

TABLE 3. SNOWFALL DATA FOR VARIOUS CITIES^a

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CITY	NUMBER OF READINGS WITH MAXIMUM TEMPERATURE IN 6-HOUR PERIOD BELOW FREEZING AT VARIOUS SNOWFALL RATES				TOTAL READINGS TAKEN	ASSUMED DESIGN RATE OF SNOWFALL ^b
	Snowfall Rate in Equivalent Inches of Water per Six Hours.					
	0.00 to 0.24	0.25 to 0.49	0.50 to 0.74	0.75 to 0.99		
Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7
Albany, N. Y.	2052	29	5	1	3720	0.16
Asheville, N. C.	463	5	1	0	3536	0.08
Billings, Mont.	1640	4	0	0	3532	0.08
Bismarck, N. D.	2838	0	0	0	3720	0.08
Boise, Idaho.	1300	3	0	0	3720	0.08
Boston, Mass.	1323	11	4	2	3720	0.16
Buffalo, N. Y.	1871	23	3	1	3720	0.16
Burlington, Vt.	2390	9	0	0	3720	0.08
Caribou, Maine.	1363	19	1	0	1672	0.16
Chicago, Ill.	1498	3	0	1	2976	0.08
Cincinnati, Ohio.	1045	3	0	0	3720	0.08
Cleveland, Ohio.	1569	2	0	0	3720	0.08
Columbus, Ohio.	1351	4	1	0	3720	0.08
Denver, Col.	1207	4	0	0	3720	0.08
Detroit, Mich.	1830	5	2	0	3720	0.08
Evansville, Ind.	916	5	1	1	3720	0.08
Hartford, Conn.	1514	44	9	3	3720	0.25
Kansas City, Mo.	1189	12	2	1	3720	0.16
Madison, Wisc.	2370	5	2	0	3720	0.08
Minneapolis, Minn.	2703	7	0	0	3720	0.08
Oklahoma City, Okla.	613	8	4	0	3720	0.16
Omaha, Neb.	1795	8	1	0	3720	0.16
Philadelphia, Pa.	891	10	2	1	3720	0.16
Pittsburgh, Pa.	1265	6	2	0	3720	0.08
Portland, Maine.	2054	33	4	1	3720	0.16
St. Louis, Mo.	1088	5	0	1	3720	0.08
Salt Lake City, Utah	1482	5	0	0	3720	0.08
Spokane, Wash.	1545	11	1	0	3720	0.16
Washington, D. C.	533	7	2	1	3348	0.16
New York, N. Y. ^c						0.16

^a Data from U. S. Weather Bureau. Based on readings taken 1:30 a.m., 7:30 a.m., 1:30 p.m., and 7:30 p.m. daily from November 15 to February 15 from 1940 to 1949. (Where the total readings are less than 3720 the period of record is less than 10 years). The difference between Col. 6 and the sum of readings in Cols. 2, 3, 4, and 5 is the number of readings with a maximum temperature (in the 6-hr period) above freezing.

^b The design rate is found as follows: Proceed to left (on line for any city) from Column 5 until the column containing the tenth reading is found. Assume that the larger value in the heading of the selected column is an average maximum value, and should be multiplied by 2 to obtain the maximum rate for a 6-hour period. This maximum rate divided by 6 is the design rate per hour. This is equivalent to dividing the larger value in the heading of the selected column by 3.

For example: For Albany, N. Y. Columns 5 and 4 total six readings, and consequently the tenth reading is in Column 3, which has the larger value of 0.49 in the column heading. Dividing 0.49 by 3, the design water equivalent of 0.16 inches per hour is found, as listed in Column 7.

^c New York City record was not used in this tabulation since the records for that station were not comparable with those of the other stations.

that allowances must be made for the physical properties of the circulating fluid. This fluid may be an aqueous solution of ethylene glycol, or it may be a petroleum distillate. In either case, the manufacturer should be contacted for the physical properties. Ethylene glycol solutions should

TABLE 4. HEAT OUTPUT AND FLUID TEMPERATURE FOR SNOW MELTING SYSTEMS

RATE OF SNOWFALL	ϕ		$t_a = 0^\circ\text{F}$			$t_a = 10^\circ\text{F}$			$t_a = 20^\circ\text{F}$			$t_a = 30^\circ\text{F}$		
			Velocity v			Velocity v			Velocity v			Velocity v		
			5	10	15	5	10	15	5	10	15	5	10	15
0.08	1.0	q_o	151	205	260	127	168	209	102	128	154	75	84	94
		t_m	108	135	162	97	117	138	85	97	110	70	75	79
	0.0	q_o	66	66	66	64	64	64	62	62	62	60	60	60
		t_m	66	66	66	65	65	65	64	64	64	63	63	63
0.16	1.0	q_o	218	273	327	193	233	274	165	191	217	135	144	154
		t_m	142	189	198	129	149	170	117	129	142	100	105	109
	0.0	q_o	133	133	133	129	129	129	125	125	125	121	121	121
		t_m	99	99	99	97	97	97	95	95	95	93	93	93
0.25	1.0	q_o	292	347	401	265	305	346	235	261	287	203	212	221
		t_m	179	206	234	165	186	206	151	163	176	134	139	144
	0.0	q_o	208	208	208	202	202	202	195	195	195	188	188	188
		t_m	137	137	137	134	134	134	131	131	131	127	127	127

Note: This table is based on a relative humidity of 80 percent for all air temperatures.

s = Rate of snowfall, inches of water equivalent per hour (See Table 3).

ϕ = Free area ratio.

q_o = Slab output, Btu per (hour) (square foot).

t_a = Air temperature, Fahrenheit.

t_m = Fluid temperature, Fahrenheit. Based on construction as shown in Fig. 16.

v = Wind velocity, miles per hour.

contain a rust inhibitor (probably triethanolamine phosphate), and this will affect the properties slightly.

For large installations, the friction losses should be calculated by the Fanning equation

$$h_f = \frac{fV^2}{2gd} \quad (14)$$

where

h_f = the loss in head of the fluid under conditions of flow, in feet.

l = the length of the pipe, in feet.

V = the velocity, in feet per second.

g = the acceleration due to gravity = 32.174 ft per (second) (second).

d = the internal diameter of the pipe, in feet.

f = a dimensionless friction coefficient.

The factor f can be determined from the Moody chart which is Fig. 4 of Chapter 4, Fluid Flow. In determination of the Reynolds number, the effect of the inhibitor should be taken into account. The manufacturer of the anti-freeze solution must therefore be consulted. For approximate data for ethylene glycol without an inhibitor and for a light oil, see Table 5.

For small installations requiring less than 1 hp pump capacity, it may be satisfactory to compute the pump head required from friction loss tables for hot water heating systems, as given in Chapter 22, and to correct for the effect of the anti-freeze solution.

Generally, hydraulic tables are prepared for water at 60 F and, 10 to 15 year old pipe. Since the circuit will be closed and the pipe will not scale