TABLE 10. SUMMER DESIGN SOL-AIR TEMPERATURES FOR NEW YORK, N. Y. (NORTH LATITUDE 40°46'; ELEVATION 180 FT)

MEAN SUN TIME	SOL-AIR TEMPERATURE, t_e FAHRENHEIT DEGREES					
	Any Surface[b]	Horizontal	North	East	South	West
Ratio[a]: $\frac{b}{f_o}$	0	0.25	0.25	0.25	0.25	0.25
12 midnight	79	79	79	79	79	79
1 a.m.	78	78	78	78	78	78
2	77	77	77	77	77	77
3	77	77	77	77	77	77
4	76	76	76	76	76	76
5	76	76	76	76	76	76
6	76	81	80	89	77	77
7	80	96	85	106	82	82
8	82	110	85	114	86	85
9	86	127	90	120	97	90
10	88	137	92	114	104	92
11	90	148	94	106	111	94
12 noon	92	155	97	97	115	98
1 p.m.	93	154	98	98	117	108
2	94	152	99	99	112	126
3	94	144	99	99	102	136
4	94	136	99	99	99	145
5	93	121	103	97	97	140
6	90	106	106	93	93	134
7	88	93	102	90	90	115
8	85	85	85	85	85	85
9	83	83	83	83	83	83
10	82	82	82	82	82	82
11	81	81	81	81	81	81
24-hr avg, t_m	84.8	106.4	88.5	92.3	90.7	96.5

[a]b = surface absorptivity, dimensionless.
f_o = unit convective conductance, Btu per (hr) (sq ft) (F deg).
[b]Values in this column are magnitudes of t_o, the outdoor air temperature.

TABLE 11. SUMMER DESIGN SOL-AIR TEMPERATURES FOR LINCOLN, NEBR. (NORTH LATITUDE 40°50'; ELEVATION 1225 FT)

MEAN SUN TIME	SOL-AIR TEMPERATURE, t_e, FAHRENHEIT DEGREES					
	Any Surface[b]	Horizontal	North	East	South	West
Ratio[a]: $\frac{b}{f_o}$	0	0.25	0.25	0.25	0.25	0.25
12 midnight	89	89	89	89	89	89
1 a.m.	88	88	88	88	88	88
2	86	86	86	86	86	86
3	84	84	84	84	84	84
4	84	84	84	84	84	84
5	82	82	82	82	82	82
6	81	87	88	100	82	82
7	82	103	93	125	85	85
8	88	124	94	137	92	92
9	93	143	98	142	104	98
10	96	160	102	138	115	102
11	100	172	106	129	125	106
12 noon	102	178	108	115	130	108
1 p.m.	104	180	110	110	132	119
2	106	178	112	112	131	137
3	107	170	113	113	126	150
4	107	158	112	112	117	158
5	106	142	113	110	110	157
6	105	126	117	108	108	149
7	102	109	113	104	104	128
8	98	99	98	98	98	98
9	94	94	94	94	94	94
10	92	92	92	92	92	92
11	90	90	90	90	90	90
24-hr avg, t_m	94.4	121.6	98.6	105.9	102.1	106.6

[a]b = surface absorptivity, dimensionless.
f_o = unit convective conductance, Btu per (hr) (sq ft) (F deg).
[b]Values in this column are magnitudes of t_o, the outdoor air temperature.

all things considered, a simple interpolation between the four points of the compass should serve for all but the most accurate calculations.

An example of the use of the tables in determining sol-air temperature is given.

Example 2. Find the summer design sol-air temperature in New York, N. Y., for a west wall which has a solar absorptivity of 0.7, at a sun time of 3:00 p. m.

Use $f_o = 4$; then $\frac{b}{f_o}$ for this wall is $\frac{0.7}{4.0}$ or 0.175.

From Table 10: for $\frac{b}{f_o} = 0$, $t_e = 94$ F; for $\frac{b}{f_o} = 0.25$, $t_e = 136$ F; and by linear interpolation for this wall:

$$t_e = 94 + \frac{0.175}{0.25}(136 - 94) = 94 + 29 = 123 \text{ F}.$$

Sol-air temperatures are especially helpful in the calculation of periodic heat transfer, as will be illustrated in the material which follows.

PRINCIPLES OF PERIODIC HEAT FLOW

Calculation principles for periodic heat flow are dealt with briefly in this section; in the section which follows, practical tables will be given to facilitate rapid design estimates.

Time Lag

The fundamental analysis of periodic heat flow is complicated when compared with steady-state calculations on account of the time-variable storage of heat from point to point through a wall or roof. The cyclic variation of outdoor conditions produces a related cyclic variation of temperature and heat flow throughout each structural section exposed to the weather. The cyclic variations undergo a progressive *shift in phase* and *decrease in amplitude* in going through a wall with constant conditions maintained in the indoor space.

By a *shift in phase* is meant that as the cyclic temperature wave passes through the wall, the time of occurrence of the maximum temperature at any point shifts farther and farther behind the time of the outer-surface maximum for successive positions through the wall. The resultant *time lag* between the outer-surface and inner-surface maximum temperatures is important, for it may be the determining factor in fixing the time of the maximum cooling load.

By a *decrease in amplitude* is meant that as the cyclic temperature wave passes through the wall, the difference between the maximum temperature of a cycle and the mean temperature of the cycle, which is the amplitude of the wave by definition, decreases progressively as the wave passes through the wall. The magnitude of the *temperature amplitude* at the inner wall surface is necessary for the determination of the instantaneous rate of heat transfer to the indoor space.

Practical design data for periodic heat flow comprise a means of determining the time lag and amplitude decrement for different wall constructions and any given outdoor cycle of sol-air temperature. Both analytical and experimental studies have been made on this problem[7]. While the analytical solution has been written, it is far too detailed for direct use in rapid practical work; and the extensive numerical work required to establish a basis for simplified calculations has been only