Table 12 . . . . Instantaneous Rates of Heat Gain Due to Transmitted Direct and Diffuse or Sky Solar Radiation by a Single Sheet of Unshaded Common Window Glass

For Clear Atmospheres and 18 Deg Declination, North (August 1)

Note: For total instantaneous heat gain, add these values to the Table 13 values

Latitude	Sun Time AM → ↓		N	NE	E	SE	S	SW	W	NW	Horiz.
30 Deg north	6 a.m.	6 p.m.	25	98	108	52	*6*	*6*	*6*	*6*	17
	7	5	23	155	190	110	*10*	*10*	*10*	*10*	71
	8	4	16	148	205	136	*14*	*13*	*13*	*13*	137
	9	3	*16*[a]	106	180	136	21	*15*	*15*	*15*	195
	10	2	*17*	54	128	116	34	*17*	*16*	*16*	241
	11	1	*18*	20	59	78	45	*19*	*18*	*18*	267
	12		*18*	*19*	*19*	35	49	35	*19*	*19*	276
40 Deg north	5 a.m.	7 p.m.	3	7	6	2	*0*	*0*	*0*	0	1
	6	6	26	116	131	67	*7*	*6*	*6*	6	25
	7	5	16	149	195	124	*11*	*10*	*10*	10	77
	8	4	*14*	129	205	156	18	*12*	*12*	12	137
	9	3	*15*	79	180	162	42	*14*	*14*	14	188
	10	2	*16*	31	127	148	69	*16*	*16*	16	229
	11	1	*17*	*18*	58	113	90	23	*17*	17	252
	12		*17*	*17*	19	64	98	64	*19*	17	259
50 Deg north	5 a.m.	7 p.m.	20	54	54	20	*3*	*3*	*3*	*3*	6
	6	6	25	128	149	81	*8*	*7*	*7*	*7*	34
	7	5	*12*	139	197	136	*12*	*10*	*10*	*10*	80
	8	4	*13*	107	202	171	32	*12*	*12*	*12*	129
	9	3	*14*	54	176	183	72	*14*	*14*	*14*	173
	10	2	*15*	18	124	174	110	*16*	*15*	*15*	206
	11	1	*16*	*16*	57	143	136	42	*16*	*16*	227
	12		*16*	*16*	*18*	96	144	96	*18*	*16*	234
	↑	PM →	N	NW	W	SW	S	SE	E	NE	Horiz.

[a] Italics indicate shaded glass.

Table 13 . . . . Instantaneous Rates of Heat Gain by Convection and Radiation from a Single Sheet of Unshaded Common Window Glass

For Clear Atmospheres and 18 Deg Declination, North (August 1)

For 30, 40, 50 Deg North Latitude

For 80 F Indoor Temperature

Note: For total instantaneous heat gain, add these values to the Table 12 values

Sun Time	Dry-Bulb F Deg	N	NE	E	SE	S	SW	W	NW	Horiz.
5 a.m.	74	−6	−6	−6	−6	−6	−6	−6	−6	−6
6	74	−5	−4	−4	−5	−5	−6	−6	−6	−5
7	75	−5	−2	−2	−3	−5	−5	−5	−5	−3
8	77	−3	0	1	0	−2	−3	−3	−3	0
9	80	0	2	4	3	1	0	0	0	3
10	83	3	4	6	6	5	3	3	3	8
11	87	8	8	10	11	10	9	8	8	13
12	90	12	12	12	13	14	13	12	12	16
1 p.m.	93	15	15	15	16	17	17	17	15	20
2	94	16	16	16	16	18	19	19	17	21
3	95	17	17	17	17	19	21	21	19	21
4	94	16	16	16	16	17	20	20	19	19
5	93	15	15	15	15	15	18	19	18	17
6	91	13	13	13	13	13	14	15	15	13
7	87	8	8	8	8	8	8	8	8	8
8	85	6	6	6	6	6	6	6	6	6
9	83	3	3	3	3	3	3	3	3	3

Table 14 . . . . Application Factors to Apply to Tables 12, 13 and 15 to Obtain Instantaneous Rates of Heat Gain for Various Types of Single Flat Glass and Combinations of Two Sheets of Flat Glass Spaced at ¼ In.

