

Table 8 . . . Degree Days for Industrial Heating in Various Cities of the United States*
Annual Totals for a Normal Heating Season

State	City	Degree Days		State	City	Degree Days		State	City	Degree Days	
		45F Base	55F Base			45F Base	55F Base			45F Base	55F Base
Ala.	Birmingham	6	853	Md.	Baltimore	986	2491		Dayton	1487	3147
	Mobile		245		Detroit	2240	4089		Sandusky	1949	3425
	Montgomery		504	Mass.	Boston	1787	3603		Toledo	1990	3757
Aris.	Phoenix	229			Nantucket	1514	3419	Okla.	Oklahoma City	600	1835
	Yuma	37		Mich.	Alpena	3131	5499	Ore.	Baker	2321	4307
Ark.	Fort Smith	329	1478		Detroit	2240	4089		Portland	373	1911
	Little Rock	276	1188		Escanaba	3639	5915		Roseburg	272	1868
Cal.	Eureka	1328			Grand Haven	2405	3435	Pa.	Erie	2337	3837
	Fresno	3	715		Grand Rapids	2332	4177		Harrisburg	1565	3236
	Independence	519	1930		Houghton	4029	6112		Philadelphia	1122	2695
	Los Angeles	17			Lansing	2537	4444		Scranton	1938	3755
	Red Bluff	24	822		Marquette	3713	5842		Pittsburgh	1377	3028
	Sacramento	3	803		Port Huron	2630	4275	R. I.	Block Island	871	3388
	San Diego	26			Saginaw	2312	4552	S. C.	Charleston		336
	San Francisco	384		Minn.	Sault Ste. Marie	4049	6575		Columbia		759
	San Luis Obispo	230			Duluth	4419	6774		Greenville	297	1502
Col.	Denver	1548	3440		Minneapolis	3309	5417	S. D.	Huron	3743	5078
	Grand Junction	1757	3433		Moorhead	4796	6572		Pierre	3162	5234
	Pueblo	1499	3261		St. Paul	2497	5497		Rapid City	2590	4628
Conn.	Meriden		734	Miss.	Vicksburg		468		Yankton	2898	5045
	New Haven	1769	3237	Mo.	Columbia	1252	2939	Tenn.	Chattanooga	242	1398
D.C.	Washington	1041	2487		Hannibal	1635	3231		Knoxville	431	1741
Fla.	Pensacola		127		Kansas City	1463	2980		Memphis	166	1284
Ga.	Atlanta	109	1165		St. Louis	1186	2745		Nashville	419	1678
	Augusta		601	Mont.	Springfield	982	2423				
	Macon		711		Havre	3736	5874	Tex.	Arlene		915
	Savannah		231		Helena	2843	5071		Amarillo	786	2220
Idaho.	Boise	1045	2814		Kalispell	2874	5131		El Paso	32	919
	Lewiston	1034	2658	Neb.	Lincoln	3023	3850		Fort Worth		754
	Pocatello	2161	4140		North Platte	2231	4152		Galveston		43
Ill.	Cairo	749	2119		Omaha	2284	3882		Houston		110
	Chicago	1969	3743		Valentine	2833	4801		Palestine		484
	Springfield	1677	3289	Nev.	Winnemucca	1670	3468		San Antonio		305
Ind.	Evansville	799	2335	N. H.	Concord	2646	4640	Utah.	Modena	1978	3981
	Indianapolis	1397	2829	N. J.	Atlantic City	1123	2904		Salt Lake City	1475	3202
Ia.	Charles City	3370	5293	N. M.	Sante Fe	1634	3106	Vt.	Burlington	3014	4984
	Davenport	2236	4142	N. Y.	Albany	2018	4302		Northfield	3652	7121
	Des Moines	2440	4180		Binghamton	2073	4296	Va.	Lynchburg	554	1928
	Dubuque	1628	4468		Buffalo	2359	4316		Norfolk	260	1496
	Keokuk	1926	3579		Ithaca	2412	4023		Richmond	549	1895
	Sioux City	2894	4732		New York	1058	3089	Wash.	North Head	184	2062
Kan.	Concordia	1652	2690		Oswego	2274	4383		Seattle	408	2185
	Dodge City	1385	2962		Rochester	2341	4231		Spokane	1741	3672
	Topeka	1518	1811	N. C.	Charlotte	172	1388		Tacoma	507	2365
	Wichita	1152	2587		Hatteras		718		Tacoma	993	2565
					Raleigh	229	1089	W. Va.	Elkins	1506	3327
					Wilmington		729		Parkersburg	1147	2784
Ky.	Lexington		2557					Wis.	Green Bay	3318	5331
	Louisville	1073	2294						La Crosse	3034	3992
La.	New Orleans		30	N. D.	Bismarck	3831	6468		Madison	3067	4850
	Shreveport		665		Williston	4616	6399		Milwaukee	2657	4617
Me.	Eastport	2956	5236	Ohio.	Cincinnati	1376	3003	Wyo.	Cheyenne	2500	4700
	Portland	2530	4572		Cleveland	1525	3795		Lander	3208	5450
					Columbus	1600	3255				

