TABLE 7. APPROXIMATE SOLAR DECLINATIONS IN DEGREES

DATE	DECLINATION	DATE	DECLINATION	DATE	DECLINATION
April 1	4.5	June 1	22.0	Aug. 1	18.0
April 15	10.0	June 15	23.5	Aug. 15	14.0
May 1	15.0	July 1	23.0	Sept. 1	8.5
May 15	19.0	July 15	21.5	Sept. 15	3.0

of the Sun.[9] Table 7 shows the variation of solar declination during the months ordinarily requiring cooling.

Example 1: Find the solar azimuth ϕ at 6:30 p.m. at 40 deg north latitude on August 1st.

Solution: From Table 6 in the column of γ for a wall facing west ϕ for 6:00 p.m. is 90 + 14 = 104 deg, and at 7:00 p.m. is 90 + 24 = 114 deg. By interpolation, ϕ for 6:30 p.m. is 109 deg west of south (at 5:30 a.m. ϕ would be 109 deg east of south.)

Example 2: Find K for a wall facing 18 deg east of south at 10:00 a.m. on August 1 at 50 deg north latitude.

Solution: The wall azimuth is 18 deg. The solar azimuth is 48 deg east (Table 6). The wall solar azimuth is 48 − 18 or 30 deg. From Table 6, β is 50 deg. Then

$$K = \cos\beta \cos\gamma = \cos 50 \times \cos 30 = 0.643 \times 0.866 = 0.557.$$

Example 3: Find K for the wall in *Example 2* at 3:00 p.m.

Solution: The solar azimuth is 65 deg west. The wall solar azimuth is therefore 65 + 18 = 83 deg. The angle β is 42 deg.

$$K = \cos 42 \times \cos 83 = 0.743 \times 0.122 = 0.091.$$

Example 4: Find the total solar irradiation for the wall for the conditions of *Example 2*.

Solution: Use clear atmosphere solar intensities. At 50 deg altitude, the direct normal radiation is 273 Btu per (hr) (sq ft). Then,

$$I_D = K \times I_{Dn} = 0.557 \times 273 = 152.0 \text{ Btu per (hr) (sq ft).}$$

By linear interpolation, the diffuse irradiation is

$$I_d = 25 + \tfrac{18}{90}(33 - 25) = 26.6 \text{ Btu per (hr) (sq ft).}$$

The total solar irradiation is

$$I_t = 152.0 + 26.6 = 178.6 \text{ Btu per (hr)(sq ft).}$$

PERIODIC HEAT FLOW THROUGH WALLS AND ROOFS

The calculation of heat flow, through a structural section of a building exposed to the weather, requires consideration of the diurnal cycles of solar irradiation and air temperature. These cycles and other factors lead to a periodic variation in the instantaneous rate of heat flow into the weather surface, and a related periodic variation in the rate of heat flow into the air conditioned space. Because of heat capacity and other factors, these heat flow cycles are, in general, out of time phase and unequal in amplitude.

In order to calculate the rate of heat entry into the weather surface of a building, it is necessary to know:

1. The intensity of direct solar radiation striking the surface.
2. The absorptivity (or reflectivity) of the surface for direct solar radiation.
3. The intensity of diffuse or sky solar radiation striking the surface.

TABLE 8. SUMMER DESIGN SOL-AIR TEMPERATURES USED FOR TABLES 9 AND 10

MEAN SUN TIME	SOL-AIR TEMPERATURE t_e FAHRENHEIT DEGREES								
	Any Surface[b]	Horiz.	North	East		South		West	
Ratio[a]: $\frac{\alpha}{f_{co}}$	0	0.225	0	0.225	0.125	0.225	0.125	0.225	0.125
12 Midnight	77	77	77	77	77	77	77	77	77
1 AM	76	76	76	76	76	76	76	76	76
2	76	76	76	76	76	76	76	76	76
3	75	75	75	75	75	75	75	75	75
4	74	74	74	74	74	74	74	74	74
5	74	74	74	75	80	74	74	74	74
6	74	76	74	110	93	74	74	74	74
7	75	91	75	123	100	75	75	75	75
8	77	106	77	126	103	82	78	77	77
9	80	119	80	125	104	93	86	80	80
10	83	129	83	117	100	102	93	83	83
11	87	137	87	108	96	110	99	89	87
12 Noon	90	142	90	92	92	114	104	96	92
1 PM	93	144	93	93	93	115	105	110	102
2	94	140	94	95	94	111	104	124	111
3	95	132	95	95	95	104	100	135	119
4	94	120	94	94	94	99	96	141	120
5	93	107	93	93	93	95	94	139	118
6	91	96	91	91	91	91	91	125	111
7	87	90	87	87	87	88	87	103	94
8	85	85	85	85	85	85	85	85	85
9	83	83	83	83	83	83	83	83	83
10	81	81	81	81	81	81	81	81	81
11	79	79	79	79	79	79	79	79	79
24 Hr Avg t_m	83.1	100.5	83.1	93.0	88.4	89.0	86.2	93.0	88.4

[a] α = surface absorptivity, dimensionless: roof = 0.9; dark walls = 0.9, and light walls = 0.5. f_{co} = unit convective conductance = 4.0 Btu per (hr) (F deg).
[b] values in this column are magnitudes of t_o, the outdoor air temperature.

4. The absorptivity (or reflectivity) of the surface for diffuse or sky solar radiation.
5. The rate at which the surface emits radiation to the sky and other surroundings.
6. The rate at which the surface absorbs the low temperature radiation emitted by the sky and other surroundings by virtue of their temperatures and radiating characteristics.
7. The temperature of the surrounding air.
8. The temperature of the outer building surface.
9. The unit convective conductance for heat transfer between the air and the building surface.

The Sol-Air Temperature

The complex interrelationship of the above factors can be considerably simplified through the use of the sol-air temperature concept. The sol-