Glass[a]	Normal Incidence Transmittance	Factor to Apply to Table 12	Factor to Apply to Table 13
Single common window	0.87	1.00	$1.0(X)^{c} + 0.0(Y)^{d}$
Single regular plate	0.77	0.87	$1.0(X) + 0.25(Y)$
Single heat absorbing plate	0.41	0.46[b]	$1.0(X) + 1.00(Y)$
Double common window	0.76	0.85	$0.6(X) + 0.10(Y)$
Double regular plate	0.60	0.66[b]	$0.6(X) + 0.55(Y)$
Heat absorbing plate outdoors / Regular plate indoors	0.35	0.37[b]	$0.6(X) + 0.75(Y)$

[a] Common window glass ⅛ in. thick. Plate glass ¼ in. thick.
[b] For better precision, increase factors 10 percent when glass is in the shade.
[c] X values are Table 13 values.
[d] Y values are Table 15 values.

side surface conductance for convection f_{ci} as given by Equation 3, and an equivalent surface conductance for radiation f_{ri} as given by Equation 4. Inside surfaces *seen* by the glass are assumed to radiate as a black body at room air temperature.

$$f_{ci} = 0.27\ (t_{gi} - t_i)^{0.25} \tag{3}$$

$$f_{ri} = 0.162 \left[\left(\frac{t_{gi} + 460}{100} \right)^4 - \left(\frac{t_i + 460}{100} \right)^4 \right] \Big/ (t_{gi} - t_i) \tag{4}$$

where

t_{gi} = temperature of inside surface of glass, Fahrenheit.
t_i = temperature of indoor air, Fahrenheit.

A more complete treatment of the problem is given in an ASHAE research paper.[23]

Design Tables for Flat Glass

Tables 12 and 13 give design values of instantaneous rates of heat gain for *single unshaded common window glass* for a *solar declination of 18 deg. This corresponds to* a *nominal* August 1 day. The tables are based upon the solar intensity values for a clear atmosphere as given in Table 4. Table 12 values represent the first bracketed term of Equation 2a; therefore, the values are dependent only upon values of I and τ. Table 13 values represent the second term of Equation 2a, and are based upon a 80 F indoor temperature and a dry-bulb temperature cycle, with a 95 F maximum as tabulated. *The total heat gain is the sum* of the Table 12 and Table 13 values. In preparing Table 13, convection and radiation heat *exchange were combined, and a combined surface conductance* of 4.0 used. Corrections to be applied for other design temperatures are given in Table 24 in a later section Effect of Deviation from Design Conditions.

Tables 12 and 13 may be used for other types of glass with good accuracy, by using the factors given in Table 14. Table 12 values are multiplied by the appropriate factor given in Table 14 to obtain heat gain due to transmitted solar radiation. For glasses having a transmittance for normally incident radiation differing from the table values, factors may *be found by linear interpolation. To obtain instantaneous* rates of heat gain by convection and radiation, two steps are required. *First*, Table 13 values are multiplied by the appropriate coefficient of X listed in Table 14. *Second*, Table 15 values are multiplied by the appropriate coefficient of Y listed in Table 14, and added to the first value. All convection and radiation gain values for double glass were computed for a ¼-in. air space. No great error is involved in cooling load estimates if these are used for double glass with other air spaces.

Example 8: Find the total instantaneous heat gain through a single sheet of regular plate glass in a southwest wall at 2 p.m. sun time and 40-deg north latitude on August 1. The maximum dry-bulb temperature for design is 98 F; the atmosphere is clear. The indoor temperature is 80 F.

Solution: From Table 12 the heat gain due to transmitted radiation is 148 Btu per (hr) (sq ft) for common window glass; from Table 14, the factor for regular plate glass is 0.87. The coefficient of X in Table 14 is 1.0, while X is found from Table 13 for common window glass for the same hour, orientation and latitude. The coefficient of Y in Table 14 is 0.25, while the Y value is found from Table 15 for a southwest wall at 2:00 p.m. and 40-deg north latitude. The correction for design dry-bulb temperature is found from Table 24 to be 1.0 Btu per (hr) (sq ft) per degree difference from 95 F design temperature. The total instantaneous heat gain is, from Equation 2a,

$$\begin{aligned} q &= 0.87 \times 148 + 1.0 \times 19 + 0.25 \times 27 + 1.0\ (98 - 95) \\ &= 157.5 \text{ Btu per (hr) (sq ft).} \end{aligned}$$

Design Tables for Rolled Figured Glass

Tables 16 and 17 give design values of instantaneous rates of heat gain for a number of common patterns of single vertical sheets of rolled figured glass. The tables are for a solar declination of 18 deg, which corresponds to a nominal August 1 day, and are based upon the solar intensity values for a clear atmosphere as given in Table 4. The values are given in terms of corrections to apply to Tables 12 and 13. The heat gain due to transmitted solar radiation is found by *multiplying the* Table 12 values *by the approximate percentages* given in Table 17. To obtain instantaneous rates of heat gain by convection and radiation, Table 15 values are multiplied by the appropriate value of Y from Table 16 and then added to the corresponding Table 13 values. The total instantaneous heat gain is the sum of the gain due to transmitted solar radiation and the gain by convection and radiation.

The values given in Tables 16 and 17 are based upon an ASHAE research paper[23] to which the reader is directed for *additional data. The values in Tables 16 and 17 may be used* with fair precision for other patterns of similar transmittance and surface characteristics. For example, the data for hammered glass may be used for glass having shallow, closely spaced ribs or for glass having small, closely spaced circular indentations. Because some patterns have distinct orienta-