consumption is

$$\frac{2891}{6047} \times 51{,}800 = 24{,}800 \text{ lb.}$$

Estimating Electrical Energy Consumption

With increased numbers of electric heating installations, operating cost estimates and experience records are accumulating. Experience indicates Formula 6 cannot be used to estimate seasonal power consumption for heating.

Even using a utilization efficiency of 100 percent all data available indicate that the use of Equation 6 will yield kilowatt-hour consumptions above those observed for houses that are built and insulated in accordance with NEMA requirements. This does not mean that the efficiency must be greater than 100 percent but rather it probably points out the fact that calculated heat losses for these residences are higher than actual heat losses. One reason for this probably lies in the infiltration factor which is generally assumed to be the same for given type of window construction regardless of how well the house is insulated. Since much of the infiltration occurs through cracks which are not around windows and doors and which may be affected by the amount of insulation and the tightness of any vapor barrier used, it is quite probable that the infiltration rating in houses *insulated in accordance with NEMA recommendations* is considerably less than that assumed in the heat loss calculations. The high indoor humidity usually observed in these houses is further indication that this is true.

Until better procedures for calculating losses of these buildings are available, the following formula taken from the *NEMA Manual for Electric House Heating* appears to be the best available for estimating the annual energy use of residential electric heating systems:

$$\text{kwh} = \frac{(\text{HL}) \times (\text{DD}) \times \text{C}}{(\text{TD})}$$

where

kwh = Annual kilowatt-hour consumption
C = constant
HL = Heat loss of building in kilowatts (Btuh divided by 3415)
DD = Annual degree days
TD = difference between indoor and outdoor design temperature, Fahrenheit.

The constant C depends on a number of variables such as weather conditions in the locality, orientation, design and construction of the building, living habits of the occupants, design of heating system, and internal sources of heat. To be applicable, the method of calculating the heat loss must be in accordance with the procedure specified in the *NEMA Manual*. The *NEMA Manual* reports that based upon experience with many thousand electric heating installations, the value recommended for C is 18.5 unless local experience of a statistical nature has established a more reliable value for the particular area concerned. REA *Bulletin* 142-1, *Electric House Heating* suggests correction factors for degree days to be applied to the NEMA formula when the annual degree days are less than 1800.