* From Degree-Day Handbook, by C. Strock and C. H. B. Hotchkiss (The Industrial Press, 1957, pp. 123-134). Values are not coordinated with Table 3 which is from a later source.

Estimating Fuel Consumption for Space Heating

average indoor temperature of approximately 70 F is assumed throughout the period. If an average indoor 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 indoor 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:

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

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.

Additional figures are to be found in a paper presented before the Society.¹²

Example 8: A store in Philadelphia with a heating system designed to maintain 70 F indoors 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:

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

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 approximately 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 plant. The resulting unit value, by eliminating the outdoor temperature variable, indicates whether the operating efficiency of the plant is above or below the previous month or year.

INDUSTRIAL DEGREE DAYS

When estimating the heating requirements of warehouses, factories, and other buildings where the indoor temperature to be maintained differs greatly from the usual indoor temperature range of 68 to 72 F, it is common to use degree days based on temperatures of 55 to 45 F. These are generally referred to as industrial degree days, and are listed in Table 8 for a number of cities using both 55 F and 45 F as the base. In general, the degree days (55 F base) are used

when the temperature of the heated space is to be maintained at approximately 60 F. For an inside temperature of about 50 F, the degree days calculated on a 45 F base should be used.

The industrial degree days are useful for estimating fuel consumption by comparison between localities in which the difference in degree days is not too great, and where the known fuel consumption of one building may be used to determine unit consumption per degree day.

MAXIMUM DEMANDS AND LOAD FACTORS

In one form of district heating rates, a portion of the charge is based upon the maximum demand of the building. The maximum demand may be measured in several different ways. It may be taken as the instantaneous peak or as the rate of use during any specified interval. One method is to take the average of the three highest hours during the winter. These figures are shown for a number of buildings in Detroit in Table 9.¹³

Table 9 . . . Building Load Factors and Demands of Some Detroit Buildings

Building Classification	Load Factor	Lb of Demand per (Hour) (Sq Ft EDR)
Clubs and Lodges	0.318	0.184
Hotels	0.316	0.207
Printing	0.287	0.217
Offices	0.263	0.209
Apartments	0.255	0.225
Retail Stores	0.238	0.182
Auto Sales and Service	0.223	0.248
Banks	0.203	0.158
Churches	0.158	0.152
Department Stores	0.138	0.145
Theaters	0.126	0.151

These maximum demands were measured by an attachment on the condensate meter, and therefore represent the amounts of condensate passed through the meter in the highest hours, rather than the true rate at which steam is supplied. There might be slight differences in these two quantities due to time lag and to storage of condensate in the system, but wherever this has been investigated it has been found to be negligible.

The load factor of a building is the ratio of the average load to the maximum load and is an index of the utilization. Thus, in Table 9, the theaters, operating for short hours, have a load factor of 0.126 as compared with the figure of 0.318 for clubs and lodges.

REFERENCES

¹² W. S. Harris and R. J. Martin: Heat transmitted to the I=B=R research home from the chimney (ASHVE TRANSACTIONS, Vol. 59, 1953, p. 97).

¹³ S. Konzo: The Stoker-fired Warm-air Furnace in the Research Residence (University of Illinois, Engineering Experiment Station Circular 39, 1939, p. 98).

¹⁴ Performance of a Hot Water Heating System in the I=B=R Research Home at the University of Illinois (University of Illinois, Engineering Experiment Station Bulletin No. 349, January 4, 1944).

¹⁵ W. G. Colborne: Performance of intermittently-fired oil furnaces (ASHAE TRANSACTIONS, Vol. 63, 1957, p. 427).